Applications in Remote Sensing and GIS for Coastal Ecosystem Analyses
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Salt marshes are dynamic environments that act as important buffer zones, which allow exchange of nutrients and energy with marine and terrestrial environments. These areas create vital habitats for many bird and fish species, which can be good indicators of the health of the marsh (Zhang). Currently they are at risk due to sea level rise and increasing development along coastal areas. Urbanization and anthropogenic changes in land use adjacent to coastal areas caused a loss in productivity in salt marshes in recent years (Fedra and Feoli). Many of the salt marshes have declined in size due to reclamation for recreation activities and industrialization. Just as the salt marshes are dynamic so is the appropriate management protocol. It is necessary to continue to monitor the pathways of these estuarine habitats to better understand their management needs. One of the most efficient ways to analyze these areas is with remote sensing technology and GIS applications.

Due to the deterioration to estuarine habitats and the difficulty accessing these areas, remote sensing coupled with a GIS is the best way to monitor and analyze salt marsh ecology (Dahdouh-Guebas). Two major themes arise when assessing salt marshes. The first approach is to comprehensively analyze the area over an extended period of time. The techniques of satellite remote sensing, along with GIS applications have been used recently to examine the spatial and temporal patterns of land use and land cover change to understand interactions along the coast (Weng).

Multi-spectral imagery (Landstat Thematic Mapper) is commonly used for extensive research studies with larger areas that quantify changes in land use/cover around the coast. This big picture approach works well on a state or country level and helps to develop long term management plans for estuarine habitats as well as the surrounding terrestrial environments. The satellite images used are generally enhanced using linear contrast stretching and histogram equalization to help rectify the accuracy for quantifying specific areas (Weng).

These studies also work on digital image classification for land cover/use types using various spectral wavelengths with green, red and near infrared being the most effective for determining various classification levels similar to the Anderson classification system. Many classification systems are often recreated using models to help guide decisions, but are ultimately specifically designed for the study area and specific purposes of the research (Chen et al., Chauvaud et al., Silvestri et al., Zharikov et al).

GIS is used to overlay the images from previous years to calculate the changes in spatial distribution of land use/cover. It is even possible to interpret mathematically in a GIS the probability of pixel changes. This suggests that a GIS can predict the movement and flow of future land use/cover data, which can
be very useful in determining a management plan for salt marshes. This has been recorded to be successful in past studies (Chen et al., Weng).

The second main approach is to use aerial photographs with higher resolution rather than orbital satellite images to map salt marshes in finer detail. This method uses much more ground technology for accuracy proofing. Instruments such as Trimble Navigation GPS are used to input extremely accurate coordinate points directly into a GIS for easy manipulation of data. These are also helpful in assessing spatial accuracy on the ground and to differentially correct UTM’s (Universal Transverse Mercator) in the remote sensing image (Zhang et al.).

Many other hand held field spectrometers are used for collecting green biomass on the salt marshes (Silvestri et al., Zhang et al.). Various vegetation indices were incorporated with the field spectrometers to assess species dominance in an area. The spectrometer was used as ground truthing devices to test whether the indices were accurate. It is common to use many indices throughout one study area to define the different plant species. This has been used for studies that have found correlations with specific plant species and slight elevation differences, which can be helpful in determining the fate of the salt marsh as sea level continues to rise (Zhang et al.).

An important part of estuary management is to understand the immediate sub aquatic environments. Because the tidal flow creates such a dynamic setting, it is difficult for aerial photo acquisition. However it is extremely important to have images that can be used to portray a continuous area with consistent views. In this situation a combination of images is necessary in order to georeference to the particular view required for the research. This is an extra step that causes more time but is necessary for the accuracy of the project (Chauvaud et al., Zharikov et al.).

A reoccurring theme throughout the literature was the over classification of areas. When manipulating the color bands to represent what is pertinent to the research, it is easy to get carried away with too much detail. Many authors discussed the need for simpler classification systems even when working on a very detailed project. Color bands were misinterpreted by the GIS and therefore calculated errors in the results. This area of research needs to be tested further and each individual project will have different classification requirements (Chauvaud et al., Silvestri et al., Zharikov et al.).

Remote sensing and GIS applications are very useful in the detection, description, quantifying and monitoring of coastal salt marshes for management purposes (Fedra and Feoli). Although field work is still required for many projects, remote sensing and GIS provides a nonintrusive way to examine these fragile environments over a large area without causing more unnecessary degradation. Through this, appropriate management strategies evolve as well as predicting changes in land use/cover in the future, which will ultimately provide the means for the best conservation practices.
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This paper discusses the beneficial aspects of incorporating remote sensing and GIS technologies with Markov modeling changes, a process that has limited applications in the past. This combination of techniques was successfully used to analyze and predict the land use and land cover changes of the Zhuijiang Delta in China. Using Landstat Thematic Mapper data, images were collected during 1989 through 1997, where they determined land use/land cover change using a change matrix. GIS was used to overlay the data and determine change information within each county or city. With this, the authors were able to validate the use of stochastic modeling (Markov process).


This paper is very similar to the Weng (2002) paper in that they both use similar approaches to interpret land use/land cover changes through integrating thematic mapper (TM) remote sensing data and GIS tools over an extended period of time. This paper however, explains the process in a more clear and concise manner. The study flow chart was easily understood and could stand alone with little explanation. Also discussed, was the different ‘keys’ used in satellite imagery and photo interpretation. Through TM and GIS, the authors created rules to interpret and classify to a certain degree the study area based on the digital information such as hue, texture and color. Another interesting aspect to this paper was learning how they used different data sources from remote sensing satellites and configured them into a single database using GIS. This was necessary due to the length of the study (20 years). The results showed a dramatic decline in the coastal zones of the Pearl River Estuary and showed a need for new management strategies.

A comprehensive study was conducted to correlate vegetation patterns with other environmental factors that typically have influence in salt marshes in California. The environmental factor (salinity, biomass, redox, and nutrients) data where point sampled in the field using a variety of instruments, such as a field spectrometer and a Trimble Navigation Pathfinder Basic Plus GPS for differential correction. Canopy reflectance was also collected in the field due to the changes that occurs based on the various environmental factors. The point samples were then interpolated using the Inverse Distance Weighted function along with a simple kriging function. What was most intriguing about this paper was the thorough analysis if various vegetation indices to correlate the vegetation patterns with the field work data. Using Landstat Thematic Mapper bands 1-4, formulas were calculated based on the energy levels in the canopy reflectance data. This paper is a valuable resource for those using vegetation indices, because it methodically goes through which ones are more effective for different variable and plant species.


The product of this paper was a DEM (Digital Elevation Model) for a salt marsh area in the Venice lagoon in Italy. This was created with the help of a model that uses halophytic plants as indicators for elevation differences in the marsh, which is directly related to the tidal regime of the area. Soil samples and topography were sampled on the ground at random locations uniformly chosen throughout the study site. By using the MIVIS sensor (a hyperspectral infrared and imaging spectrometer), and incorporating unmixing techniques, the authors were able to decipher vegetation cover fractions. Although the edge pixel posed some issues with fractions, the overall procedure was determined to be a useful tool in vegetation mapping. This paper was chosen for its applicability to other areas in the Venice lagoon as well as other parts of the world.


In efforts to understand individual ecosystems and the links to the various biological processes, commercially processed high-resolution true-color aerial images (1.3m pixel size) by MapView as well as raw scanned true-color aerial images (GeoScape 1999-2000) was used in conjunction with GIS applications to map the east coast of Australia. One of the limiting factors that occurred in imagery acquisition of estuary systems is the range of tidal flow. As stated in the
article, not all of the MapView images were taken within two hours of low tide. Therefore, the GeoScape photos were georeferenced to the corresponding MapView images, which resulted in seamless aerial photography for the study area. An extensive classification system of 24 land use/cover types was developed specifically for this area that was found to not be very helpful. In discussing the set backs of the project they noted that the fewer classification categories, the more accurate the final map. What struck me about this paper was while the methods for interpreting the imagery were technically complex (at least for my understanding so far), they were intended to be replicated by conservation agencies to aid them in management decision-making.


In order to differentiate the small communities of the tropical marine system of the West Indies, the remote sensing technology must be at a high resolution. This study started with true-color photos from the Service Hydrographique et Oceanographique de la Marine (SHOM). A reference map was used to rectify any distortions. This article explains in depth the process of separating the color bands and manipulating them in a GIS so that the categories that were pertinent to the project could be accurately interpreted. This is important especially when analyzing water features and sub-aquatic ecosystems. For example only the blue radiations can deeply penetrate water and this is still contingent on wavelength, bathymetry and water turbidity, playing a major factor for coastal areas. Turbidity and upland runoff into coastal areas can alter which wavelength is most effective. Usually in this scenario, the green wavelength would be more accurate in assessing the water depth. The final product was an accurate ma of the Bay of Robert coastal areas that depicted 12 categories of ecosystem types. These categories were referenced through field surveys. This paper was chosen for its originality in discussing the various wavelength capabilities.

References Cited not in Annotated Bibliography:
