The Modeling of Beach Erosion and Shoreline Changes Supported by prior Research Based on Video Image Processing in Duck, North Carolina.

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Abstract- Climate change has affected the North Carolina coastal environments and coastal hazards have already taken place in that area. Significant adverse impacts in the form of frequent storms and higher rates of beach erosion have been registered, thus, making compelling the necessity of a current understanding of the vulnerability of coastal zones. We propose to study this vulnerability in the Duck area, North Carolina (location: Lat 36 10 57" N Long 75 45 05" W) utilizing the work of the Army Corps of Engineers at Duck, North Carolina at the Field Research facility www.FRF.com . Our interest in their work lies on the use of video imagery based techniques (researched, designed, experimented and developed by the Coastal Imaging Lab of Oregon State University) implemented for the capture and understanding of changes of near shore morphology since beaches are continuously changing from geological materials (sands, dead and/or bleached corals…etc) shifted by waves, tides, and currents moving sediments and eroding shorelines; this phenomenon carries very challenging, above all devastating outcomes on coastal communities. We are most interested in the intolerant and dramatic periods of storms and hurricanes (when sediment transport is more energetic [Stockdon and Holman, 2000] and shoreline changes are more rapid) associated with extended cloudcover when satellite fails to produce images of events occurring during those times.

I. INTRODUCTION

The Remote Sensing Team conducted research based on prior research provided by the Field Research Facility. They modeled the data in a Google Earth Applications. They utilized Javascript, wrote a .kml program and opened the .kml program in Google Earth. The following information gives a brief history of video imaging, and satellite remote sensing.

Introduction to video imaging and its History

The maturation of low-cost multispectral CCD video technology in combination with the Global Positioning System (GPS) has progressed to the point where quantifiable and meaningful results are been derived from low-altitude aerial digital video systems. This low-cost technology also provides meaningful and critical data that will be required for regional and site-specific land and emergency management. Historically, video has not had the resolution or repeatability to be used for spatial processing, but newer digital systems have expanded the capabilities. Potential applications include the areas of precision farming, oil-spill clean up, fire remediation, coastal monitoring and corridor mapping. In this article, we explain the use of a low-altitude digital video system to study coastal movement and compare it to satellite remote sensing platforms. Salient information such as color, texture, wave pattern and orientation can be extracted from the images and used in a geographic information system (GIS) for landscape and site-specific analysis. The video system compares quite favorably to optical and digital equipment, which performs similar functions. Complex mathematical manipulation of data cannot be performed with the video image analysis system, but those functions, which can be performed, are accomplished very rapidly and at modest cost.

Satellite and Remote Sensing

In the broadest sense, remote sensing is the small or large-scale acquisition of information about an object or phenomenon, by the use of recording or real-time sensing device(s) that is not in physical or intimate contact with the object (such as by way of aircraft, spacecraft, satellite, buoy, or ship). In practice, remote sensing is the standoff collection through the use of a variety of devices for gathering information on a given object or area. Thus, Earth observation or weather satellite collection platforms, ocean and atmospheric observing weather buoy platforms, monitoring of a pregnancy via ultrasound, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and space probes are all examples of remote sensing.

Remote sensing makes it possible to collect data on life-threatening or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, the effects of climate change on glaciers and Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the cold war made use of stand- off collection of data about dangerous border areas. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects not be disturbed.

Orbital platforms such as satellites collect and transmit data from different parts of the electromagnetic spectrum, ranging from visible to infrared, microwaves and even radio waves, which in conjunction with larger scale aerial or ground-based sensing and analysis, provides researchers with enough information to monitor trends such as El Niño and other natural long and short term phenomena. Other uses include different areas of the earth sciences such as natural resource management, agricultural fields such as land usage and conservation, and national security and overhead and ground-based collection on border areas.

How the Field Research Facility uses Video imaging technique

The Field Research Facility (FRF) Tower is 43 meter (141 ft) tall and was built in 1986. It is used to support radio antennae and video cameras. At the top of the tower is a 2.1-meter square room (7 square ft) equipped with 110 volt power, an intercom to the FRF Building, and coax video cables to the FRF's video lab. This room also has the best view in Duck according to FRF staff

High-resolution video cameras are mounted on the top of the FRF observation Tower. Camera C0 faces NNE, C1 faces E (offshore), C2 faces SSE, C3 faces NE, C4 faces SE, C5 faces N, and C6 faces S. Each image has GCP's (ground control points), which are used to determine the camera's orientation relative to the ground topography. The most noticeable GCP's are three disks from camera C0.

These GCP's allow for photo transformations of image coordinates to ground coordinates. Thus, time sequences of these images can be used to monitor changes in sand bar changes in the shoreline position and potentially other variables. Also, these cameras are used to collect data on horizontal distributions of wave-breaking and shoreline movement. One application of these systems is the imaging of the sandbar location as it affects wave breaking.

Each camera takes a snapshot and a 10-minute time-averaged image (timex.jpg) every hour. Averaging 600 frames taken once per second create Timex. These images are useful at revealing the underlying morphology as waves break over the submerged sandbars. The 10-minute averaging serves to smooth out variations in wave dissipation (white water) due to wave groups. File names contain the date, time, camera, and image type information.

UNDERSTANDING BEACH EROSION

Beach erosion in simplest term can be defined as the removal of beach sand caused by wave action and long shore currents. Beaches erode because the supply of sand to the beach cannot keep up with the loss of sand to the sea.

The causes of beach erosion can be widely categorized as follows:

1) Anthropogenic causes
2) Natural causes

1. Anthropogenic causes

1.1 Construction of artificial structures: Construction of artificial structures such as moles for harbor protection, jetties, and breakwaters to stem the ocean waves from over flooding their banks often results in the trapping of millions of tons of sand sediment which would have been added to the beach from the sea. This causes the rate of sand removal to be greater than the rate of replenishment, leading to beach erosion.

1.2 **Deforestation:** the voluntary removal and harvesting of mangroves, considered as natural coastal habitats and coastal protection, for logging purposes.

1.3 **Dredging:** excavation activity or operation usually carried out at least partly underwater in shallow areas of sea and fresh water with the purpose of gathering bottom sediments and disposing of them at a different location, mostly to keep waterways navigable. Dredging and sand mining projects have potentially contributed to change in sediment movement and deposition, a major factor contributing to beach erosion.

1.4 **Tourism and urban and industrial development pressure:** Beaches, for coastal nations, represent a great source of revenues. They offer a wide variety of lodging initiatives and recreational activities through hotel development involving sand removal.

2. Natural causes

2.1 Sandy nature of the coastline causes beach erosion because sandy soil has a very porous nature of bonding. Sandy soils will involve mainly capillary binding, and will therefore release most of the water at higher potentials, while clayey soils, with adhesive and osmotic binding, will release water at lower (more negative) potentials. This is the reason for the erodible nature of the beach. ("The free encyclopedia")

2.2 Wave and tide characteristics

Most interest in tides is in their erosion power. Experiments show that water moving half a mile an hour will transport medium-size sand grains, and at three miles an hour will carry gravel an inch in diameter. So, they have evidence that the tidal current significantly affects the size, sorting, and distribution of sediment over most of the sea floor.

The major influence on costal area is actually exercised by waves. The most dynamic sediment transport is realized by waves, especially during storms when changes and the fluid motions are more rapid. This dynamic and dramatic near shore zone period is accompanied by extended cloud cover, alongside storm surge, observed in this article.

http://gometaldetecting.com/ocean-tides.html

2.3 Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean sea level 15 feet or more. This increase in water rise causes severe flooding in coastal areas. Once the sea level rises and flooding occurs, the end result is

Fig. 1 Effect of 15 feet surge on the ocean

The slope of the continental shelf also determines the level of surge in a particular area. A shallow slope off the coast (top picture) will allow a greater surge to inundate coastal communities.

http://www.nhc.noaa.gov?HAW2?english?stom_surge.shtml

II. METHODOLOGY

The team in the course of the research traveled to Duck beach, Duck, North Carolina visiting the Field Research Facility of the US Army Corps of Engineer to be acquainted with the operations of the center, how the video imaging tower works, and how to obtain data from the FRF website. From the site, we were able to access the bathymetry files by years from which we pulled out the longitude and latitude of the northernmost profile. The method was to obtain not only the geographic data on the beach before the Hurricane Isabel in 2003, but also the geographic data after the event. Since a strong storm is expected to massively move coastal sediments, we want to try and compare the positional shift in the beach after the Hurricane.

The second aspect of the methodology used was the use of Google earth KML file java script to show these positions on a global map. Writing the java script and saving in word pad as a kml file extension achieved this. This is shown below:

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.2">
  <Document>
    <name>Paths</name>
    <description>Examples of paths. Note that the
tessellate tag is by default
      set to 0. If you want to create tessellated lines,
they must be authored
      (or edited) directly in KML.</description>
    <Style id="yellowLineGreenPoly">
      <LineStyle>
        <color>7f00ffff</color>
        <width>4</width>
```

```
      </LineStyle>
      <PolyStyle>
        <color>7f00ff00</color>
      </PolyStyle>
    </Style>
    <Placemark>
      <name>Absolute Extruded</name>
      <description>Transparent green wall with yellow outlines</description>
      <styleUrl>#yellowLineGreenPoly</styleUrl>
      <LineString>
        <extrude>1</extrude>
        <tessellate>1</tessellate>
        <altitudeMode>absolute</altitudeMode>
        <coordinates> -75.75276839,36.18718441,2357
          -75.75272952,36.18718733,2357
          -75.75272019,36.18718891,2357
          -75.75270589,36.18719217,2357
          -75.75265401,36.18720116,2357
          -75.75262145,36.18720247,2357
          -75.75253050,36.18726310,2357
          -75.75252746,36.18726468,2357
          -75.75251962,36.18726622,2357

          -75.75252434,36.18726630,2357
          -75.75251632,36.18726788,2357
        </coordinates>
      </LineString>
    </Placemark>
  </Document>
</kml>
```

III. RESULTS AND ANALYSIS

Results show that the novel technique is one of the best techniques as compared with the satellite during storm surges and hurricane, and the cost of setting up one is a lot cheaper than lunching a satellite into space. It also presents imagery in the form of human vision i.e. in the horizontal format as against the vertical view any satellite imagery produces. The pictorial representation of the hurricane Isabel showed waves as high as the 25 ft piers along the coast.

Further more, it can be seen that there is a change in the geographic position of the shoreline after the Isabel as compared with the position before the Isabel. This is evident in the geographic data obtained for both the year before the Isabel, 2002 and the year after it, 2004.

IV. CONCLUSION

To conclude, we have observed how coastal video imaging, through the time exposure (Timex) system can help collect, analyze and archive images. This system is very useful to researchers, coastal zone managers naturally interested in erosion control, equipped with relevant numerical wave modeling, policy makers, interested in the comprehensive management and environmental studies. It offers a suite of optical measurements as ways to scientifically monitor coasts in real time, quantify the various coastline features, such as length, width of a coastline ranging from meters to kilometers and wave properties. In addition, it can easily offset the logistical difficulty of maintaining in-situ equipment and instruments especially during periods when bottom changes can bury sensors, therefore invariably alter the expected accurate and reliable data, and even render impossible in-situ data collection.

V. FUTURE RESEARCH

Since most of the coastal third world countries do not have the economic prowess to monitor their coastline changes via the use of satellite remote sensing, it is therefore our recommendation, that the use of video imaging remote sensing which is a lot less cheaper than the launching of a space vehicle, be encouraged in order to observe and monitor such critical temporal changes. We also have taken into account that the tidal change also has an effect on beach erosion. This would be an area of interest for prior research.

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