

Animated Change Detection Maps: Application of Ward Island

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ABSTRACT

A GIS will be utilized to show the best locations for new features on Ward Island without destroying the remaining vegetation of the land. Historical aerial photographs have been obtained and geo-rectified then set to a specific scale for overlay analysis to produce an animated map. This map animation will show the changes that have occurred at Ward Island between the years of 1938 to 2003. The research will also be used to assist Texas A&M University – Corpus Christi in deciding the best location to build facilities for the increasing university growth on the limited 200 acre island.

INTRODUCTION

The concept for this project is to use aerial photography to demonstrate the changes that have occurred at Ward Island in Corpus Christi, Texas. The aerial photographs taken over a 65 year period will show the changes that occurred throughout the years of 1938 to 2003. The changes that have occurred at Ward Island have affected the vegetation of the Island and needs to be protected for the remaining vegetation to survive.

HISTORY

Ward Island is situated in Corpus Christi Bay in the Coastal Bend of Texas. The elevation of Ward Island is approximately 15 feet above sea level. Many geologic processes are affecting the shoreline of Ward Island. Some of the current processes include: the normal daily processes such as tides, wind, waves, etc.; short-duration, seasonal, and high physical energy processes such as hurricanes and tropical storms; and the long-term subsidence or sea

level changes (Hickman 7). All of these geologic features are affecting Ward Island and must be examined for the future of Ward Island.

OWNERSHIP

Ward Island was originally a 258-acre peninsula named for John C. Ward, who obtained the island in 1892. His plans were to develop the island into a resort community until a depression in 1893; however the island became a popular fishing and hunting site. In 1909, W.E. James and Herman Anderson purchased the land and a tourist business remained until the 1940's.

During World War II, the island was acquired by the U.S. Navy for a radar station and training base commissioned in July of 1942. After the island was acquired by the U. S. Navy, the base provided training to the Navy, Marine, Coast Guard, and Royal Canadian Air Force personnel. In 1943, the base was renamed Naval Air Technical Training Center. The training center included 87 main buildings such as, barracks, classrooms, administration building, mess hall, library, and chapel.

In October of 1947, after the base closed, the island became the site of the University of Corpus Christi, which eventually developed into Texas A&M University-Corpus Christi. In the spring of 1948, the college began classes. The institution was affiliated with the Baptist General Convention of Texas. In 1970, Hurricane Celia damaged the campus and the University of Corpus Christi and the Baptist General Convention ended their affiliation to each other. Wanting to continue higher education in Corpus Christi, civil leaders sought local support and the state legislation to convert the University of Corpus Christi to a state-supported institution.

On September 4, 1973 Texas A&I University at Corpus Christi opened the doors with 969 students. The citizens of Corpus Christi approved a bond to purchase the island and the island was subsequently given to the state of Texas as the site for the new state-supported university.

In 1977, the legislature changed the name of the institution to Corpus Christi State University. This name also included Laredo State University. In 1989, the Texas legislature merged Corpus Christi State University and two other universities into the Texas A&M University system. In 1994, the institution became a four-year university. The university is continually growing with the enrollment in 1998 at more than 6,300 and offering 55 undergraduate and graduate degree programs.

DATASETS

For this project, several datasets will be utilized. The main dataset that will be used and most of the analysis will be performed is based on the aerial photographs. These photographs have been obtained from Lanmon Aerial Photography, Inc. The Lanmon's have allowed for the use of the aerial photographs of Ward Island that they have acquired since 1938. The use of the Oso Creek NE 2 Digital Ortho Quarter Quadrangle (DOQQ) will be utilized to rectify the photographs that have been obtained in order to align all the photographs in the north direction. A vegetation index of Ward Island has also been obtained from the Texas General Land Office. This index is useful in showing the changes that have occurred in the vegetation on Ward Island. All of these datasets have been utilized in the completion of this project.

SOFTWARE

Several different types of software will be utilized during the process of this project. The first software is Adobe Photoshop. Adobe Photoshop is an image editing software that makes photographs into professional quality. The software will be used to scan and clean the aerial photographs.

Another type of software that was utilized in this project is ArcGIS. This software is used for many different applications. This software may be used to “display and query maps, create publication-quality hard-copy output, develop custom mapping applications, and perform many other map-based tasks” (Minami Cover). This software along with the extensions included, will also be utilized throughout most of the project.

The Spatial Analyst Extension helps solve a wide variety of spatial problems by providing powerful tools to perform spatial analysis. Spatial Analyst allows the derivation of information from data, identify spatial relationships, find suitable locations, or calculate the cost of travel (McCoy and Johnston 3). These are a few of the applications that Spatial Analyst allows the user to perform. The surfaces will be overlaid to find the land use of a particular part of land.

Another ArcGIS extension that will be utilized is the Geostatistical Analyst extension. This extension allows the user to quantify the quality of their surface models by measuring the statistical errors of predicted surfaces. The Geostatistical Analyst helps to close the gap between geostatistics and GIS using deterministic and geostatistical methods. The extension will be used for the rectification purposes for this particular project.

The final type of software that will be utilized is Sonic Foundry Viscosity 1.5. This software is a 2-dimensional animation software package that fuses the process of image

editing and animation by integrating animation effects and real-time playback. The software will be utilized to display certain aerial photographs from 1938 to the present and show how the land has changed throughout the years.

AERIAL PHOTOGRAPHS

Aerial photographs are a very useful type of information. They can be used in several different types of applications. For this project, they are useful in showing the changes that have occurred on Ward Island throughout the years. A similar project was performed for the Main Unit of Petersburg National Battlefield. For this project, a map was produced in ArcView showing the vegetation classification (Millinor). This is just one of the many uses of aerial photographs for interpretation.

Obtaining the photographs is one of the first steps that need to be taken for this project. The aerial images were flown by Lanmon Aerial Photography, Inc. throughout the years and have allowed the use their library of photographs for this project. Each of the photographs were flown in different years and at different flying heights starting in 1938 and continuing on through the present.

Scanning the photographs is the next step taken. The photographs were scanned at 600 dpi. After the photographs are scanned, Adobe Photoshop will be used to color balance and clean the images from any material that may have gotten on the images from scanning. The images will then be saved in a tiff format and put into ArcGIS for rectifying.

The next step will be rectifying the photographs. Using ArcGIS, the images will be rectified to the Oso Creek NE 2 Digital Ortho Quarter Quadrangle (DOQQ). Similar points will be obtained from the aerial photographs and the DOQQ so that the aerial photograph overlays the DOQQ.

There are several steps that were taken to get the photographs scanned and ready for rectifying. The procedure for scanning starts by searching through the database the Lanmon's keep to find all of the Ward Island photographs. Once the photographs are found, they will be cut apart from the rest of the role of photographs if necessary. Then using a cleaning cloth and film cleaner, the photographs will be cleaned and the glass for the scanner will also be cleaned. Then the use of a blow dryer to make sure that the photograph is dry and to prevent newton rings when the photograph is scanned in. The photograph is then placed on the glass to be scanned. On the computer, open Adobe Photoshop and import the photograph from the scanner. At this point, the dpi is set to 600 and whether the photograph is color or black and white. After the photograph is finished scanning, if there are no newton rings, continue cleaning the image. Repeat this procedure for all 39 photographs.

To clean the photographs, Adobe Photoshop was used to zoom to the actual pixels and pan around the image to try and find any stray pieces of cloth or other pieces of dirt. If any pieces are found, using the stamp tool, hold the alt key and click on a similar color of what needs to be covered and then release the alt key and click in the place that needs to be covered. Once the image is cleaned, the next step is to color balance the image.

Color balancing is very tedious process. To color balance, there are several different tools that may be utilized. One way is to go to the image menu; select adjust and then select auto levels. This method will automatically adjust the color to what the computer thinks the image looks best, however, this method usually is not enough. Another tool that may be utilized is in the image menu, select adjust, and then select curves. This tool will allow the user to draw a box around a corner or any part of the image that needs adjusting, and adjust only what is inside the box.

Rectifying the aerial photographs is the next step after scanning and cleaning the photographs. The procedure for rectifying is to open the DOQQ and the aerial photograph that is being rectified. In ArcGIS, make sure the layer that is in the box is the aerial photograph and not the DOQQ. Click the geo-referencing menu and uncheck auto adjust. Then select the control point button, and pick the common points on both the aerial photograph and the DOQQ. The number of control points is up to the user to decide the amount. With five control points for all of the aerial images, a root mean square error (RMSE) is calculated for the rectification. See Appendix A, Table 1.1 for RMSE for aerial photographs. According to Lo and Yeung, the RMSE is “the discrepancies between the coordinate values of sample points and their corresponding reference coordinate values are used to compute the overall accuracy of the map” (Lo and Yeung 113). The coordinate system was set to NAD 1983, Universal Transverse Mercator (UTM), zone 14N. The scale was then set to 14,000 for all the aerial photographs and exported as a jpeg file.

For rectification, five control points were taken for each image. Table 2.1, Table 2.2, Table 2.3, and Table 2.4 represent the negative numbers for the aerial photographs that correspond to the control points that were used for rectification. These Tables may be compared to the map found in Appendix B for the location of the control points.

ANIMATION

The animation is utilized to show the changes that have occurred at Ward Island from 1938 to 2003. The animation contained selected aerial photographs for selected years based on the amount of change that occurred over the years. The years included in the animation are 1938, 1948, 1958, 1962, 1965, 1971, 1982, 1990, 1994, 1998, and 2003. These years were selected because they showed the most change that occurred. The other years showed

little or no change therefore, those photographs are insignificant for the animation. The animation was compressed using the Compressor Microsoft MPEG-4 Video Coder. The animation was then saved as an audio video interleave file for use in other multimedia programs.

VEGETATION INDEX

The vegetation index of Ward Island obtained from the Texas General Land Office is useful in showing the changes that have occurred in the vegetation on Ward Island. This land use/land cover data is in the Universal Transverse Mercator (UTM) projection, in the 1927 North American Datum, and the Clarke 1866 Spheroid Zone 14. As noted on the Texas General Land Office website, the Natural Resources Inventory, Data Description section, the files consist of imagery classified by James Hinson and Warren Pulich of the TPWD using characteristics from the U.S. Fish and Wildlife National Wetland Inventory system, the National Oceanic and Atmospheric Association (NOAA) Coastal-Change Analysis Program, and the Anderson Land Use/Land Cover system. The imagery that is being viewed in this project was produced by the Energy and Environmental Systems Institute at Rice University. The vegetation index is broken down into several classes and sub-classes to develop a unique classification for each type of vegetation.

CHANGES

Many changes have occurred at Ward Island since 1938. The buildings, vegetation, roads, land use/land cover, and the ownership are all included as changes that have occurred. When comparing the aerial photograph from 1938 to the 2001 aerial photograph, several buildings have been constructed. There are currently fifty-one buildings that have been established. There are six academic buildings, a student union, two recreational facilities, an

office facility, fourteen housing units, and twenty-seven support/service buildings. Along with the change in the buildings, there has also been a change in the vegetation. The roads are another attribute that has changed drastically throughout the years. As can be seen in 1938, there is one road and that is what is currently Ocean Drive. Several of the entrances and roads used to drive for parking have also changed with the increase of the student population and growth of the school. Land use/land cover is another attribute that has changed. In 1938, the land was used as a popular hunting and fishing site, while in 1948 the land was used as a Naval Air Base, and currently the land is being used to promote higher education, thus showing a dramatic change in the use of the land. Finally, the ownership is another change worth mentioning. As stated earlier, Ward Island has been through several transfers of title since 1938 and probably more before 1938.

RECLASSIFICATION

As indicated by the maps showing the reclassification for 1938 and 2001 a dramatic amount of change has occurred in simply the amount of vegetation that remains. According to McCoy and Johnston, reclassification means, “replacing input cell values with new output cell values” (McCoy and Johnston 171). Through the use of the Spatial Analyst extension a reclassification was produced in order to show the changes that have occurred at Ward Island throughout the years. As can be seen on the Reclassification for 1938 Aerial Photograph Map in Appendix A, the island’s classifications were mainly vegetation, mud flats, and water. In comparison to the Reclassification for 2001 Aerial Photograph Map as seen in Appendix B, the island consists of less vegetation and more buildings and roads. As shown in Appendix B Figure 2, Mollie Beattie formerly of the Coastal Habitat Community, shows a picture of Ward Island showing where the tidal flats are located. In the reclassification the

tidal flats were represented as mud flats based the best interpretation by Dr. Hickman. Beattie writes that, “the Blind Oso is an urban tidal flat associated with Oso Bay, a tertiary bay of Corpus Christi Bay. Oso Bay receives about 57 million gallons of treated municipal wastewater each day and over 1.9 billion liters of hypersaline water from the Laguna Madre via the cooling ponds of the Barney Davis Power Plant. Discharges from the power plant affect the hydrology of lower Oso Creek and Oso Bay. Sediments in this flat are primarily clay. Although the hydrology of the entire bay is driven mainly by the discharges from the power and wastewater treatment plants, wind still plays an important role in the flooding and exposure of the Blind Oso” (Beattie 1). When producing the classifications, ArcGIS may not be the best software to use for doing the reclassification for these particular aerial photographs because the reclassification is grouping similar values based on the reflectance instead of the actual features in the photograph.

MAPS PRODUCED

Three different items were produced for this particular project. Maps showing the vegetation classification for the aerial photographs obtained in the years of 1938 and 2001. The rectified aerial photographs for the 39 obtained years will also be produced. An animation file has also been created that shows several of the aerial images from 1938 to the present. This animation will give us an idea of the changes that have occurred at Ward Island over the past 65 years.

ANALYSIS

The utilization of aerial photographs for showing change can be useful in showing the amount of vegetation that has changed, the land use and land cover, the buildings that have been changed, and how the roads have changed throughout the years. Many steps and

procedures are required for this type of application. The project can be used for many different applications currently and in the future. The use of aerial photographs can be helpful in the prediction of the future vegetation classifications, the future size of the island, and finding suitable locations for new buildings in order to preserve the remaining vegetation and any habitats that reside on Ward Island.

CONCLUSION

Through the utilization of aerial photography, many different types of analysis can be performed. The changes that have occurred at Ward Island have been significant over the past 65 years and will continually change. There are currently two buildings in the process of being constructed therefore, more changes are occurring with the vegetation and the land use. This project is just one of the many ways in which aerial photography can be utilized. Through the utilization of aerial photography and software programs that are available for use, this project may be an excellent example of how to detect changes that have occurred in the past and will continue to occur in the future.

APPENDIX A

Negative Number:	B/W or Color:	Date Flown:	RMS Error:
0103-11F	B/W	01-08-03	1.31203
0396-10C	B/W	01-03-96	2.43068
0894-4	B/W	01-05-94	3.07520
0984-62	B/W	02-13-84	2.17345
0991-12C	B/W	02-09-91	2.45853
0994-4	B/W	01-06-94	2.47458
10698-1	Color	06-14-98	2.66782
13790-1	B/W	07-12-90	2.34594
1587-10E	B/W	02-07-87	1.32050
16792-2	B/W	08-24-92	2.98051
17200-12C	B/W	07-16-00	1.60009
184-8-01	B/W	07-20-58	1.74109
1962-A3	B/W	01-28-62	0.78415
1965-C4	B/W	03-09-65	2.13986
21298-1	Color	04-15-98	3.16992
21601-1	Color	10-16-01	1.62819
2180-1	B/W	02-25-80	1.26373
2196-3	Color	01-12-96	2.94257
23394-3	Color	10-11-94	1.37537
2700-1	Color	02-04-00	3.66018
2995-1	Color	02-06-95	1.18696
3094-1	Color	02-13-94	0.85513
3571-1	Color	10-10-71	1.64737
4082-2	B/W	05-02-82	1.23672
4296-1	Color	02-13-96	0.72782
48-0-1746	B/W	12-09-48	1.45746
5000-1	Color	03-11-00	1.89670
5594-C12	B/W	03-10-94	1.82415
6598-C13	B/W	04-10-98	1.18999
6801-1	Color	04-25-01	1.17505
7195-C12	B/W	03-14-95	1.19783
7601-1	Color	05-02-01	1.28662
7897-1	Color	04-23-97	1.72134
9592-2	B/W	04-27-92	2.35392
BRE-2-104	B/W	10-25-38	21.43356
1966-C4	B/W	09-29-66	1.41081
18702-1	Color	10-17-02	2.99447
1702-1	B/W	10-26-02	<u>1.24173</u>

Mean RMS Error: 2.37847421

Table 1.1 – Root Mean Square (RMS) Error Report for Rectified Aerial Photographs

Negative Numbers	Control Points
3571-1	Student Services Center (4)
1966-C4	First Entrance
1965-C4	Road by Conrad Blucher Institute
	Second Entrance Near Guard Shack
	Road by the Apartments

Table 2.1 Control Points

Negative Numbers	Control Points
1962-A3	Center Entrance
184-8-01	First Entrance
	Road by the Police Station
	Second Entrance
	Road by the Apartments

Table 2.2 Control Points

Negative Numbers	Control Points
48-0-1746	Center Entrance
	First Entrance
	Road by Conrad Blucher Institute
	Second Entrance
	Road by the Apartments

Table 2.3 Control Points

Negative Numbers	Control Points
All Other Photographs	Student Services Center (4)
	First Entrance
	Road by Conrad Blucher Institute
	Second Entrance
	Road by the Apartments & Center for Instructoin

Table 2.4 Control Points

APPENDIX B



Key

Buildings and Points of Interest

- | | | | |
|----|------------------------------------|----|--------------------------------|
| 1 | Corpus Christi Hall | 15 | Environmental Studies |
| 2 | University Services Center | 16 | Natural Resources Center |
| 3 | Center for the Arts | 17 | Conrad Blucher Institute |
| 4 | Student Services Center | 18 | Physical Plant |
| 5 | Mary and Jeff Bell Library | 19 | Driftwood and Sandpiper |
| 6 | Faculty Center | 20 | Miramar University Apartments |
| 7 | Glasscock Fitness, Wellness Center | 21 | Recreational Sports Fields |
| 8 | Center for the Sciences | 22 | Islanders Softball Field |
| 9 | Center for Instruction | 23 | Tennis Courts |
| 10 | Science and Technology | 24 | Islanders Baseball Field |
| 11 | University Center | 25 | University Beach |
| 12 | Moody Sustainers Field House | 26 | Baptist Learning Center |
| 13 | Classroom East | 27 | Newman Catholic Student Center |
| 14 | Early Childhood Development Center | | |

Parking Lots

- | | |
|---|--------------------------|
| A | NRC parking |
| B | Starfish Lot |
| C | Seahorse Lot |
| D | Sailboat Lot |
| E | Gated parking |
| F | Jellyfish Lot |
| G | Reserved parking |
| H | Visitor parking |
| I | Reserved parking |
| K | Visitor parking |
| L | Sanddollar Lot |
| M | Tarpon Lot |
| N | Gated parking |
| O | Curlew Lot |
| P | Resident students |
| R | Religion centers parking |

Figure 1 Texas A&M University-Corpus Christi Campus Map



Figure 2 Beattie Image for Classification