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Geographic Information System (GIS) mapping project in Pedro Vicente Maldonado Ecuadorian Scientific Station antarctica base (Greenwich Island) Antarctic Peninsular

By:

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Appendix I – ORAL PRESENTATION

Geographic Information System (GIS) Mapping Project in Pedro Vicente Maldonado Ecuadorian Scientific Station Antarctica Base (Greenwich Island) Antarctic Peninsular

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Abstract

Essentially, the outputs from the GIS project in the expedition were GIS database, spatial maps and 3D terrain model of the Pedro Vicente Maldonado Ecuadorian Scientific Station Antarctica Base area. GIS techniques were used for developing the data base, maps and 3D model. The main source of data was obtained by a Global Positioning System (GPS) survey using a kinematic GPS (GPS-RTK) which allowed continuous point mapping in the terrain. GPS units were utilized in the collection of spatial data for all field works. The coordinates obtained were used to produce a point map which is then exported into GIS software where the proximity of cartographic phenomena and boundaries were mapped. All the collected data were subsequently gathered to develop the GIS database and to compile and generate different maps to test for spatial and temporal relationships. The developed GIS database can be used in conjunction with other ecological datasets to provide biogeographically information, potential range distribution, and sampling adequacy. The database is applicable to geographical management and to multi-disciplinary research projects.

Introduction

Once, detailed spatial mapping is a difficult or even impossible task in areas without topographic information. Even in locations where good topographic maps are available, mapping of small or very irregular landforms can be difficult and not rigorous. Presently Geographic Information Systems (GIS) is a significant contribution for detailed spatial surveying, mapping and development of the spatial database with accuracy at much faster rates than before. Moreover, this is practical with a kinematic GPS (GPS-RTK) that allows mapping points or lines continuously in the terrain with an error of a few centimetres.

Basically, the objectives of GIS project in the expedition were to gather field data and subsequently compile other data obtained by different scientists which will be transferred into a GIS program. The georeferenced data then is used to generate and compile different maps to test for spatial and temporal relationships. The project's tasks include developing a standard spatial data model, obtaining and integrating spatial data sets and providing an interface for the data. This is basic for study of the relationship between geology, geomorphology, glacial retreat and their impacts to the biology, environmental management and for multi-disciplinary research projects.

Description of work done

Detailed mapping was carried out around Pedro Vicente Maldonado Ecuadorian Scientific Station Antarctica Base at 62° 31'S, 59° 47'W. This will provide a coherent geological and topographical picture of the surroundings. The mapping areas that were carried out are as follows:

1. The Fort William headland area
2. The Glacier sites
3. The coastal area
4. The raised beach sites

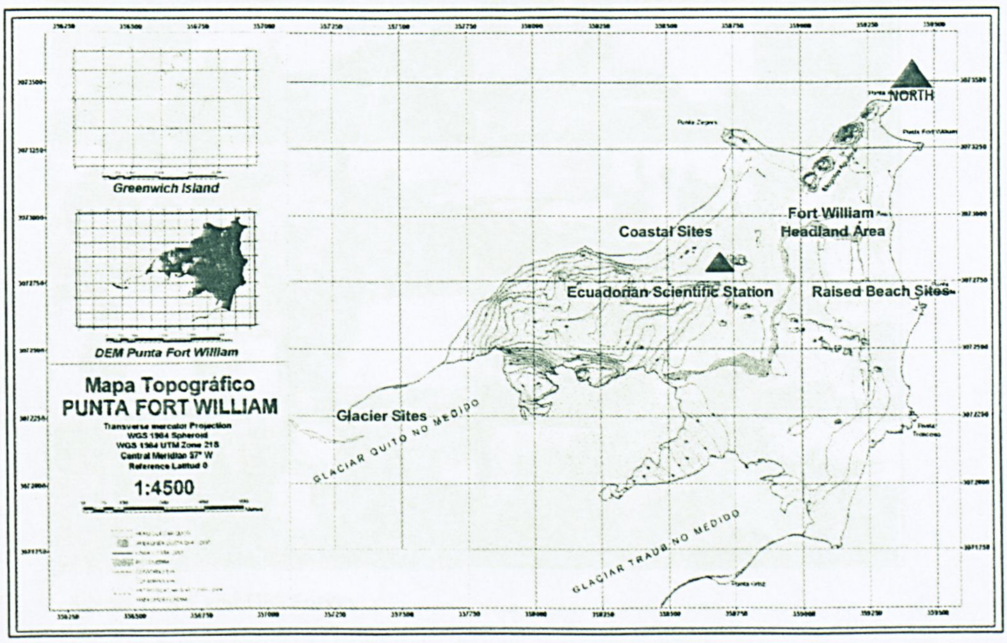

Figure 1: The Mapping areas

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Method & Technique- GIS Procedures

Primarily, GIS techniques were used for mapping and developing the spatial data base in the project. The main source of data was obtained by a Global Positioning System (GPS) survey using a kinematic GPS (GPS-RTK) which allowed continuous point mapping in the terrain. Each point consists of Northing (UTM), Easting (UTM) and altitude readings in WGS 1984 (UTM), Universal Transverse Mercator Projection with UTM Zone 21°S Central Meridian 57° W. GPS units were utilized in the collection of spatial data for all field works. The coordinates obtained were used to produce a point map which is then exported into GIS software where the proximity of cartographic phenomena and boundaries were mapped. Other data gathered from field observations on topography, geology, landforms, flora and fauna were also used for mapping the station and its adjoining areas. All the collected data were subsequently gathered to develop the GIS database and to compile and generate different maps to test for spatial and temporal relationships. The GIS and GPS survey as shown below in Figure 2.

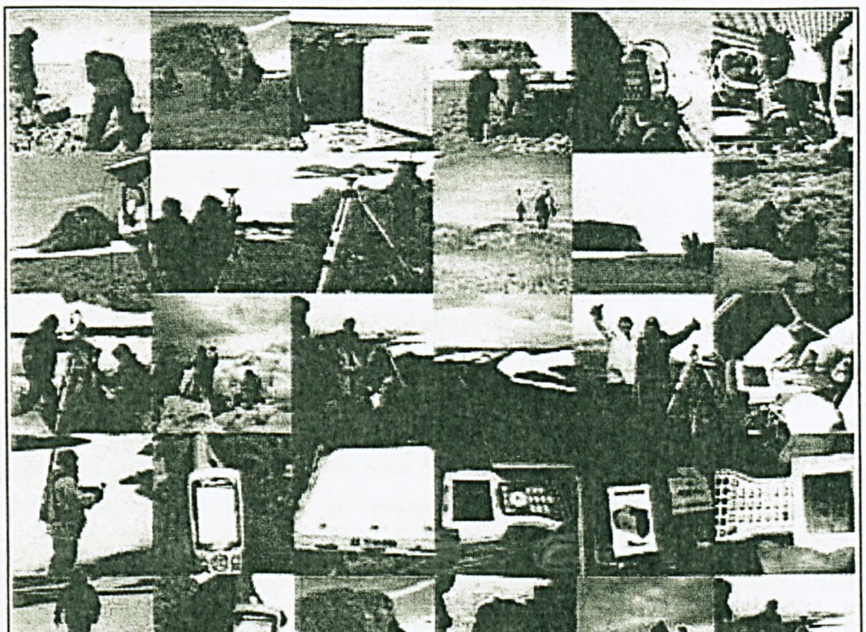

Figure 2: GIS and GPS Survey

For the detailed GIS and GPS survey, the system was programmed to record coordinates continuously at 1 m intervals as the operator was moving. The chosen paths were saved in memory as sets of individual points representing latitude, longitude and altitude. The data collected in the field survey was exported into an ASCII table, with the identification of the measurement point number, latitude (UTM), longitude (UTM) and

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altitude. This table was then imported into the Geographic Information System Arc GIS 9.2. The coordinates were then used to produce a point map that was exported in to a drawing package as shown in Figure 3. The proximity between the points is large enough for drawing the lines that form the cartographic phenomena. The final spatial map was constructed within the drawing package and includes both the information collected with the GPS-RTK system and the classical field survey.

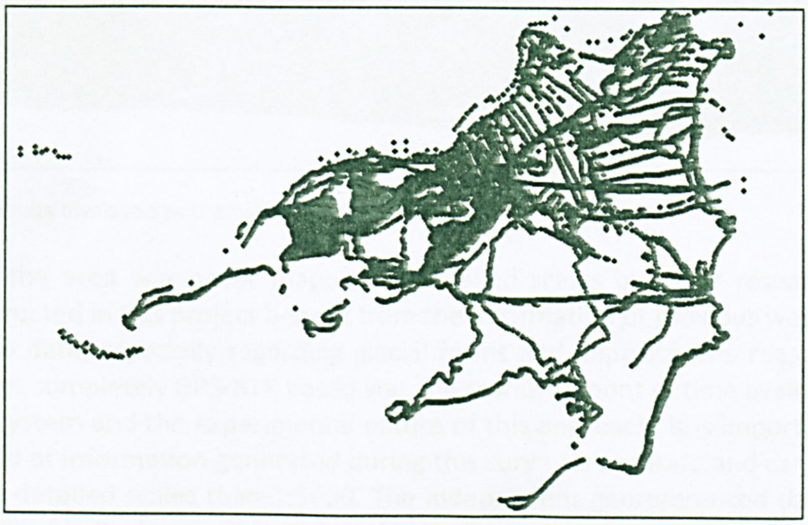

Figure 3: Points from GPS Survey

In this project, digital maps of Greenwich Island with a scale of 1:50,000 were used as the base map for the thematic layers and listings of each processed data in the field area. Spatial and non-spatial data were analyzed through various functions of GIS techniques, such as geoprocessing, data analysis and overlaying, and GIS modelling. The results were then displayed as thematic layers in 2D and 3D GIS model as shown in Figure 4. The Arc Toolbox application in Arc GIS 9.2 which provides a powerful set of geoprocessing functions was used to import the GPS data surveys and map layers into Arc Map application. Each of the different shoreline types and boundaries were imported as different layers. In the geographic data view, geographic layers representing the GPS survey types were compiled into GIS data sets. A table of contents interface organizes and controls the drawing properties of the GIS data layers in the data frame. Designed for the GIS mapping, Arc Map also enables the use of different in-built symbols to represent some important environmental resources. In the page layout view, the layout can be modified to improve the design and visual balance of the composition by adding new map elements and changing the properties of the existing map elements.

Figure 4: Results displayed as thematic layers in GIS model

Previously, the area was never mapped at detailed scales by other researchers. The maps constructed in this project benefit from the information of previous works but also contain new data, especially regarding glacial forms and deposits. The reason why the maps are not completely GPS-RTK based was the scarce amount of time available for the use of the system and the experimental nature of this approach. It is important to note that the kind of information generated during this survey is accurate and can be used in much more detailed scales than 1:5000. The independent georeferenced data allows a high flexibility for its future use, making its application possible in a variety of scales. Furthermore, the use of this kind of system allows a very accurate and fast mapping as well as full integration with GIS. These can be significant factors for its implementation, despite its relatively high cost; the system has applications for a wide range of mapping purposes in the framework of earth, biological or environmental. In areas without or with bad topographic maps the GPS-RTK can also be used to generate contour or to correct the topographic background.

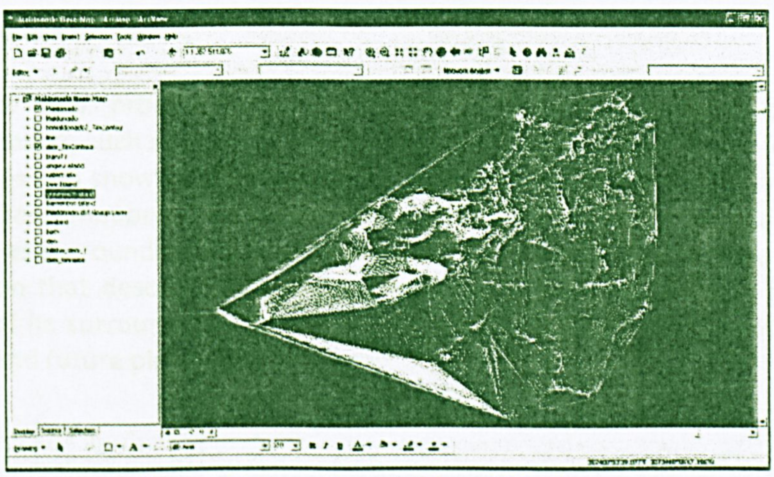

Figure 5: Contour Generated from GPS points

Result & Output

Consequently, the outputs from the GIS project in the expedition were:

i. GIS database

A GIS database for Pedro Vicente Maldonado Ecuadorian Scientific Station Antarctica Base and its surroundings was developed. The database could be utilized in presenting and distributing existing information on the base station area. The database contains topographical data, and also data on the geology, landforms, and flora and fauna. The database additionally provides biogeographical, geological and topographical information. The data representative of the attributes associated with the objects are placed in files accessible by a geographic information system (GIS) software which utilizes the data to form a geographic information system (GIS) database from which GIS maps are formed as shown in Figure 6.

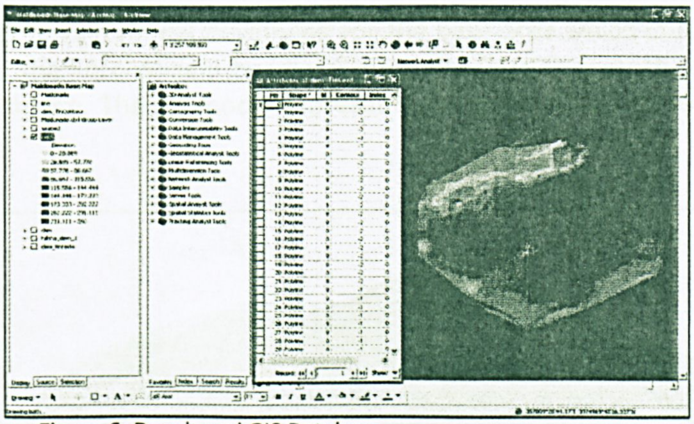

Figure 6: Developed GIS Database

ii. Spatial maps

Among the maps produced from the mapping project were maps of location sites of flora and fauna, such as penguin habitats and birds' nests, and physical features such as rivers, lakes and snowmelt boundary. The shoreline and bathymetry near the base area had also been mapped. The spatial maps significantly visualize the spatial patterns of the features surrounding the base area as shown in Figure 7. The maps provide spatial information that describes the physical features of the area and the biogeographical features of its surrounding. The maps are essential in the management of the current research and future planning of the area.

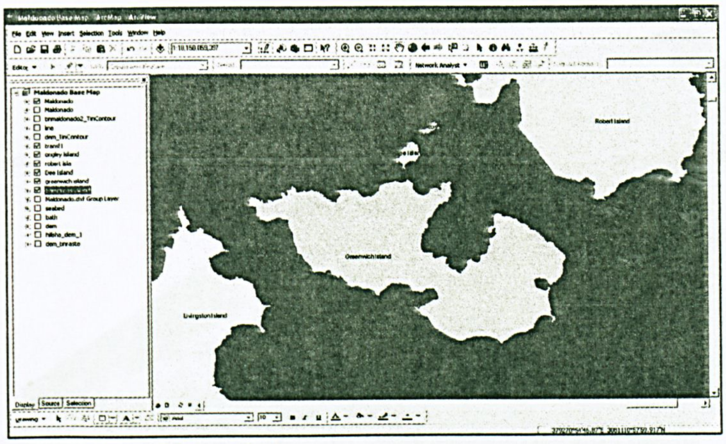

Figure 7: Spatial Maps

iii. 3D terrain model

Figure 8 shows a 3D terrain model developed for the base area which include the four mapping area sites; the Fort William headland area, the Glacier sites, the coastal area and the raised beach site. The 3D model represents the ground surface topography of the areas.

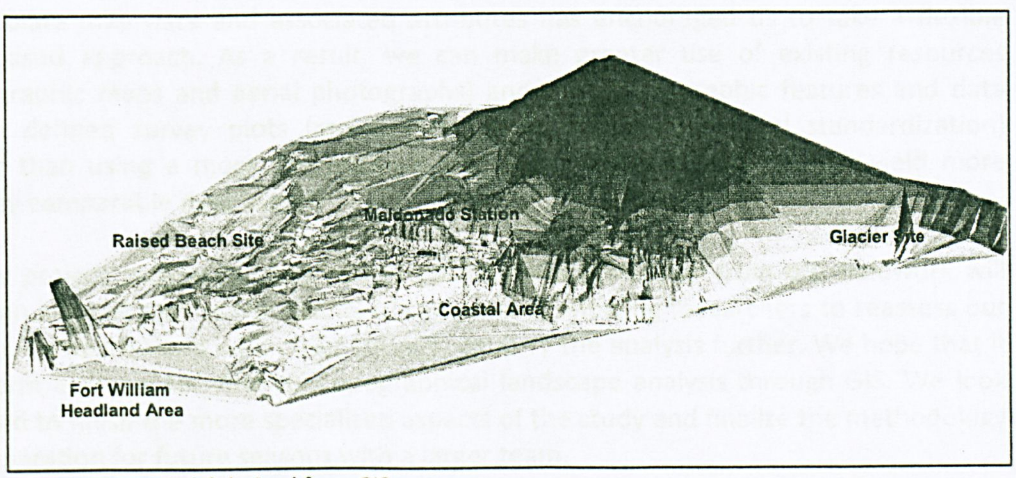

Figure 8: 3D Model derived from GIS

The model was produced using GIS techniques, and utilized the elevation data obtained by direct GPS survey using kinematic methods and a laser range finder. Terrain analysis had been done to evaluate the watershed, vertical profiling and slope of the areas. The 3D model will be used by various researchers to study the relationship between terrain and other biogeographical elements.

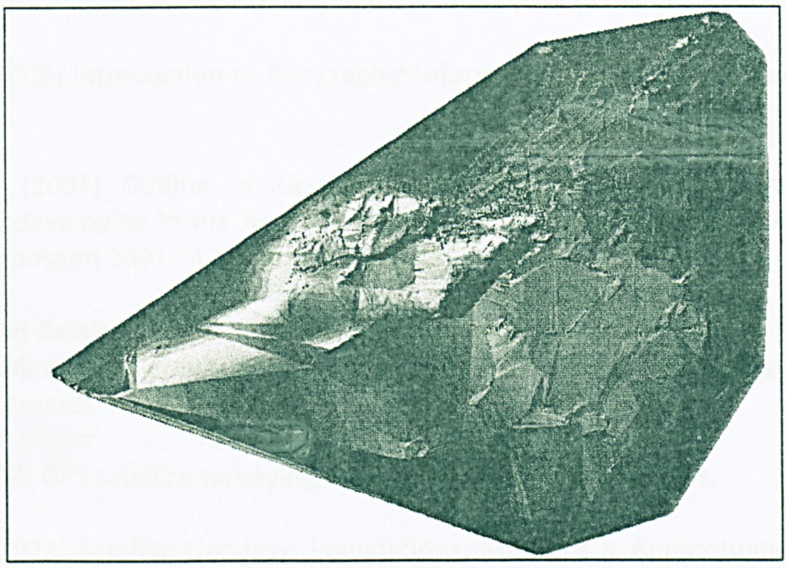

Figure 9: GIS Manipulated-TIN Surface

Conclusion

As a conclusion, it is worth noting that the availability of GIS has influenced not only our procedures but our whole approach to the survey. The ability to easily capture and manipulate map data and associated attributes has encouraged us to take a flexible map-based approach. As a result, we can make greater use of existing resources (topographic maps and aerial photographs) and record geographic features and data within defined survey plots (requiring mapping and mathematical standardization) rather than using a more conventional grid-based approach that would, yield more directly comparable data values.

As the project progresses, the integrated database generated from our fieldwork will form an integral part of the results of the project, allowing researchers to reassess our results, compare them with other surveys, or carry the analysis further. We hope that it will form a model for detailed topographical landscape analysis through GIS. We look forward to finish the more specialized aspects of the study and finalize the methodology in preparation for future seasons with a larger team.

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Appendix II – POSTER PRESENTATION

Data Elevation Model Mapping (DEM) for Punta Fort William Using GIS Application and Techniques

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