Highlights

? RS and GIS to manage marine environment
? GPS Field techniques
? Database Linking

Highlights

? Image Analysis
? GIS for Utilities, FEA
? Vegetation Monitoring

Pacific Islands
GIS/RS *news*

The Newsletter of the GIS/Remote Sensing Users in the Pacific
Issue 1 /2003
May 2003

GIS and Remote Sensing: Leaps and bounds through SOPAC-EU Project

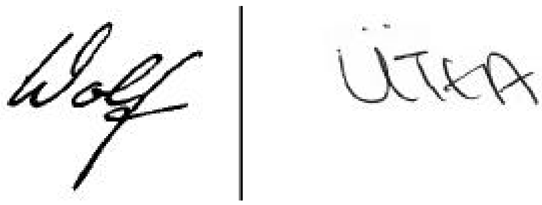
During 2002 only one issue of the GIS&RS newsletter was published. This year, the situation will hopefully change as the circumstances have been altered. Now, through the SOPAC-EU project producing the newsletter is a part of the official work program and not a programmed office activity as before. Also the newsletter team has changed again: ***Wolf Forstreuter*** is still looking after the overall production and ***Lala Bukarau*** after the editorial style. New in the team are ***Litea Biukoto*** and ***Elizabeth Lomani*** assisting in editorial work together with ***Silika Tuivanuavou*** from the 2002 team. ***Elenoa Rokodi*** handles the distribution as ***Abigail Duaibe*** left for studies in New Zealand.

The newsletter is still facing the situation that it takes lots of time to get articles in from Pacific Islanders. There are plenty GIS and remote sensing newsletters available world wide, however, we want to develop the GIS&RS tools in the Pacific with the specific prevailing conditions of this region, which in many cases do not allow a simple technology transfer from other regions.

The SOPAC-EU project (see article by Litea) will establish GIS&RS support for the eight Pacific ACP countries linked to the EDF8 funding (Lome convention) and this project possibly will be extended to 6 further Pacific ACP countries linked to EDF9 funding (Cotonou convention). The newsletter will permanently report on the EU project activities as they are focused around GIS.

This issue of the newsletter covers a wide range of issues from GIS application in Pacific Island Utilities, environmental activities, documentation of squatter settlements to rapid mapping of land boundaries, which is an important activity in Fiji and will become increasing important in other Pacific Island Countries. Besides this, the current newsletter explains technical topics such as linking tabular and spatial data, handling of GPS equipment and mapping of bathymetry.

We hope to get more newsletter contributions during the next weeks and month.

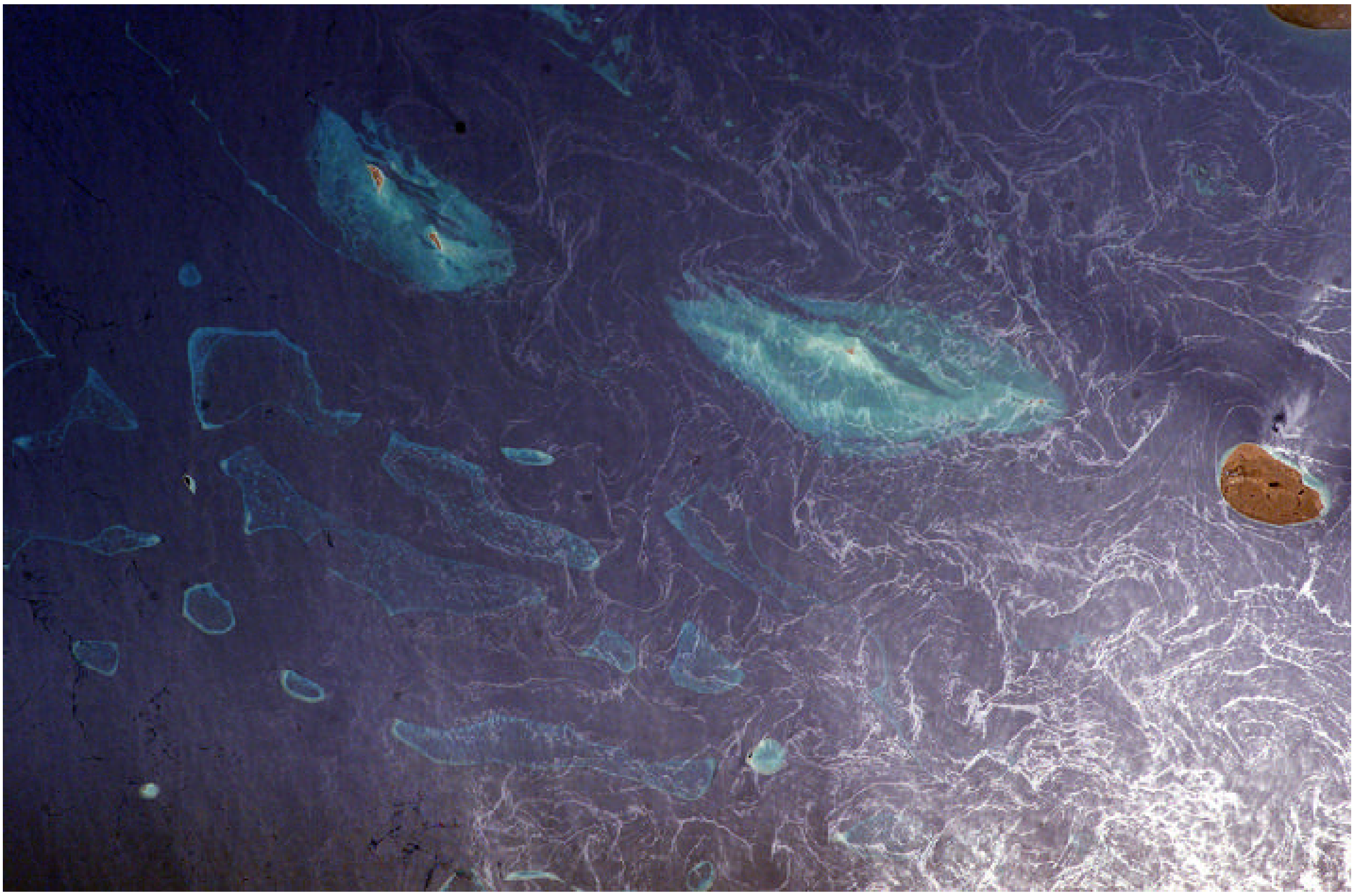


Handing out certificates after one of RS training courses of the SOPAC-EU project

ISSN 1562-4250

Contents

Above and Under the Red Sea



This unique photograph of shallow Red Sea waters off the coast of Saudi Arabia gives us a glimpse of both the coral reefs under the surface, and the texture and movements of surface waters. On the left side of the image we see through the water column to the reefs below the surface. On the right side of the image, the sun reflects off of microscopic oily films formed by a combination of natural biological sources and human activities on the sea surface (visit Oceanography from the Space Shuttle for more info). The films are concentrated by surface water movements and variably dampen surface capillary waves, which effect how the sun's light is reflected. This creates patterns of brighter and darker reflections when viewed from orbit. These patterns trace the complex surface water dynamics along the coast.

Fiji Coral Reef Conservation Project, Mamanuca Islands- Coral Cay Conservation

James Comley
Coral Cay Conservation

Coral Cay Conservation (CCC) is a not-for-profit organisation whose stated aims are to provide resources to help sustain livelihoods and alleviate poverty through the protection, restoration and management of coral reefs and tropical forests. CCC is self-financed through the use of international volunteers. Operating in this manner, we are able to provide opportunities to our host-country counterparts that would otherwise be prohibitively expensive on an economic and resource basis.

The main output from CCC projects is the production of a detailed habitat map that is based on ground-truthed field data collected by our teams of volunteers. Overlaid onto this basemap is data on the conservation value of the marine habitats identified (Edinger and Risk, 2000), information on fish populations, live hard coral cover and overall univariate biodiversity measures. The end product provides a highly pictorial, visually accessible and readily understood management tool. Ultimately, our in-country counterparts then use this tool in partnership with fundamental socio-economic and demographic data as a basis for making informed management decisions. The marine reserves and Marine Protected Areas (MPAs) that result are based upon a sound scientific footing, at the heart of which lies the GIS and habitat map created from field survey data extrapolated with the aid of an additional data source in the form of remotely sensed data.

The data analysis and management procedure that CCC uses is three fold. An unsupervised classification using an ISOCLASS/ ISOSTAT equivalent algorithm is used to identify spatially confined areas in which spectral reflectance values are homogenous and there it can be assumed that habitat variation will be low. By contrast, areas of high spectral variability are likely to have high habitat heterogeneity. Using this information allows survey strategies to be tailored to concentrate survey effort where it is most needed and therefore make better use of the resources we have at our disposal.

The field data we collect represents a multivariate 'snapshot' of the benthic community present and contains a semi quantitative abundance of some 150 sessile organisms and substrates. This data is analysed using the Plymouth Routines In Multivariate Ecological Research (PRIMER) software. Firstly, each record is ordinated against all others based on the abundance of the species observed in a Multi-Dimensional Scaling (MDS) process. A hierarchal cluster plot based on the Bray-Curtis similarity measure is then constructed which identifies natural groupings of site records where each of these groups is representative of a habitat. These habitats are given a descriptive name using the data together with the geomorphological area of reef in which they were found. Finally, each habitat is given a quantitative description from the data and other variables such as fish assemblages and conservation values are associated with them. The field data we collect is spatially defined using GPS, allowing a list of GPS locations of examples of each habitat is produced.

Image pre-processing steps we take are the georectification of the imagery, the development of land and deepwater masks and, in the case of satellite imagery where there are an appropriate number of spectral bands, atmospheric correction using the Msixs radiometric transfer model and the construction of a water column correction procedure following that proposed by Lyzenga.

The georectification of the image is done using the polynomial, rubber sheet, nearest neighbour resampling algorithm. In the case of multispectral satellite imagery, land and deep-water masks are defined by creating a band-ratioing model relying on the disparity in attenuation of light of different wavelengths in the water column. This method is not possible for tri-spectra aerial imagery. Instead, Areas Of Interest (AOIs) are digitised and manual digital number recoding is done.

The water column correction technique we employ is based upon the physical properties of light of differing wavelengths passing through the water column. Sites of bare substrate of equal reflectance properties, but at different depths are found. Viewed on the remotely-sensed image, the disparity in spectral signature between these sites can be attributed solely to the presence of the overlying water column. If enough replicate sites are used, then the ratio of absorption of red versus green versus blue light represents the effect of the absorption of the water column. In this way, a model is constructed that recodes the digital numbers of pixels to remove the spectral contamination of the overlying water.

The next stage we perform following pre-processing is the development of spectral signature sets. The spatially-located sites characteristic of each habitat are identified on the image. These 'seed pixels' are then used to 'grow' AOIs based on user-defined differences measured by statistical variability around that of the seed pixel. The resulting spectral signatures of each habitat are examined using the image histograms and the signature set is evaluated and refined in a user-defined iterative process.

Using these signature sets, supervised classification is then performed on the image. The two classification models we use most commonly are the maximum likelihood classifier and the minimum distance with null class removal algorithm.

The resulting thematic map then undergoes a process of contextual editing using defined decision rules to recode any obviously misclassified pixels. Finally, a 3x3 median filter is used in the post-classification smoothing of the image. Whilst this may reduce the final accuracy of the end product, it reduces the pixelated appearance of the image, making it a more user-friendly end product.

The Fiji Reef Conservation Project is a three-year program that has been running since April of 2002 following a successful pilot phase program. Approaching the end of year one, we are currently working towards the production of habitat maps of areas surveyed thus far. The resulting report will contain geographical defined areas of high importance to the restoration and continued management of the Mamanuca Islands.

We are currently engaged in a discussion with other stakeholders throughout Fiji to assess the feasibility of Coral Cay extending its work outside of the present study area.

Further information on our organisation is available at www.coralcay.org, or we can be contacted directly at coralcayfiji@connect.com.fj or on telephone (00679) 6511518.

SOPAC Completes Multibeam Mapping of Penrhyn Atoll, Cook Islands

Robert Smith, Simon Young
SOPAC

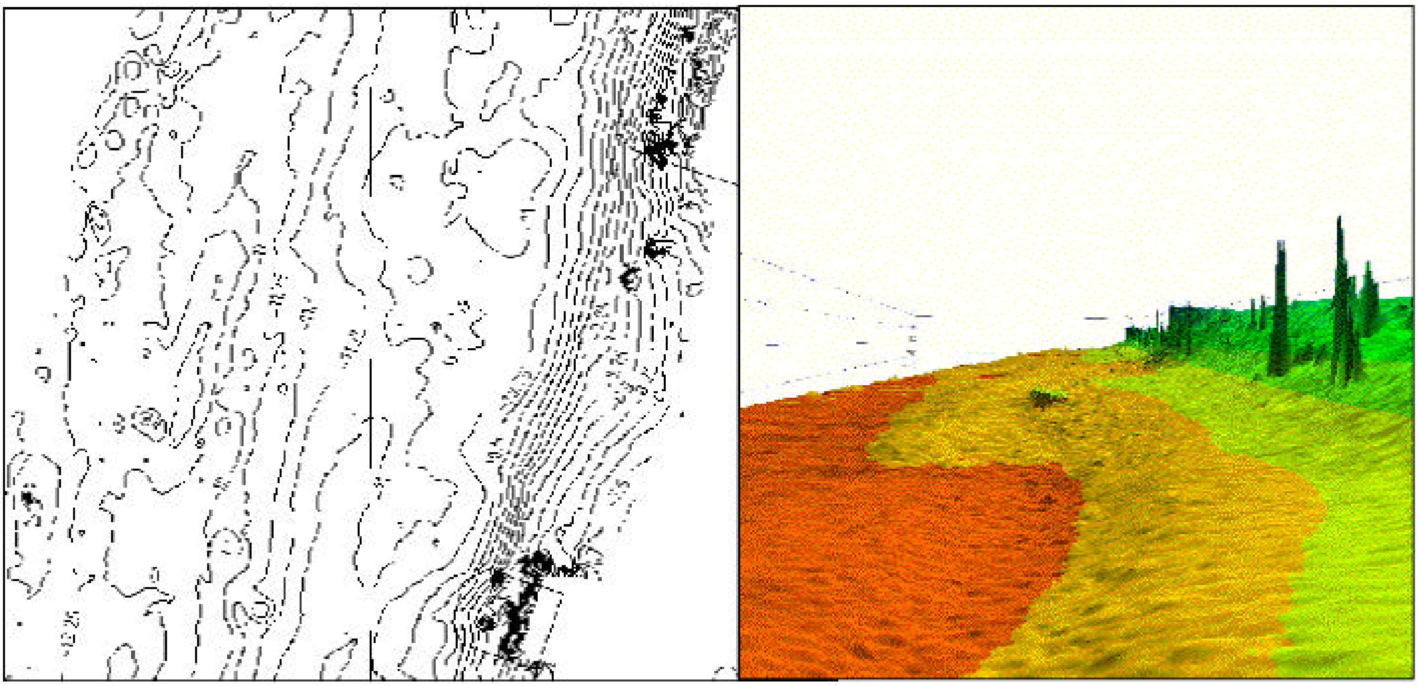
The Ministry of Marine Resources of the Cook Islands as part of their efforts to develop back pearl farming in outer atolls requested SOPAC to complete a multibeam survey of Penrhyn Atoll. This is by far the largest atoll targeted to map entirely with multibeam to provide an unprecedented dataset of the whole atoll. Located around 9º South, 157º 58" West the atoll is the most northern island in the Cooks and one of the remotest. The atoll is rectangular in shape, 23 km in length and 15km at its widest. With a lagoon perimeter of 60km the lagoon has an area of some 189 km^2. Being a rather remote atoll presented some logistical difficulties. This meant all equipment including a suitable vessel to complete the multibeam survey were shipped to Penrhyn ahead of the arrival of the survey team.

Existing knowledge of the bathymetry of the lagoon was limited to small-scale hydrographic chart data and a lot of local assumptions as to lagoon depth and shape. From the air the lagoon can be seen to be studded by a vast number of coral reef patches indicating a complex morphology hidden by lagoon waters.

Penrhyn as viewed from the northwest. Picture provided by Polynesian Black Pearls)

To map the bathymetry of the lagoon a 200m east west line spacing along the entire length of the lagoon was completed with some 1000 kilometers of survey data collected. The results from the survey show the lagoon shape to be rather complex with as much as 70% of the lagoon deeper than 50m. The seafloor is mostly rocky with sediments confined to the deeper portions of the lagoon and coral heads dominate the seabed.

Other survey work undertaken included the acquisition of current data on lagoon circulation, with the deployment of 4 current meters and routine “Conductivity Temperature Depth” CTD profile measurements of lagoon water such as temperature, conductivity (salinity) dissolved oxygen, and turbidity. In addition seabed, water and biological sampling was completed to develop a comprehensive baseline dataset for the lagoon. These studies are aimed at providing a data base in a Geographical Information System, GIS, to simplify and improve coastal and oceanic marine resource management of the developing black pearl industry in Penrhyn Atoll.



The swathmapper creates a digital terrain model that can then be used to produce contour lines.

Downloading Trimble GPS Receivers in the Field

Wolf Forstreuter, SOPAC
Reece Gardner, GeoSystems

Introduction

Surveying and mapping in the South Pacific often requires extended periods of time in the field. During this time the GPS rover unit cannot be downloaded to the desktop computer. This article describes how Trimble GPS rover receivers may be downloaded in the field (to a field laptop). Data files can then be deleted from the GeoExplorer II to provide more storage for further work.

GeoExplorer II

The Trimble Pathfinder Office software CD contains a small file called load.exe. This file enables you to download the GPS rover files directly to a directory on a laptop computer without having Pathfinder Office installed.

Use the instructions below to download the GeoExplorer II using load.exe:

o Locate load.exe on the Pathfinder Office CD

o Copy the load.exe file to your target directory

o Switch to MS-DOS window

o Go into the target directory

o Connect the GPS rover and computer using the serial cable

o Switch the GeoExplorer II into Data Transfer mode

o Run load.exe

Figure 1: *The GeoExplorer 3 with attached serial clip*

The data files will be transferred to the laptop computer and you can delete the files from the GeoExplorer II.

Figure 2: *The GeoExplorer 3 in position during data download*

GeoExplorer 3

To download a GeoExplorer 3 the Pathfinder Office software must be installed on the laptop computer. In the office the GeoExplorer 3 is downloaded using the Support Module and a power supply. In the field the GeoExplorer may be downloaded using the serial clip (Figure 1).

Use the instructions below to download the GeoExplorer 3 using the serial clip:

o Attach the serial clip to the GeoExplorer 3

o Connect The GeoExplorer 3 and computer using the serial cable (null-modem)

o On the GeoExplorer 3 go to the SYS Setup screen and select Configurations, then select COMMS

o Change the Data transfer setting from Support module to Serial clip. The RTCM input and NMEA output settings should be set to Off.

o Initiate data transfer from Pathfinder Office in the usual manner.

Again, once the data files have been transferred to the laptop the files on the GeoExplorer 3 can be deleted making memory available for further work.

GPS Survey in Southwest Viti Levu

Jeremaiya Taganesia

This project was initiated by the joint purchasing of IKONOS images that covered the Navua, Korolevu and Sigatoka areas by SOPAC, the Mineral Resources Department and the University of the South Pacific (see last newsletter). To be able to use the images as suitable backdrops, they first had to be rectified. The Public Works Department provided their roads network layer but the surveyed roads consisted mostly of the major roads and those they maintained. Some of the areas covered by the satellite images had little or no roads covered by the PWD roads layer, so this survey was setup to cover some of the smaller roads and logging tracks that would provide important ground control points for the image rectification process.

The Global Positioning System units used to conduct the survey were GeoExplorer II units from SOPAC and a GeoExplorer III unit from the Mineral Resources Department. A car antenna was used with one of the GeoExplorer II units.

The GPS units were set up to log positional data at a five-second interval that was changed on the second day to a one-second interval to improve the accuracy and quality.

The GPS units were capable of operating when placed on the dashboard of the vehicle with the unit facing forward (Figure 1) but when satellite coverage was poor, the units had to held out of the window or by a member of the survey team standing outside the vehicle (Figure 2).

Figure 2: *Lanieta Veileqe of USP holding the GPS unit out the window when satellite strength is weak .*

Figure 1. GPS unit on the dashboard having adequate reception

The survey revealed that the best data was collected from the GeoExplorer II unit with a car antenna attached to it. Of the units that were without antennas, the GeoExplorer III seemed to have a slight technological advantage that enabled better satellite reception and consequently better data quality than that of the GeoExplorer II.

It is recommended that car antennas be used with the GPS units for better data accuracy and quality in future GPS surveys covering road networks,. For more precision logging of positions, it is also recommended that the logging interval of GPS positions be as small as practicable for the GPS units being used, a one-second interval being optimal.

Linking Access Tabular Data to GIS Layers

Wolf Forstreuter
SOPAC

Introduction

Most GIS products combine spatial data and tabular data. The spatial element points such as, lines or polygons have a record in an attached table. MapInfo automatically creates a table when generating a new spatial data layer. In many established GIS this MapInfo table stores all attribute data. The link between tabular and spatial data is provided, but the user is limited to the MapInfo facilities based on dBASE when analysing the tabular data content.

MapInfo can also import Access tables, with a map element created for each record. This enables the analysis of the tabular data content in an Access environment without it being limited to MapInfo's dBASE structure. However, changing of the table structure is difficult and the tabular database has to include the MapInfo ID for each record.

For four years, SOPAC is proposing to link tabular data and MapInfo spatial data by a unique identifier only. This allows keeping the tabular data content separate from the map spatial data and only linking it, if required for spatial data analysis.

The Spatial Data Component

When creating the MapInfo layer or spatial data component the operator must have in mind which tabular data he wants to attach at a later stage. The map element must be able to be linked to one only record. Therefore, it is important to have a well-structured tabular database first before creating the MapInfo layer.

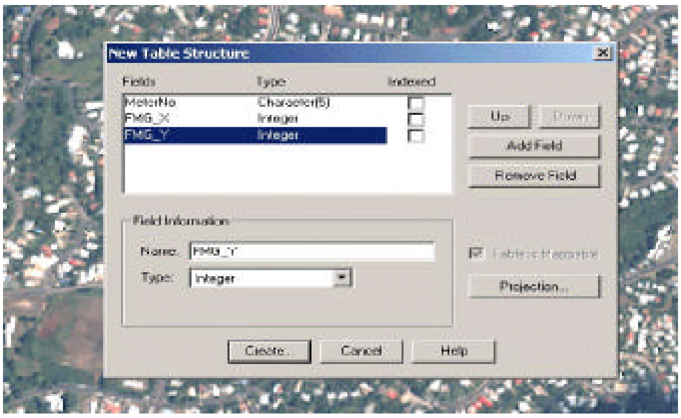


Figure 1: *Creating the MapInfo table containing unique identifier and fields for spatial content*

As told before, a MapInfo spatial layer automatically creates a table. When the operator wants to link the spatial layer to an Access table at a later stage, this table only requires two fields: 1) an unique identifier and 2) a field for the spatial content.

The **unique identifier** is a number or character string, which is identical with the one in the corresponding record of the tabular database (in the examples shown in figure 1, the field MeterNo), which later will be linked to the map element.

The field for the **spatial content** will be:

a) X and Y coordinates (like in our example) for point features,

b) a field LENGTH for line and polyline elements and

c) an AREA field for regions (polygon) elements.

The Tabular Database

The tabular database, typically an Access database, must have a corresponding table, which contains records having the same unique identifier, which is in our example the meter number. The table also should contain a field for the spatial content.

Linking Access and MapInfo Table

To link the Access database with the spatial data layer you have to first import the corresponding Access table and then link it with the MapInfo table through a SQL statement.

The **import of the Access table** happens by opening it in MapInfo. Then, you have to make the table mappable where you have to select the same projection employed to the corresponding MapInfo table. The sequence is Table, Maintenance, Structure, click on mappable, select projection. Finally you add the table to the active map window.

The linking of both tables is performed through SQL SELECT in MapInfo. The steps within the SQL menu are as follows (see figure 2):

a) select both tables

b) set condition "link tables for all records where unique identifier of MapInfo table equals unique identifier of Access table"

c) store selection into LinkTable

The temporary LinkTable, which contains the fields of both tables (see figure 3), can be addressed like a single table. It is possible to create a thematic map colouring the map features, which are part of the MapInfo table (in our example the meter), due to

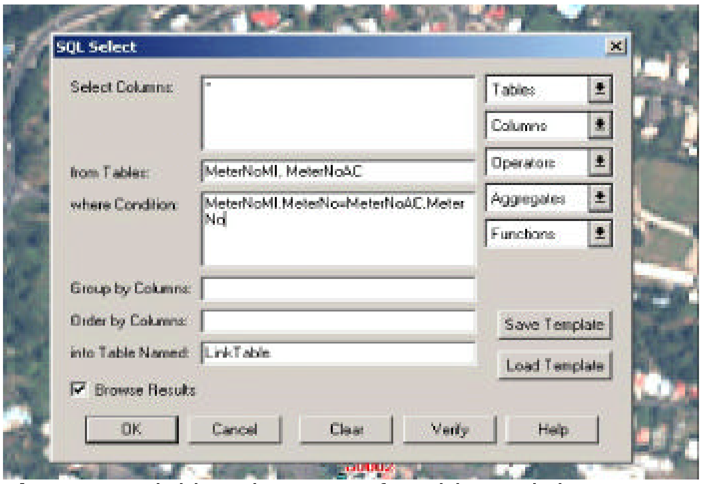


Figure 2: *Linking the MapInfo table and the Access table through a SQL query into a combined table called LinkTable*

content stored in the Access table such as meter type. It is also possible to label the map features with content stored in the Access table.

The procedure contains several steps and seems to be complicated, however, though MapBasic a small routine can be written which performs all steps automatically.

The Importance of the “Field of Spatial Content”

In many cases MapInfo is only used to provide the spatial overview, in other words a map display. More advanced users may want to carry out additional spatial analysis. Having a display of pipes for the Rarotonga Waterworks is not sufficient the utility wants to know the length of pipes within one suburb. Such an analysis requires two steps:

1) filling the field for the spatial content in the MapInfo table and
2) bringing the spatial content across to Access.

To **fill the field of spatial content** MapInfo provides a facility allowing the calculation of length, position or area of the map elements. The sequence is: Table, Update Column, select the field for spatial dimension, Assist, select spatial dimension and all records will be filled with the corresponding position, length or area.

The easy way to **get spatial content across to Access** is to export the MapInfo table and then subsequently import it to Access. Then, both tables have to be linked through the unique identifier. In Access an UpdateQuery transfers the data from the table exported from MapInfo to the corresponding Access table.

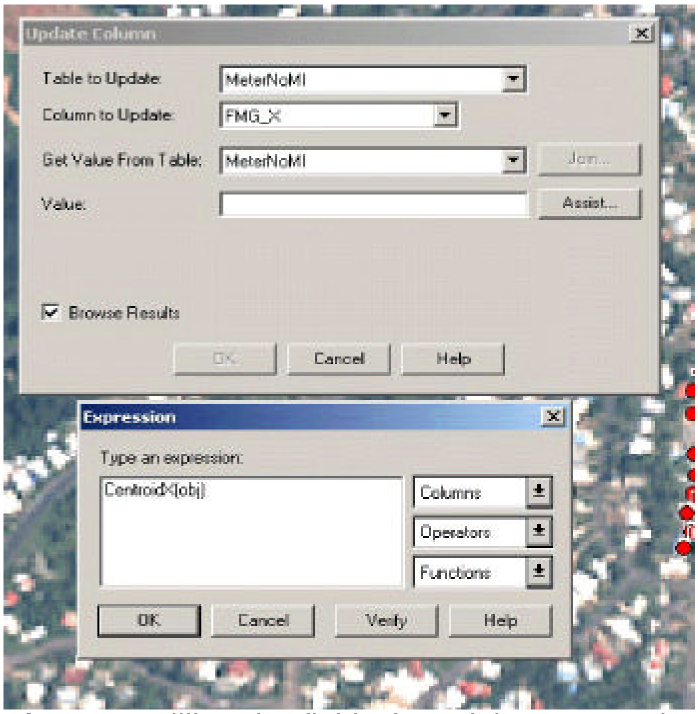


Figure 3: *Filling the field of spatial content using MapInfo tools*

Again this procedure seems to be complicated as many steps are involved, however, also this procedure can be handled by a routine where MapInfo is called within Access environment. Then the MapInfo export including the exit of MapInfo is handled by a MapBasic routine.

Summary

It was noted that in several SOPAC member countries GIS application created two databases, one set of MapInfo tables and a separate set of Access tables. Too often the link between Access and MapInfo was lost, after the map elements were created from the imported Access table. The consequence was that users keep two sets of tables, where both are not updates; the MapInfo tables do not have the latest information of the Access database and the Access tables do not have the updated spatial information.

To handle both tables in the described way allows an easy handling (cleaning) of the spatial data layer as all records must have a graphic object and a unique identifier. The spatial data layer keeps a small file size and can be distributed easily. The tabular data set can be handled totally independently in Access, which enables many more database handling tools than MapInfo can offer for the tabular data.

Hopefully this will eliminate the current practice of two different databases in MapInfo and in Access running parallel, both having to be updated separately.

Settlement in Nasinu Town, Suva

Elizabeth Lomani, SOPAC

Background

The Nasinu town council wanted to analyse how the Suva suburb Nasinu was growing during the last 20 years. Nasinu town was growing fast due to the low-cost housing.

Aerial photographs were rectified and multi-temporal imagery were produced out of the rectified image layers as described by Silika Tuivanuavou in news letter 1 - 2002. Now, the Nasinu town council wanted to have exact figures of houses built in the three periods:

- In and before 1973
- Between 1973 and 1986
- Between 1986 and 1996.

(Figures 1 and 2)

ESCAP financed a GIS analysis which was carried out by SOPAC.

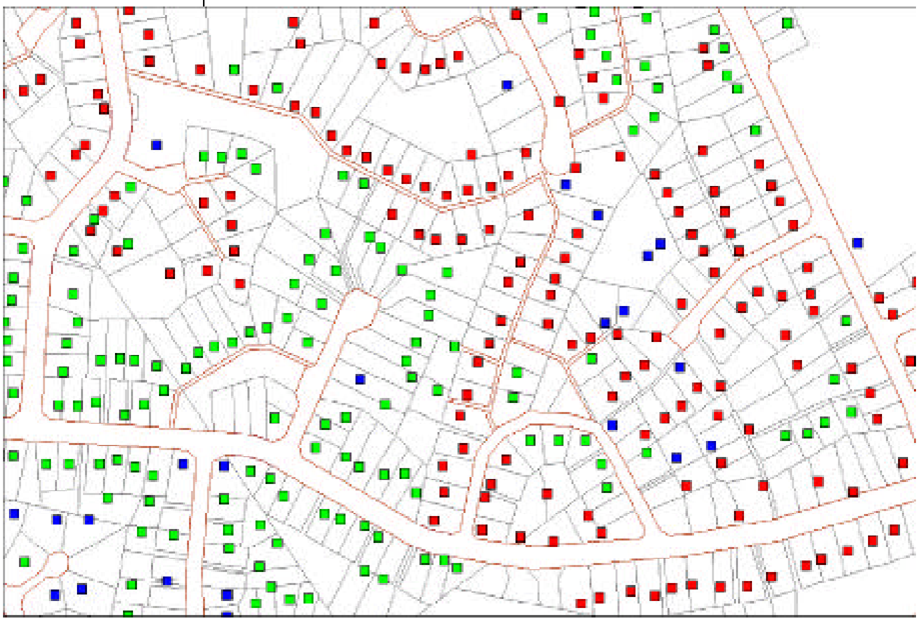


Figure 2: *Result of GIS analysis, The colours of this sub-area indicate in which period the houses were constructed. Red houses were constructed before 1973, green houses were constructed between 1973 and 1986 and blue houses were constructed between 1986 and 1996.*

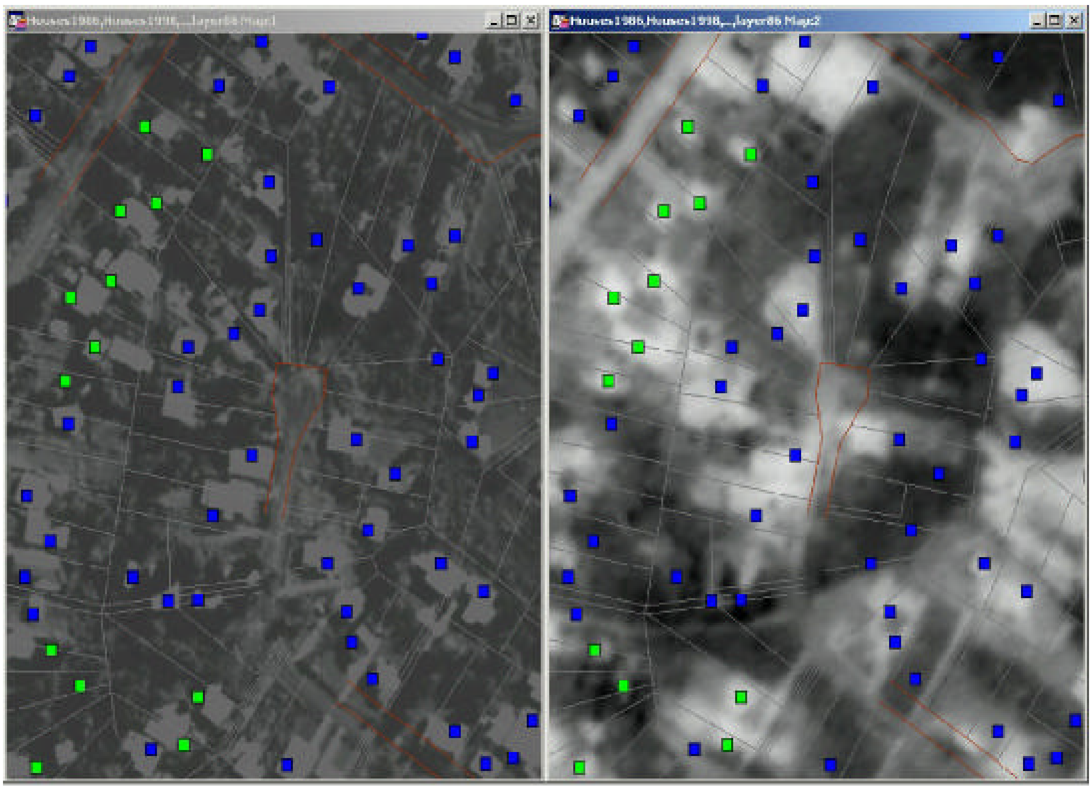


Figure 01*: Layer 1996 (left) and layer 1986 (right) displayed together in separate windows to verify the interpretation.*

Settlements in Nasinu Town, Suva

GIS Analysis

Four different layers were available for the GIS analysis (see S. Tuivanuavou newsletter 1 - 2002):

- Multi-temporal image layer
- The rectified aerial photographs 1973
- The rectified aerial photographs 1986
- The rectified aerial photographs 1996

Another layer was produced by digitising the Nasinu town boundaries to separate houses outside of Nasinu from the ones located within the town. Then, three layers were created one for each of the three time periods. The digitising of house locations started within the oldest houses built during or before 1973 then continued with the houses constructed between 1973 and 1986. The layer 1996 was digitised last. It appeared to be practical to toggle between the multi-temporal layer and the black and white layers. It also proved to be practical to display two layers in separate windows for direct comparison (Figure 1).

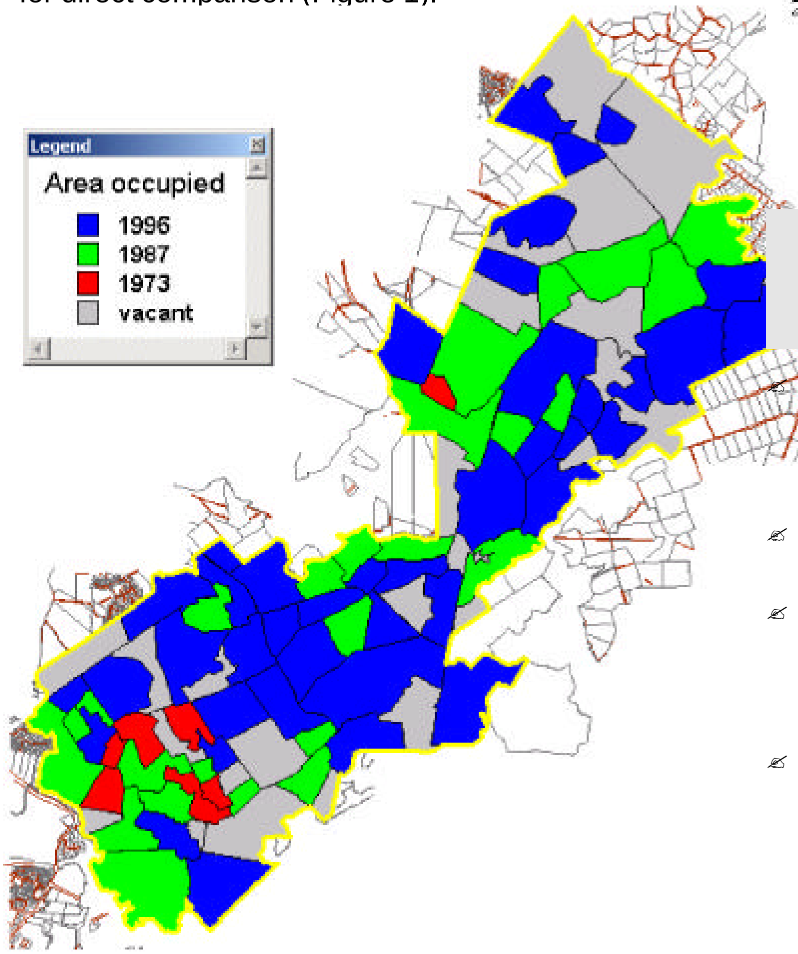


Figure 3: *Area occupied by houses in the years 1973, 1986 and 1996*

Results

Before the aerial photographs were recorded in 1973, 749 houses had been constructed. Between 1973 and 1986, 3540 houses were built and between 1986 and 1996, 6732 houses were constructed. The area occupied by settlements was 60 hectare in 1973 and increased by 457 hectare by 1986. By 1996, a further 843 hectare were occupied by settlements, (Figure 3).

If this trend continues 1260 hectares will be required by 2010 if the type of settlement does not change (Figure 4).

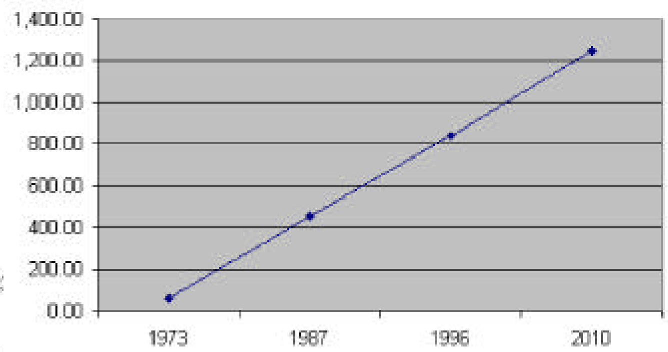


Figure 4: Extrapolation of required space for housing if current trend continues like before.

EDF 8 Project Updates

- GPS Road Mapping exercise was carried out on Efate. The road network will serve as the basemap for the rectification of the IKONOS imagery covering Efate.
- Imagery for Tuvalu and Samoa will also be ordered once quotations come in.
- The commissioning of the new swath mapper was carried out and work has begun for the Fiji Project Area on the South East coast of Viti Levu. The area selected will cover Naselai to Momi.
- Franck Martin represents SOPAC at the next SPC population GIS steering committee meeting in Noumea, New Caledonia. The objective of the project is to improve access to data and make it possible for Statistical Offices to produce exactly what planners need, whenever they need it.
- Wolf presented at the Head of Forestry meeting in Nadi to explain how the EU project can assist in vegetation monitoring of water catchments.
- The project will also focus on GIS&RS support for utilities and will start in Vanuatu shortly.

GPS Base Stations

Reece Gardner
GeoSystems, New Zealand

GPS mapping in the South Pacific mapping is well proven and widely used.

During my recent visit to Suva, Fiji, I visited many organizations and it was exciting to see so many people using GPS to help them in their work. I was concerned to hear, however, that organisations seem to be working independently with regards to establishing base stations.

Fact: A single GPS base station in the Suva area will satisfy the needs of EVERY GPS user within a range of 200 - 300 km.

It would be great to see organisations working together, rather than duplicating effort and infrastructure.

SOPAC has made excellent advancement in this area by establishing a permanent base station that is uploading data to the Internet every hour. The data from this base station is available freely to any user with Internet access. The SOPAC base station antenna is partially obstructed by some nearby trees. Obviously, the base station operation would be improved by moving the antenna to a better site or trimming the offending trees.

Figure 1: *SOPAC GPS base station antenna on top of the MRD building in Mead Rd., Suva. The trees are visible in the background.*

SOPAC is looking to make changes to the website (http://www.sopac.org.fj/gps/ssf/) and the data structure to provide faster access for remote users.

In New Zealand, Land Information New Zealand (LINZ) and the Institute of Geological and Nuclear Sciences have together established a network of base stations that cover the North Island. The data from these base stations is available freely to any person with Internet access. If you are interested take a look at: http://www.linz.govt.nz/positionz

Implementing the National Biodiversity Strategy for the Tropical Forests of Fiji: Building Conservation Landscapes into Forestry Operations & Forest Certification

David M. Olson, WCS South Pacific

The tropical forests of Fiji are among the most unusual in the world. Fiji harbours a large number of species and genera with links to the ancient supercontinent of Gondwana, including the most primitive flowering plants in the world and unique groups of iguanas and parrots. Like Madagascar and New Caledonia, the plants and animals of Fiji suggest that the islands are a long-isolated remnant of a continental terrains. The forests are unusually diverse for oceanic islands and have strong links to those forests further west e.g., New Guinea. Fijian forests also contain a wealth of endemic species spawned from the long isolation of the archipelago. This combination of features makes Fijian biodiversity highly distinctive at a global and regional level. Unfortunately, the forests of Fiji are also threatened. Centuries of deforestation for agriculture and settlement in the lowlands, and today's exploitation of remaining native forests for timber and plantations are reducing the last remaining blocks of Fijian forest. In order to promote the rational use of renewable resources, we will work with the Ministry of Fisheries and Forests of Fiji, the Fijian Department of the Environment, the National Trust of Fiji, the Native Land Trust Board, SOPAC, the University of the South Pacific, the forestry industry within Fiji, local NGOs, and local communities to help implement the conservation vision for Fijian forests developed in the National Biodiversity Strategy. Specifically, we intend to work with the forestry sector and private landowners to prioritise different areas for conservation and resource extraction across whole landscapes, and to develop forestry certification guidelines that help achieve landscape-level conservation and renewable-resource goals. This process will include:

1) identification and mapping of representative conservation areas and corridors,
2) mapping of forests in terms of their value for ecosystem services and non-timber forest products,
3) guidelines for minimum-area requirements for sensitive species and ecological processes,
4) identification of focal species for monitoring and

management, and

5) recommendations for landscape features and management prescriptions for protected forests, exploited forests, and plantations.

The tropical forests of Fiji are among the most unusual in the world. Fiji harbours a large number of species and genera with links to the ancient supercontinent of Gondwana

Because the pace of deforestation and logging is rapid, and remaining blocks of forests are increasingly broken into smaller blocks, there is a limited window of opportunity to put in place a long-term, landscape-scale conservation strategy for Fijian forests. This strategy should effectively address conservation goals at the landscape level, as well as help refine management guidelines for production forests, plantations, and protected natural forests to ensure that they conserve biodiversity, maintain ecological services, and meet the needs of local peoples and economies. Fiji is interested in accessing more international markets for its timber products by making them more attractive through a robust certification process. A major aim of this project is to integrate landscape-scale conservation and renewable resource issues into certification guidelines. If successful, Fiji's wood products would be recognised as one of the very few operations in the tropics where this has been accomplished. This would represent a major selling point for international markets.

The Fiji National Code of Logging Practices specifies operational details concerning logging equipment, construction of roads, skid trails and landings, protection of watercourses, equipment safety, and training. Environmental concerns are largely focused on reducing erosion through slope restrictions, stream buffers, and road-building guidelines. Forestry certification efforts, spearheaded internationally by the Forest Stewardship Council, have also made great advances in identifying forestry practices that are compatible with reducing environmental damage at local scales. The problem, however, is that guidelines for logging practices and certification requirements for logging operations typically do not address landscape-scale requirements for the conservation of biodiversity or ecological services. In order to design effective conservation and resource landscapes, several important questions dealing with landscape-scale patterns and processes need to be fully addressed including:

WCS is working with the forestry sector to further improve logging practise and towards certification

- How much habitat area is required to maintain viable populations of the most area-sensitive native species?
- How much habitat area is required to maintain populations of these species to ensure their ecological function, such as seed dispersal or pollination, is maintained throughout the ecosystem? (Note: Species densities for functionality may be greater than for viable populations).
- What kind of replication of conservation areas is necessary to maintain the long-term persistence of wide-ranging species in Fiji?
- Can forestry operations be designed to reduce the impact of habitat fragmentation on sensitive species? Which species are most sensitive to

fragmentation?

- Are there certain forestry practices that should be avoided or encouraged to promote the persistence of non-timber forest products in harvested areas and across whole landscapes?
- How should forested watersheds be managed to maintain critical ecological services, such as flood control or persistent stream flow?
- What level of connectivity between forest blocks is necessary to maintain landscape-scale movements of key species and gene flow, seed dispersal, and pollination among populations of harvested species? How wide should corridors be to be effective? What level of habitat degradation is acceptable?
- How important are lowland forests to various focal species (e.g., shining parrots) and how should altitudinal habitat corridors be designed to maintain seasonal movements or provide access to lowland cyclone refugia from mobile species?
- How should forestry operations and conservation areas be designed to minimize the spread of alien species into natural forests?

It is these kinds of issues that will ultimately determine the fate of many species and ecological processes across landscapes, and the sustained renewal of natural resources and ecosystem services for Fijians. We hope to help bridge the gap between forestry codes and certification and new approaches in designing effective Forest Resource and Conservation Landscapes. Such landscapes, which map forestry production zones, core conservation areas, buffers zones, and habitat corridors, are the most cost-effective way to ensure that extinction is halted and natural forests continue to provide renewable resources and ecological services into the future.

A successful strategy for Fijian forests can act as a model for other forest situations throughout the Pacific and beyond. Close collaboration between the Wildlife Conservation Society, the government of Fiji, the forestry sector, Fijian biologists, and local communities is critical to accomplish this work and to ensure the results are implemented on the ground.

GIS will be a critical tool for conducting the analyses and presenting results of this project. Basic coverages such as topography, villages, hydrology, current natural forest cover, forest classifications, provinces, and land tenure will be required for most analyses. We are conducting field research and working with specialists to develop maps showing distinct biological communities across Fiji. These are used to assess the contribution of different conservation areas towards representing the full range of forest communities. Special features, such as caves and ancient trees, are also to be highlighted as points. Forest cover data will be queried to identify larger blocks of intact forest, optimal corridor areas, and remote forests where rats and other alien species occur at lower densities. Forested watersheds will be analysed to assess their relative value for ecosystem services such as flood control and water retention. We look forward to working with the GIS community on this project.

A Project of the Wildlife Conservation Society,
Supported by the USAID/EAPEI

David M. Olson, Program Director, WCS South Pacific, 11 Ma'afu Street, Suva, Fiji
Tel: (679) 331-5174, E-mail: dolson@wcs.org

Training GIS Backdrop Production

Wolf Forstreuter, SOPAC

The SOPAC-EU project will purchase high-resolution satellite image data for all Pacific ACP countries. This image data will allow the production of image backdrops usable at 1:10,000 scale.

A scale of 1:10,000 will be the operational level of survey and analysis for most parts of the project area in Fiji. Maps at this scale are not available in Fiji except for very small sub-areas. High-resolution image data will fill the gap, however, images have to be converted to GIS backdrops before they can be utilised. The training will ensure that GIS backdrops are produced and employed by stakeholders in Fiji.

During training the participants converted IKONOS images into GIS backdrops usable in MapInfo environment. The first step was the image rectification, where the DGPS survey road network was used as reference. This data was kindly provided by PWD. Then, the participants learned how to register the image data in MapInfo by editing the corresponding MapInfo TAB files.

One training result is that all participants gained the confidence in producing GIS backdrops, now. This will have two effects:

1. More people will understand and utilise GIS backdrops. So far the participants came from 10

Training GIS Backdrop Production

Figure 1: *Multi-spectral IKONOS image data after image rectification to Fiji Map Grid. The DGPS surveyed road network (red overlay) provided by PWD was used as reference. The image shows Pacific Harbour at the South Coast of Viti Levu, Fiji*

different stakeholder groups of the EU-SOPAC project. Experience shows that this has a synergistic effect and other staff within the stakeholder organisations will learn from the trainees, now. This will bypass the use of digitising tables, which are problematic in the tropical environment.

2. The trainees will continue to produce GIS backdrops. They learned the most difficult GIS backdrop production, which is the conversion of high-resolution image data. Apart from images, physical maps also available can be converted to GIS backdrops. This is much easier as they are already in orthogonal projection and just the distortion during the scanning process has to be corrected by a linear transformation.

Figure 2: *At SOPAC Talanoa club after handing out the workshop certificates.*

The other result is the availability of the backdrops as such. They now allow other users to do image interpretation with cost effective GIS software rather than purchasing expensive image analysis software. Furthermore, they enable other spatial analysis to be performed at 1:10,000 scale using these backdrops as map replacement. It was mentioned before that there are no maps at 1:10,000 scale.

In Fiji, image analysis including geometric correction of image data is not new. The participants of the first training group have the required software and just need a nudge to stimulate further backdrop production and subsequent utilisation.

Currently, the GIS backdrops ended at the coastline as they were no reference points, which could be used for the offshore areas of the images. A method must be developed to rectify the part of the image data extending from the shoreline into the sea, because it is very important to employ the image backdrop for reef mapping, coral monitoring and other nearshore management activities. The multi-beam mapper purchased under the SOPAC-EU project will provide this, see Quan Chung et al. GIS & RS for Pearl Farm Management in Manihiki, Newsletter 1 - 2002.

Such training will be carried out in the other Pacific ACP countries which are all part of the project. In Fiji, further training demand was addressed by different stakeholders and the training will be repeated. Unfortunately, the number of participants has to be limited to 6 people per course due to restrictions on space and available computers. Future training will include image to image rectification allowing quantitative change detection of vegetation and shoreline.

GPS and GIS Improvement at the Native Land Trust Board in Fiji

Silika Tuivanuavou

Introduction

From May 13, 2002 to September 15, 2002, NLTB underwent training in the use of GPS by the consultant based at SOPAC, Fiji. This training was funded by ADB upon request by NLTB for the quick survey of its native leases to facilitate fast issues of leases, which is politically important in Fiji. The conventional survey used by NLTB described in the following chapter was slow and this project overcame this problem.

The Conventional Survey at NLTB

A conventional survey required a "point of origin" with known coordinates to be used as a basis for the survey. One day was normally set aside to identify such a point. This can be a trigonometric point or an old survey mark. Even then, the survey mark once identified in the field was also required in the survey to verify the coordinates. Identifying and getting the survey plan can take up to more than a week.

For the conventional survey three instruments were necessary, a measurement tape, a compass and a clinometer. One person records the compass bearing and inclination in his notebook, while two other people handled the measurement tape and measuring the distance to the next peg. However, if there is a change in slope a point had to be established to which the distance was to be noted allowing a calculation of horizontal distance later in the office. If there was an obstacle to the direct boundary line, the team had to survey a line around the obstacle, which required additional compass bearing and slope readings.

The sketch map and notebook was then handed to the draughtsman at the office after the field trip. The draughtsman then calculates a polygon in the horizontal plane out of the recorded bearings, inclinations and distances. If the calculation does not result in closing the polygon, the team has to redo the survey. This will always be the case even if one recording was missing or wrong.

Once the polygon of a survey is closed, then the draughtsman can draw the plan and calculate the area. The draughtsman then digitises the plan to get the information into InfoCAD where he is able to plot a map. The described draughting work takes about one-week for a one-day field survey.

However, the new way of mapping creates digital position data in the field, which is directly imported to GIS, where calculations are performed semi automatically.

The New Way of Mapping

Carrying out the survey with GPS equipment renders it unnecessary to identify a point of origin. Every GPS recorded point automatically has X and Y coordinates in a known projection. Distance measurements and subsequent recordings of inclinations and distances are not necessary. The surveyor just stores a number of GPS readings for every point in the instrument, which will be averaged to provide exact coordinates. He also records his way from peg to peg in the GPS data storage.

A normal residential plot requires about 8 to 10 minutes. In addition the surveyor records the outline of the houses within a plot, which takes an average of 12 to 15 minutes per house.

Back in the office the surveyor himself and not a third person does the area calculation and computerized drawing. After downloading the GPS data he edits the map on the screen with plot and peg number as well as a scale bar. The area calculation and the calculation of distances from plot to plot is handled by the software. In addition to the procedure before, the surveyor carries out two additional activities:

a) he calculates the position for every peg, which is an important documentation and

b) he displays the lots on a 1:50,000 backdrop, which allows easy identification of their location

Figure 1: *Position recording of a fence post used as bounc ary marker in a corner of an residential plot, which has t be separated from agricultural lease area .*

Figure 2: *To avoid multiple path houses were recorded several meters away from roof and house walls. To record a house 8 points were recorded, see figure 3*

The introduced method of mapping and documenting landowner boundaries is more accurate and especially much faster than the conventional way of mapping used at NLTB before. This could be transferred to other organisations in Fiji and other Pacific Island Countries.
One to two maps a day of land parcels were produced jointly during the training by the teams who were in training and transferred to NLTB Head Quarters. Maps were accompanied by a field report. These field reports provided additional documentary information of the x, y position of the markers indicating the boundaries, the distance in meters between the markers and the position of the houses on the land parcels. The map and report production continued after the teams were trained,
The spatial information of land parcels is stored in the divisions and centralised at NLTB Head Quarters, ready to be transferred to other government departments if requested. The workshop carried out in the three divisions demonstrated that NLTB personnel are now capable of undertaking mapping about 10 times faster than before. This is also reflected in the NLTB internal reports.

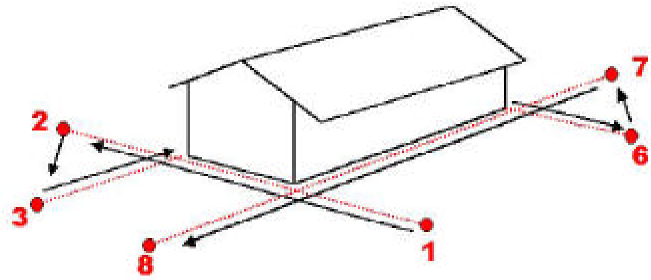


Figure 3: For every house 8 points were recorded in line with the wall, which later were joined within the GIS to create the outline of the house. This procedure does not fulfill the requirements of cadastral mapping. However, it provides a clear picture of house numbers and house locations within a lease area.

The first step of a lease survey was the preparation of a locality map. Maps at the suitable scale of 1:10,000 or larger do not exist for most areas in Fiji and the survey team had to draft a sketch map from available resources such as the 1:50,000 topographic maps or historical land ownership maps at the scale of 1 inch to 16 chain.
The map editing and calculations of areas, peg to peg distances and peg positions took about 45 minutes for 30 to 40 plots. Finally, the surveyor writes a field survey report which should take him

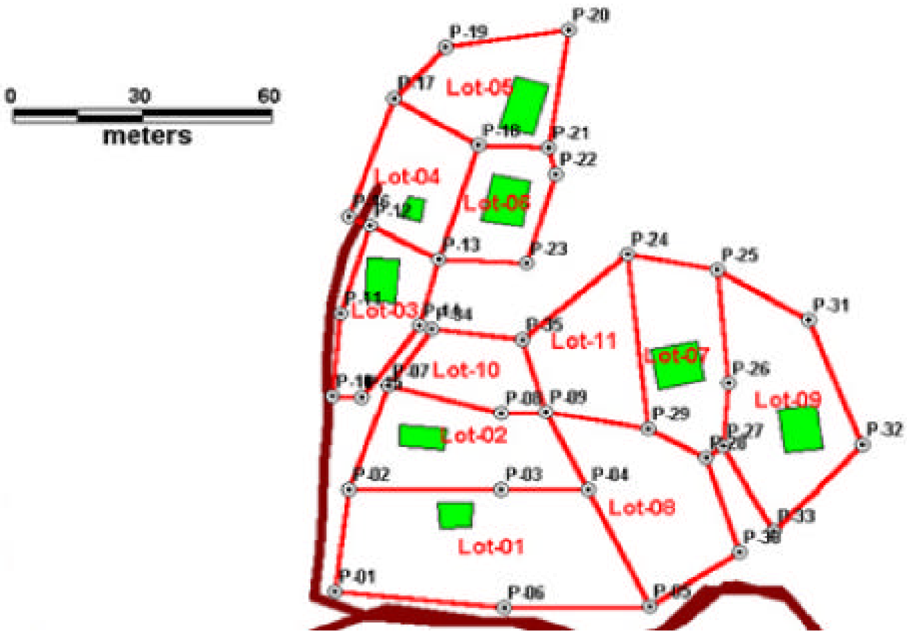


Figure 4: *The GPS survey displayed in the field office after the editing by the field survey staff. The boundary pegs and the parcels are numbered and the corresponding records of the attached tabular database show the peg x, y position and the parcel size as an automated GIS calculation. The house location (green) is clearly visible. Another map of the same field report shows the distance from peg to pep, which helps the re-identification at a later stage.*

about ten minutes as all tables a) lot table showing area, lease type, name of tenants and file record number b) peg table showing coordinates of the peg positions and peg type just have to be imported by copy and paste from Excel to the corresponding word document. The different maps showing a) plot outline, b) peg number, c) distance from peg to peg and d) the lots on 1:50,000 backdrop are directly imported as JPEG images which takes one or two minutes to execute.

Within one day, one person alone should be able to carry out a) fieldwork, b) map editing and c) report writing for about 15 to 20 residential lots depending on the number of houses on the lots and the time required driving to the place and back. These figures do not include discussions of disputed territory between land-owners. This should be solved before the survey takes place. Agricultural lots require much more time due to their larger size. In addition, these lots often have creeks as boundaries, which have to be followed manually with the GPS and this can require more time than the usual boundaries.

Results

The mapping performance recorded in the NLTB internal reports also shows that staff working with the new equipment became highly motivated after firsthand experience of the timesaving effect of the new mapping system. The workshops in the different divisions drew an overwhelming enthusiastic response from the divisional NLTB management when the field staff demonstrated the new way of map production. During the final workshop most organisations present were impressed by the high-resolution GIS backdrop and the technical method of screen digitising from the back-drops avoiding digitising from maps on digitising tablets, which are sensitive in tropical environment. This also applied to the handling of tabular data in Microsoft Access database and linking this tabular data through a common field rather than importing the complete table into the GIS software. NLTB can now realistically present an image of a professional and modern organisation using sophisticated mapping methods which is fundamental to their daily mapping work.

The purpose of the project, which was to increase the speed of mapping by NLTB, has been fulfilled. GPS units left in the project are being utilised on a daily basis. Comparing the old and new methods, the increase in mapping speed is estimated to be about ten times.

For further information contact:
Silika Tuivanuavou, silika@nltb.com.fj

GIS for Fiji Electricity Authority

Timoci Bavadra

Introduction

In today's competitive world, a successful utility must make maximum use of its resources, from people to equipment to information. Using GIS to integrate geographic with other corporate data has become absolutely vital to this task.

In 1998, Fiji Electricity Authority (FEA) set up its GIS with initial funding from regional EU funded energy project. SOPAC was contracted to carry out the initial GIS development and training. However, plans to extend the project were halted as Management shelved the project a year later. After a lapse of more than 5 years, the FEA Drawing Office has been given the green light to re-activate the project in developing a GIS for the FEA Distribution Network.

GIS for FEA

With the main operation of the Drawing & Survey Office now located in Suva, work has begun with SOPAC to prepare baseline data required for the GIS. This ongoing activity will include converting hardcopy distribution network drawings to digital or electronic format over the next 3 years and capturing new data through GPS. FEA purchased 2 handheld Trimble GPS units, GeoExplorer III, from GeoSystems New Zealand.

The tabular database will contain a record of all its distribution assets and keep track of maintenance and servicing of most of its overhead equipment. The information can be accessed and used during operations and for monitoring the distribution system.

FEA plans to capture specific features in Suva over the first 3 months of the project and later expanding to map the remaining Central Division.

Geographical features captured include:

Point features:

- Pole positions
- Pillar boxes
- Underground cable joints

- Street light column

Line features:
- Electrical Overhead conductors
- Underground cable

The meter locations will be captured by on screen digitizing from IKONOS high-resolution image data (see figure 1).
In preparation for the project, integral members of the team have been on training sessions.

A joint one week-long training session with Telecom Fiji was conducted by Wolf Forstreuter, SOPAC at the Vatuwaqa Telecom Training center. Components covered as follows:
- GPS data enhancement in Pathfinder Office,
- Map editing in MapInfo environment
- Report design in MS Office environment.

In a separate training session, Reece Gardner, GeoSystems (New Zealand) conducted a Trimble GPS Mapping Course in Suva. The two-day course covered Trimble GPS Mapping Systems covering field and office operation.

FEA relies on maps for operational purposes. GIS will allow a faster response to customer.

Figure 1: *FEA vector data of street lights, overhead lines and power poles. The map backdrop is a 1:10,000 IKONOS multispectral image.*

Hawaii Synergy Project Offers New Opportunities for Remote Sensing of Pacific Islands

Peter Mouginis-Mark and Blair Craig, Hawaii Synergy project, University of Hawaii at Manoa, Honolulu, Hawaii, USA.

Following a series of meetings during the 11th Pacific Regional Disaster Managers' Meeting in Sigatoka, Fiji, May 5th - 7th 2003, a collaborative relationship was established between SOPAC and the Hawaii Synergy project. The Hawaii Synergy project is one of several efforts sponsored in the United States by the National Aeronautics and Space Administration (NASA). The goal of the national program is the promotion of the use of data from NASA's satellite such as Landsat 7, Terra and Aqua. The Hawaii Synergy project is run out of the University of Hawaii in Honolulu, USA, and has as its focus the use of NASA data for disaster mitigation and preparedness in the southwest Pacific.

Hawaii Synergy's Dr. Peter Mouginis-Mark (Principal Investigator) and Mr. Blair Craig (staff scientist) met with SOPAC's Dr. Wolf Forstreuter and Alan Mearns to discuss collaborations in Fiji and the SW Pacific. Two of Hawaii Synergy's current projects offer good promise for local GIS and remote sensing projects. First, the capability to produce cloud-free images of whole islands using data from the Landsat 7 spacecraft has been developed. Individual images of most Pacific Islands have at least some clouds in them, and so Hawaii Synergy has developed techniques for the removal of these clouds via the combination of several different images collected several weeks or months apart. As a test of this method, a cloud-free image of Fiji (Figure 1) has been prepared from segments of six different Landsat 7 scenes.

Landsat 7 obtains data that have a spatial resolution of 30 m/pixel in multispectral mode, and 15 m/pixel in panchromatic mode. As a result, these cloud-free Landsat images may be used for numerous different applications that call for image base-maps at a scale of 1:50,000 (colour) or 1:25,000 (panchromatic). Mapping watershed boundaries can be aided by such

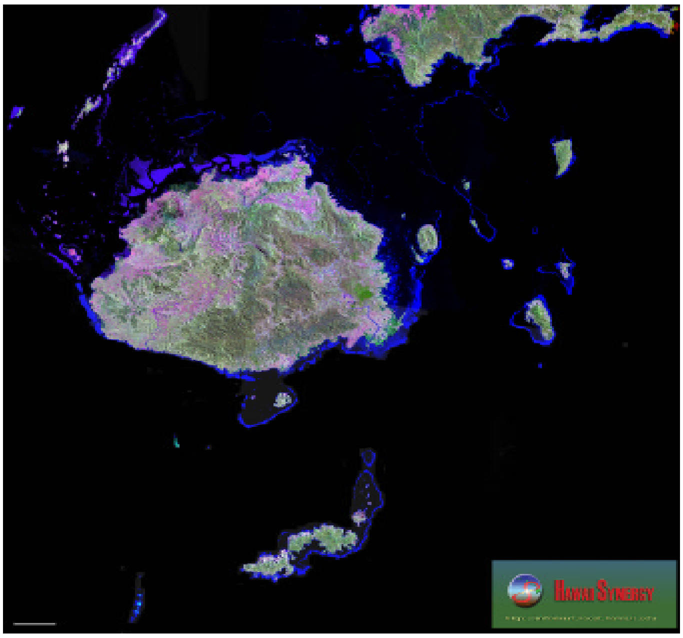


Figure 1: *Cloud-free mosaic of Fiji, produced using 6 different Landsat 7 images collected between February 2, 2000 and February 1, 2003*

maps because they enable the entire island to be viewed at constant scale. By virtue of the many different scenes that have been collected over the same area, it is also possible to detect changes in the pattern of vegetation due to forestry, or in coral reefs due to coastal sedimentation. In some instances, large-scale changes in beach geometry due to harvesting of aggregate for building materials might also be detected.

A second project that Hawaii Synergy has established may also help SOPAC. Considerable experience has been developed in the production and analysis of digital elevation data from radar measurements. Digital topography is particularly useful for the mapping watersheds, as well as the prediction of areas that might be affected by landslides. These data have also been used in some parts of the Pacific to predict where storm surges may affect parts of a coastline. Numerical models that predict where a lava flow may go also use these topographic data. The most recent example of the topographic work that Hawaii Synergy has completed is shown in Figure 2, which is a shaded relief image of the island of Savai'i, Samoa.

TOPSAR data have a spatial resolution of 5 m/pixel, and a vertical accuracy of about 2 meters. The data are collected from an aircraft, and so it is not possible to collect these data over all Pacific Islands, but there is the possibility that the next TOPSAR deployment to the Pacific (planned for 2005) could be requested to collect data over specific SOPAC areas of interest. In addition to working with these TOPSAR measurements, Hawaii Synergy has also developed in-house capabilities to produce digital topographic maps from either the ASTER instrument on the Terra spacecraft, or via orbital radar interferometry, using either the ERS-2 or RADARSAT data sets. Hawaii Synergy has also started to work with data obtained by the Shuttle Radar Topography Mission (SRTM). These orbital sensors provide the ability to determine the topography of much larger areas than TOPSAR, but have a lower spatial resolution (30 m/pixel) and a vertical accuracy of about 15 - 20 m.

At this early stage, SOPAC and the Hawaii Synergy project are still working to define the most helpful projects to collaborate on. It is clear, however, that future collaborations will benefit from the strengths of both partners, namely SOPAC's excellent local knowledge of important GIS issues and Hawaii Synergy's strengths in satellite remote sensing and data analysis. We look forward to these future projects!

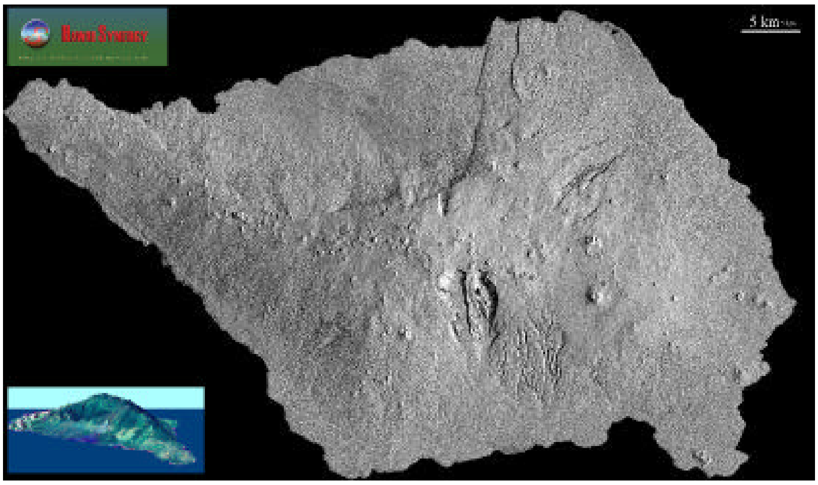


Figure 2: *Shaded relief version of a digital elevation model for the island of Savai'i, Samoa. The map is a mosaic of 11 different flight lines of data collected in 2000 by the NASA TOPSAR instrument. The artificial illumination in this image is from the right, with the Sun at 30 degrees above the horizon.*