Highlights

- **Crime and GIS in Fiji**
- **New projects in the Cooks and in Nuie**
- **GIS activity in Tonga**

Inside

- **Meeting reports**
- **Satellite news**
- **Project updates**

Fiji and South Pacific GIS/RS news

The Newsletter of the Fiji GIS/Remote Sensing User Forum
Issue 98/03
October, 1998

The newsletter expands with input from more countries and more application areas. The outlook: a richer Pacific Island GIS user community.

As a starting point, this newsletter serves as a communication device for the Fiji GIS and Remote Sensing User Forum, a group that meets monthly to share information about recent events. The Forum also provides the opportunity for those who are working on new projects to present the details of their work to others in the local GIS community. There is the opportunity for feedback and the exchange of further ideas in an informal setting. Reflecting this, the newsletter acts to publish the details of each meeting in each quarterly issue.

From the beginning stages of this revitalised publication, we wanted to build something that included areas of the Pacific Island Region besides Fiji. Relative to the rest of the Region, the Fiji GIS community is quite large, as is expected given the overall population and "westernisation" of the island. However, it is fair to say that GIS activity outside of Fiji is notable in its diversity and in its geography...an idea that reflects much that is interesting and unique about the Pacific Islands.

We are very happy that with this, our third edition of the revitalised newsletter, we see a wide range of articles coming in from across the Region. While past issues have seen articles from Tonga and Vanuatu as well as input from the Solomon Islands and others, this issue includes the The Cook Islands and Nuie. In future issues we look forward to articles from even more contributors.

What is also interesting is the wider application base of the articles we receive. In this issue we see articles on hydrographic work and increased activity for water utilities. The article from Nuie outlines the beginnings of GIS use within an integrated Land and Marine project.

A wider user base, both in terms of numbers, member countries, and in different application areas is positive for a number of reasons. The most immediate, perhaps, is that this publication becomes more interesting and informative. And, of course, we like that very much. But a wider base means a more robust GIS user community in many ways.

In its earliest stages, formal training and education is required for human development in GIS. Courses and workshops from SOPAC, USP, and others have been the established methods to upgrade skills and abilities. Technology transfer from the various agencies setting up systems has also been an avenue for education. But this sort of development is only part of the picture.

As the GIS user community gets larger, we will see more education from within. The kind of informal education that results from one-on-one and group discussions between different GIS practitioners. As the user base expands, these opportunities increase. Learning opportunities such as group problem solving and informal information sharing become as important as formal classroom or workshop settings. The comparison has often been made to the term "critical mass", as used in nuclear energy. The idea here is that if enough radioactive material gets going, the nuclear reaction will grow by itself. I prefer the analogy of lighting a fire. At first, you need to pay lots of attention to the small twigs and tinder in your fire, but once the fire gets established, it rapidly expands. So, here's to our fire taking off by itself!

This is also the idea behind the first year-end mini-conference to be held at USP on December 2 & 3, 1998. It will be an opportunity for as wide a group as possible to meet, talk, listen, and share ideas, questions and answers about GIS. Information about the mini-conference will be out shortly. If you do not get this information or would like to receive it, please contact the USP GIS Unit through James Britton at the address on the next page. While we are trying to keep the meeting as informal as possible, it would be great to include as many as we can.

Contents

Publishing

Fiji and South Pacific GIS/RS News is published through the facilities of SOPAC and The University of the South Pacific in Suva, Fiji. Besides acting as the newsletter of the Fiji GIS and Remote Sensing User Forum, this publication serves as an information and news link between individuals and organisations across the South Pacific Region who are interested in GIS, Remote Sensing and related disciplines. Articles focus on how GIS is developing within the Region and feature news on individual projects and organisations, new trends, technological problems, human resource issues, successes and failures. We encourage all types of contributions on a variety of topics from both new and established members of the GIS community both regionally and internationally.

If at all possible, please provide submissions electronically via disk or email as *unformatted* (no boldface, style, layout or other appearance attributes) text files and separate graphic files in their original format (not embedded in wordprocessing files). We can work with most system, text and image formats. If you have an idea for an article, or any questions about submitting articles, please contact any member of the editing team listed below for advice and development help.

Fiji and South Pacific GIS/RS News is available over the Internet through the SOPAC Website: `http:\\sopac.org.fj\`

James Britton
GIS Unit, Geography Department
School of Social and Economic Development
The University of the South Pacific
P.O. Box 1168 Suva, Fiji

Phone: 212 620, 212 651 or 212 542 (679)
Fax: *301 487 (679)*
Email: `britton_j@usp.ac.fj`
URL: `http:\\www.usp.ac.fj\~gisunit\`

Wolf Forstreuter, **Les Allinson**, and **Lala Bukarau**
SOPAC Secretariat
Private Mailbag
GPO Suva, Fiji

Phone: 381 377 (679) Fax: *370 040 (679)*
Email:Wolf: `wolf@sopac.org.fj`
`106160.1053@compuserve.com`
Les: `les@sopac.org.fj`
Lala: `lala@sopac.org.fj`

E-mail access concerns voiced at July meeting

Fiji GIS/Remote Sensing User Forum
Minutes of July 1998 Meeting
Library Conference Room, USP
July 14, 1998

Welcome

James Britton, Acting Director of the USP GIS Unit, opened the meeting at 14:15

Representatives from: Agriculture, FEA, Fiji School of Medicine, FLIS, Forestry, I.T.C. services, Lukemine, MRD, Regional Development, Statistics, Telecom, SOPAC, USP.

Updates

Agriculture

Viti Levu soils layer completed

FLIS

New FLIS News just published (copies available at this meeting)

Forestry

Logging plans now up to 4,015 hectares
Circulated 2 copies of the logging code for interest as follow-up to presentation at SOPAC User Forum Meeting earlier in the year

Lukemine

Garmin hand-held GPS units going into Marine Studies @ USP Notable at circa $F200 per unit. No download capability

MRD

Aero-Magnetic information for Fiji is now available and for sale at MRD. For further information, please see the article by the Director of MRD in the latest GIS/RS News (98:02) and FLIS News
Digitisation of 1:50,000 Viti Levu geology maps is under way. (40 sheets)
A database for rock sample sites has been started. This information is based on logbook data kept at MRD over the past 20 years (approx)

Telecom

Phase 1 completion projected for end of month, Phase 2 continues
100 users now on-line.

USP

Classes about to start for Semester II with project course in GIS and Remote Sensing courses running, plus the introductory GIS course (about 60 students)
Three students completed GIS-based postgraduate courses (two presenting today, the other last meeting)
Five lab sections total will be offered in 1998 in introductory GIS

SOPAC

Hazard Assessment Unit
Building and Assets Survey: Nukua'lofa field work has been completed, post-processing of the GPS data is in progress
Seismic Microzonation Map: nearing completion
Information Technology Unit
1998 aerial photographs of the Suva peninsula are available at SOPAC. They are in digital format (600 dpi) and rectified to the Fiji Map Grid at 0.5m resolution.
A GPS survey was carried out. The comparison made between the base station data at Colo-I-Suva and Lautoka showed minimal difference. The base station at Lautoka will be checked again with the trig points during the next few weeks.
Further permanent update on the SOPAC website will include information about the space borne data available for South Pacific Island Countries.
ITU is preparing for a workshop (2-3 weeks) focusing on Disaster Management to be held in Niue in August. SOPAC will be providing the software - MapInfo and MapBasic. There will be potential for using satellite images for Land Cover Change.
An attachment is arriving in August from the Lands Division, Ministry of Natural Resource Development, Kiribati, for a 2 week training in GIS.

Presentations

Update on GIS-Crime Analysis project
Rashmi Rita; FLIS

Update on GIS activities at Bureau of Statistics
Turega Christopher; Bureau of Statistics

Aerial Photograph Rectification Using GPS Surveyed GCPs
Vilici Kalou; FEA

GIS activity at Fiji School of Medicine
Zaid Ali, Frank Piscioneri, Jan Pryor; Fiji School of Medicine

Other Business

James Britton indicated that FLIC had given strong support to the year-end conference, and he urged all members of the User Forum to begin considering their presentations or contributions. He reminded Forum members that the intention of this first conference was for each participating group to outline the progress they had made over 1998, for example, challenges overcome, work completed, problems still ahead, and plans for the future.

The issue of communications between members of the GIS community was discussed. Noted were the contributions of FLIS News and the newly re-established South Pacific GIS/RS News. Several members raised the issue of electronic communications, particularly e-mail. It was noted that most members of the User Forum were not connected to e-mail and the Internet. Such a connection brings many advantages, especially in the areas of learning, problem solving, and sharing ideas and concerns among other members of the local GIS community and outside experts. Such communication is fast and inexpensive.

Examples of possibilities raised were electronic distribution of the above-mentioned journals, minutes of the GIS/RS User Forum minutes, and the use of *GISPac Net*, the Internet-based GIS information sharing network, which allows questions from individuals to be broadcast easily to a range of users and experts in GIS locally and around the world. Extensive educational resources are available via the Internet and could be accessed by members. This is especially important given the high need for GIS education among all members

The consensus was that all efforts should be made to connect members of the local GIS community as soon as possible. Efforts to support this would include awareness articles and discussion with various managers and other groups by members of the User Forum, particularly those who are connected. (A discussion of GISPac Net is available in the *GIS/RS News* issue 98-02)

Next Meeting

Second Tuesday in August (11th).

Location to be announced

Close

James Britton thanked everyone for attending.

E-mail access concerns voiced at August meeting

Fiji GIS/Remote Sensing User Forum
Minutes of August, 1998 Meeting
Conference Room, FLIS Support Centre
August 10, 1998

Welcome

Iliatia opened the meeting at 14:15

Representatives from ALTA, FEA, Forestry Department, FLIS, GLISSPAC, Lukemine, MRD, NLTB, SOPAC, Bureau of Statistics, Telecom, USP.

Updates

ALTA

The Chair first gave congratulations to Asesela for his new appointment at ALTA

ALTA is just setting up and he envisions a working environment using ARC/Info, MapInfo, and Erdas. He hopes to carry out complete basic analysis and image processing.

Forestry

Restructuring process has resulted in the lost of Asesela Wata to ALTA

Fiji Hardwood Corporation Limited discussions still on-going

Project on-going for Logging Planning for Mahogany stands with emphasis on road alignment, verification of Mataqali boundaries, and verification of small creeks. Emphasis on environmental concerns. Project includes using GPS rover for positional control.

Training: V. Latilevu attends "RS/GIS in Watershed Management" course inThailand

Other projects on-going as normal

FEA

Attachment of FEA staff with SOPAC examining MAPBASIC

FLIS

Vanua View system was commissioned yesterday (more in presentation)

Modification of T&P system completed and now being tested

Electoral mapping—first drafts completed and now with Boundaries Commission.

Street Addressing Committee moving ahead with Pilot Project (Princes Road to Nausori). Rashmi Rita is FLIS representative

GLISSPAC (Private Sector)

Has established links with Ed Lyons and AirResearch in Australia and is open for project ideas/opportunities

Lukemine

Noted delivery problems with some Trimble Products
Trimble Website has data about Trimble product Y2K compliance. Follow-up in GIS/RS News
Noted that Garmin GPS Units sent to USP (see July minutes) worked out to about F$500, plus taxes

MRD

Analysis/Interpretation of Aeromagnetic data leading towards a Regional Integrated Mapping (RIM) project is underway to produce geological maps
Manipulation of Bathymetric satellite altimeter data for Fiji EEZ has started. Hopefully a compilation of surficial information will provide a platform for a structural interpretation of Fiji's EEZ

NLTB

Data input for leases continues in Central and Eastern Divisions
Providing ALTA lease data maps to Government
Providing support land data to Monasavu land dispute issue

Bureau of Statistics

Polygonisation of EA data will be completed by end of week

Telecom (as provided in presentation)

Completion of base data, with completion projected for June 1998
Sixty percent of land coverage is now live.
Training is ongoing with workshop and completion by August 1998

SOPAC

Conducting workshop March 10-12 in the Cook Islands on GIS for marine resources and disaster relief managers
FEA have begun project similar to work already underway in Solomon Islands
Working on cadastral mapping project in Nuie
Distributing MapInfo 4.5
Provided two weeks training in MapBasic programming. The programs created update the MapInfo standard menu; the programs are transferable to other utilities; the source code is open
On Wednesday 12.08.98, a GPS base station and one rover unit will be delivered to TEPB in Tonga. Both parts were tested and they are working well
LADS Corporation (Australia) explained their system at SOPAC. The laser based instrument can record water depth up to 70m with a spatial resolution of 5m or better. The system is GPS connected, the raster data can be easily used to produce sea bed surface models; however, such surveys are very expensive. An article will be included in the next newsletter
On Wednesday this week the water utility of Suva will visit SOPAC to discuss transfer of FEA GIS set-up
SOPAC is in discussion with NRSA (in India) for purchase of panchromatic 5m resolution image data. This will be an input for a GIS/RS workshop held in Niue by end of November this year.
Seismic microzonation maps are now available for the cities Suva, Honiara, Port Vila and Nukua'lofa
The building and assets survey for these four cities is complete regarding the fieldwork. Data post processing is in progress

USP

Nothing new since semester start (see last month)

The meeting Chair noted the importance of the updates and asked all members of the User Forum to provide quality updates.

Presentations

Suva Area GIS Backdrop Data from Aerial Photography
Olivier Dupperay, SOPAC
Notes: Rectified Digital Aerial Photography Data is available for $50.00. Format: .TIF files with accompanying MapInfo .Tab files

Vanua View
Rashmi Rita, FLIS
Notes: Vanua View is a fast-access, seamless viewer of GIS data
Currently has cadastral data entered
Data and system will be available at commercial rates through FLIS

Update on Telecom Projects
S. Shandil, Telecom
Notes: System is coming together well
Data conversion is completed
Over 100 networked users over the country

Other Business

None

Next Meeting

SCC was asked if they could host the next meeting. They will investigate, but have not hosted before. James Britton agreed to coordinate the meeting for SCC. Next meeting is Tuesday, September 8th.

Close

Ilaitia thanked everyone for attending

Meeting held at Suva City Council for first time

Fiji GIS/Remote Sensing User Forum
Minutes of September, 1998 Meeting
2nd Floor Foyer, Suva Civic Centre

Welcome

The Chair, Mr. Kevin McConell brought the meeting to order at 2.20

Aneesh Singh, gave a short welcome speech on behalf of the host, Suva City Council .

Representation from NLTB, GLISSPAC, Police, Wood & Jepson, USP, SOPAC, MRD, FSM, Agriculture-Landuse, Telecom, Forestry, PWD, FEA, FLIS, Lukemine

Updates

Agriculture-Landuse

Soil map of Fiji completed

FLIS

Two pilot projects underway—Property Addressing and Site Suitability for Commissioner Central
VanuaView Version 1.1 to be released soon
The objection period for election mapping over, final mapping to be completed in two weeks

Forestry

Lukemine

MapInfo Version 5.0 to release soon

MRD

Aerial-magnetic Data—Ground truthing is been carried out by geologists using the magnetic susceptibility meter.
Large parts of VitiLevu have been covered and at present work is under way for the Vanua Levu region. This will Contribute to the production of Fiji's ??? maps
Mine Tenanment area Management - Work has began to manage Fiji's surface area leased for mining prospecting purpose through a GIS Based database
Bathymetry Data- The processing of altimetry data for Fiji's EEZ is still underway. It is hoped that results will be available in SOPAC's annual session at the end of October.

PWD

Digitizing in Suva & Nausori Area

SOPAC

Recording ground control points for rectification of Airsearch Photographs
Rectification of Honiara air-photos
Hydrodynamic modelling of Majuro

Telecom

Data maintenance work for Tamavua, Samabula and Suva are underway with completion expected by October 30, 1998
Data capture for Nasinu Cabinet 'E'-Laucala Beach area recabling pilot project is underway with completion expected by September 18, 1998
Rolta staff currently on-site training staff for these projects.
Suva City house numbering project nearing completion. Approximately 7,500 houses complete with 3,000 more to go.
Lautoka addressing beginning
Cane farm number data has been found. Over 22,000 farms to be entered into system by October 30, 1998
GIS system now in use for customer applications with excellent results. Data available for Central and Western Divisions and Lautoka.
Requirements analysis completed for Phase II (block wiring) project. Application due for completion by February, 1999
Overall GIS end-user logs show increased GIS usage across system.

USP

On Mid-Semester Break

Presentations

Addressing Update
S. Shandil, Telecom

Project Updates
Olivier Duperyay, SOPAC

FMG Datum Update
Franck Martin, SOPAC

Other Business

None

Next Meeting

FEA to host the next meeting in Lautoka on Tuesday 13th October at 10.00.

Close

Kevin McConell thanked everyone for attending.

GIS and Remote Sensing Unit for Agriculture

by Asesela Wata

Introduction

The Land Development and Resettlement Unit of Fiji's Agricultural Department wants to establish its own GIS and Remote Sensing unit to add spatial data to the existing tabular database. This is necessary for two reasons:

- The *forecast of agricultural harvest* becomes more important and it is essential to add area information to any tabular data, to enhance precision;
- Agricultural area becomes smaller and *potential agricultural areas* have to be identified, which requires spatial data analysis to estimate the land capability.

Available Data and Required Spatial Data

The Agriculture Department already holds data about the production costs such as

- Work unit costs for agricultural production,
- Amount of fertiliser used,
- Degree of mechanising,
- Distance of the production area to the market.

To estimate the market development it is essential to know: the exact area of production and classified information about the area, e.g. due to

- soil categories,
- slope classes,
- water drainage categories,
- land tenure restrictions,
- flood risk levels.

To obtain this information it has to be imported to digital map layers, such as

- Mataqali boundaries;
- Infrastructure, roads, tracks, bridges etc.;
- Soil maps;
- Rainfall maps;
- Slope, exposition and height above sea level;
- Flood risk levels
  (detailed contour lines for lower area).

Other information has to be analysed from remotely sensed data, such as

- Recent land use,
- Change of land use,
- Land slides.

Expected Output

The main output is expected as clear statistic figures based on exact area analysis combining and analysing different information layers.

Besides this, maps are required at 1:50,000, 1:25,000 and 1:10,000 scale showing the location of different harvest expectation and potential agricultural areas. Such maps are not only necessary on management level, but also on operational level to assist in planning and performance.

Required Hardware and Software

ArcInfo is already available at the Agriculture Department. *MapInfo* will be added. To perform overlay analysis for scattered areas at 1:50,000 scale a raster data GIS is required. For land cover analysis, land cover change detection or erosion monitoring remotely sensed data has to be analysed. This can be done with aerial photographs if recent images are available and purchasing satellite data will be carried out. Satellite data will become more important because a new generation of data is expected by the end of the year, allowing thematic mapping up to to 1:10,000 scale.

Both image analysis packages *ER-Mapper* and *ERDAS* Imagine will handle both raster data GIS analysis and all functions of image handling such as geometric correction, image enhancement and image classification. It is still open which of the two software packages will be purchased. The hardware will include PC, an A1 size ink jet plotter, digitising table and backup media.

GIS For Crime Analysis

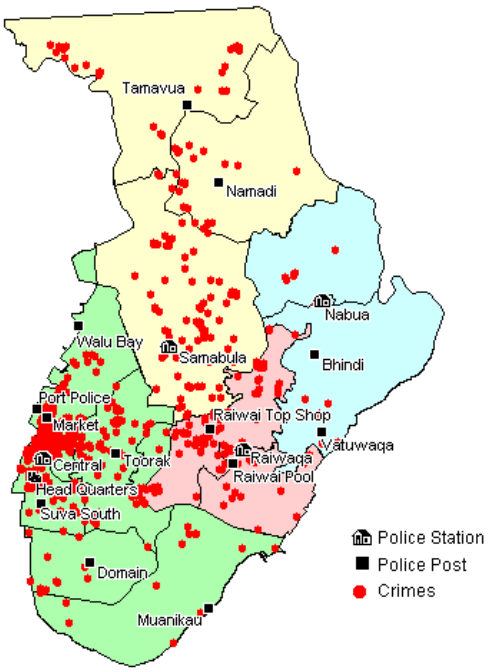
by Rasmi Rita
Project Officer, FLIS

Why GIS for Crime Analysis?

For decades, police departments have relied on paper "pin maps" to identify crime locations and patterns. Crime analysts from each station update crime locations each day by manually inserting pin markers on outdated printed wall maps of their patrol areas. Although is possible to see crime locations, there is no connection between the pin map and the reports. This situation is slowly changing, as police departments are becoming aware of the capabilities of Geographical Information Systems (GIS). GIS systems store and manage representations of geographic features. These same systems also store attributes of these features, permitting spatial analysis of variables that cannot be easily

...continued from previous page.

visualised with tables and lists. GIS has great potential in crime analysis because of its three key functions: database management, spatial analysis and visualisation. These functions provide the capabilities of linking criminal acts and their multiple characteristics with their geographic locations. GIS is a sophisticated tool which can perform a wider range of analysis tasks and provide clues for police investigations.



Map 1: Stations, Posts, Boundaries and Crimes

Social Issues

Crime is a social problem everywhere and no development in either law or penology seems to have any impact on the problem. On the other hand, improvement in police technology, crime analysis and efficient use of resources has had a significant effect (David A. Thomas, Reader in Criminal Justice, University of Cambridge; author *of Principles of Sentencing*). The objective of police and society is to reduce criminal activity. The problem is not simply overcoming the fear of crime but also discerning where, why and who is committing those crimes. There is a need to understand the correlation between the socio-economic structure of community and nature of criminal activity in order to solve and prevent crime. GIS is a tool which will help the police do this. GIS analytical capabilities can help visualise the correlation and track crime patterns. GIS has the potential to help target crime areas with preventive measures. Through GIS, communities could be given better information on crime in their immediate areas. This would help the community to work with law enforcement officials to determine what are best means to reduce the crime rate in their neighbourhood

Fiji Police Force Pilot Project

One of the key functions within the remit of the Fiji Police Force's daily responsibilities is its crime analysis operational activities. The work involves locating and identifying crime patterns using paper pin maps to assist in the investigation. However, this method has various shortcomings, such as being fairly labour intensive, time consuming and having limited display capabilities. With the apparent increase in the crime rate within Fiji, it was realised that the current system cannot cope up with the increasing demand or work load. Therefore, a more sophisticated tool is needed by the Fiji Police Force to address these difficulties within the present system for more effective and efficient services. By using Geographical Information systems (GIS) as an alternative method of analysis, not only can the current difficulties be overcome but the Police Force will be able to perform a wider range of analysis functions.

Map 2: Crime by category

However, members of the Fiji Police force are not fully aware of the capabilities of a GIS system in crime analysis. As a result of a recent visit to the Fiji Land Information Support Centre (FLISSC) by a delegation of senior police officers led by the Commissioner of Police, it was decided that a pilot project should be developed for the Police. Developing pilot projects is part of FLISSC awareness program. FLISSC set up a pilot project named "Crime Analysis and Mapping Prototype" (CAMP). Its major objective is to develop a prototype GIS System for crime analysis for Suva City in order to demonstrate the effectiveness of using GIS for crime analysis to the Fiji Police Force.

The area chosen for the pilot project was Suva Peninsular, which consists four police stations and districts - Central, Raiwaqa, Samabula, and Nabua. Using MS Access for the attribute database and MapInfo Professional 4.5 for the GIS components, FLISSC established a sample system using crime reports from the first quarter of 1998.

First a database was set up and a crime report form created. Hard copies of the forms, which also included a page for sketch of location, were sent to each station. From the sketch map on the crime report form the crime location could be linked to the spatial database. Details of the individual crime, also found on the report form, made up the attribute tables attached to the spatial data. Police stations, posts and boundaries were digitised into the system, and existing spatial data layers from CCMS were imported to form the spatial database. Then using the sketches from the forms, each crime was plotted and crime number (key field) entered.

The database and maps were linked. A custom program automatically filled x & y coordinates and the key field in the database. All the other details of crime were recorded in the Access attribute database because it is easier to handle relationships such as one crime, many suspects in a database. Now since the crime locations were mapped and the details were in both MapInfo tables and Access tables, it was possible to create queries, thematic maps, buffers and other GIS Analysis.

Since such queries were generally not possible or feasible using the older, manual systems, Police Force staff were not sure at first what sort of queries would be useful or possible. However, once the capabilities of the system were clear, they soon worked out a series of useful queries. These included

- Crime locations
- Distance from a particular feature
- Number of crimes per district
- Crime hot spots
- Crimes modus operandi same.

Suspect details

It was also possible to create thematic maps by category, modus operandi, detection, crime density, etc. Such maps had never been created by the Police Force. Maps 1 and 2 show crime locations by crime category.

There are many questions that could be answered by such a crime-related GIS system; however in this pilot project the range of possible queries was limited by the number of attributes for each crime available through the crime reports filled in by the reporting officers.

In order to set up a workable GIS System, the Police Force has to first improve and set strict standards for data collection and recording procedures and to ensure that the field police officers adhere to these standards. FLISSC has been able to show the Police Force the advantages of using GIS. Although the use of information technology has and will provide the ability for more sophisticated systems, the Fiji Police Force has to make a start in adapting their methods to support such systems.

FLISSC and Fiji Police Force would like to acknowledge USP, SOPAC & Digital Corporation for their support in this pilot project.

Mapping at Management Services Division, Department of Forestry

By Eroni Tupua and Samu Uluikadavu
Management Services Division, Department of Forestry

Introduction

The mapping system at Forestry was installed as part of the AusAID funded Fiji Forest Resource Tactical Planning Project (1994-1996). The installation of the system and training of staff was carried out during the period 1994-95. This paper documents the system, and reviews its progress to date.

Purpose of the System

The system was installed to allow Forestry to prepare 1:10,000 scale topographc base maps. These maps are used in the preparation of logging plans. Logging plans form the basis of logging operations. By having good maps, forestry operations can be better planned, which greatly improves the residual effects of logging. Good plans allow the forester to

- minimise where roading and skidding tracks are placed,
- avoid creeks and streams,
- minimise erosion effects,
- isolate logging in steep areas,
- specify watercourse buffer areas.

The net outcome is that better planning leads to improved forestry operations, and this is a direct benefit to the environment, in terms of cleaner water streams, and reduced siltation.

System Components

The mapping system is divided into two distinct sections. They are

...continued from previous page

- A GPS system used for ground control of aerial photography, and for adding detail to existing mapping, and
- A computer based stereoplotting and map editing system.

GPS system

The GPS system consists of a base station and a hand held GeoExplorer receiver. A further two receivers were acquired, one supplied jointly by the AusAID project and Forestry, and the other by the European Union funded hardwood plantation project (1996). The Department of Forestry now has three roving GeoExplorer receivers.

The Trimble Navigation Community base station was installed on the top of the Forestry garage at Colo-i-Suva. This point was surveyed accurately by The Department of Lands, using their survey grade GPS receivers. Co-ordinates were supplied in both WGS-84, and Fiji Map Grid (FMG).

The mapping advisor to the AusAID project subsequently derived a uniform set of parameters to be used in the transformation between WGS-84 and Fiji Map Grid. The GPS system works on the WGS-84 spheroid, while the Fiji Map Grid is based on the WGS-72 spheroid.

When the system is used in differential mode, a single observation is accurate to the 2-5 metre level. This is the accuracy as supplied by the manufacturer, and our experience with the system verifies this accuracy. It is possible to increase this accuracy by observing a greater number of GPS observation at each point observed.

Transformation Parameters

The transformation parameters were derived from a set of First Order control co-ordinates provided by the Department of Lands. The network included points in Viti Levu, Vanua Levu and the Lau group. The transformation paramters derived can be considered to be accurate at the one metre level. These parameters were derived for use in preparing 1:10,000 scale forest maps. Care should be taken if these parameters are used for other applications. The seven parameters derived are :

Parameters from WGS-84 to WGS-72

X = -35.176 metres	x = 1.371 secs
Y = 136.57 metres	y = -0.842 secs
Z = -36.965 metres	z = -4.718 secs
Scale = 1.537 ppm	

Use of the GPS system

The GPS system is used for the ground control of aerial photgraphy, and for adding mapping detail to existing mapping. Points are identified on the aerial photography, and survey ground control is derived using the GPS roving receivers in the field. When selecting points in the field, a field stereoscope and aerial photographs are used to ensure that the correct point is chosen. A minimum of 120 GPS observations at 5 second intervals is observed for each point. Initial trials of the GPS system of the system, by observing other First and Second order control throughout Fiji, has provided Forestry with the confidence that points can be observed to the one metre accuracy level.

The GPS system is also used for adding detail to the existing base maps. Some of the aerial photography used is often dated, and in time infrastructure features such as roads and logged out areas change. This detail is now mapped using GPS and the information overlayed in the mapping system to reflect the changes. Lease boundaries, compartment and stand boundaries can also be mapped and overlayed onto the mapping.

The Mapping System

The mapping system installed at the Management Services Division is a Zeiss Visopret, connected to the computer based Microstation package. This allows the operator to view stereospopic aerial photography and directly map the terrain with both point and line features. In general the following detail is collected :

- linear features such as ridgelines, creeks, and roads;
- spot heights;
- where applicable, cleared and/or vegetated areas;
- buildings, villages and other artificial features.

After the collection of data from the stereoplotter, the data is transferred to another computer, also running the Microstation software. This system has Microstation and and an add-on software package called GWN-DTM, which allows the operator to build a digital terrain model using the data collected from the stereoplotter. After building the terrain model, contours are automatically produced, and final map editing allows the production of maps at 1:10,000 scale.

The GWN-DTM software package has the ability to produce the following products from the digital terrain model:

- Slope analysis,
- Plane and slope areas
- Longitudinal sections,
- Road design and volumes,
- Aerial Triangulation.

Aerial trinagulation is the process of extending ground control to aerial photography without the need to acquire 4-6 ground control points for each stereo-model. The process requires the operator to prepare the aerial photography by placing marks on the photographs (pugging) using a point transfer device. The marks are then observed in the stereoplotter and the results processed through a computer program that computes the ground control coordinates for each pug mark. As part of the mapping system the program PAT-M was purchased to undertake this adjustment. In undertaking the aerial triangulation, Forestry uses the Department of Lands point transfer device, while Lands uses Forestry´s PAT-M program.

Mapping Progress

The mapping system was installed in April 1994, and training of staff within the Forestry department commenced from that date. Up to the period December 1995, a total of approximately 52,000 hectares of 1:10,000 scale topographic mapping was completed. Since 1996, a further 62,000 hectares have been completed. The Department is now at a stage where demand has been met, and there is now a slowly declining need for further mapping. The emphasis is now on preparing 1:10,000 scale topographic maps for the hardwood plantation areas.

Acknowledgements

The authors would like to thank AusAID for their major contribution to the provision of the mapping system and the local training of counterpart staff. The benefits of the mapping combined with the training of forestry staff in logging planning has greatly enhanced the standard of forest harvest practices in Fiji.

GIS/GPS Systems for the Suva Water Supply

A recent meeting was held between the management of the Suva Water Supply (under the Water and Sewerage Section of PWD) and SOPAC staffs to discuss the introduction of GIS/GPS systems to improve the performance of Fiji's largest water supply system. SOPAC staff made several presentations showing what is required to set up a GIS system to meet the on going demands of the Suva water supply plus the potential benefits. The presentations highlighted the training aspect of the proposed project and the fact the most additional add-on software routines may be developed by staff themselves knowing that SOPAC backup support is not far away.

Demonstration of a small GIS example containing water related information was given. Mr Wilisoni, Principal Engineer, got an insight into the power of GIS based data management and its application to the operation of a water utility. The possibility to collect data by using GPS and the need to connect to GIS with water distribution modeling software was emphasised.

The next step is to develop a project that meets the current and future needs of the Suva Water Supply.

Vanua View: Land titles for the masses.

Observations by Franck Martin
SOPAC

The Fiji Land Information System, FLIS, is introducing a new tool for land planners, real estate agencies and other bodies. *Vanua View* is a software package developed by TerraLink, a New Zealand company, to visualise the geographical information held at FLIS. This package is composed of a CD containing the data and the software to display the data. The FLIS is planning to provide monthly upgrades. A subscription scheme will be available to customers.

The software allows the display of the cadastral information of Fiji. It will simplify the process of locating information about land plots. The advantage of the software is its fast rendering engine and its query system, which has been tailored for the Fiji data sets. However, the system does not allow exporting data and its sole purpose is only data displaying. It is unfortunate that the software does not allow reporting of geographical co-ordinates of land units as registered through surveys. It is understood that this function is not available as the original data stored on Microstation is not organised as land units but simply as a line collection which does not retain geographical information such as surfaces and tabular information.

Vanua View brings new flexibility to the land information, as it will set the FLIS in a process of monthly updates available to the public. It also fits in the FLIS policy of cost sustainability of the land information system by requesting users to pay for the data; however, one may wonder why government bodies and the public should pay for data they already own through taxes.

Laser Now Collects New Coastal Data for All Pacific GIS Users

by Hamish Jolly
LADS Corportation

High density bathymetric data represents the basic GIS data set required by GIS managers for decision-support in relation to marine coastal zone management issues and inshore marine resources. This is particularly important for Pacific Island nations whose populations rely heavily on the coastal marine environment.

Using advanced techniques, coastal bathymetric data can now be collected quickly and cost effectively using the Laser Airborne Depth Sounder (LADS Mk II), so that a full coastal bathymetric data set (for waters up to 70m deep) is now within reach of most Pacific Island nations. Where development funding may be required, the full data set can be delivered in a timeframe consistent with a conventional development project.

The new generation LADS Mk II surveys up to 64sq km per hour, to a depth of 70 metres at a fraction of the cost of conventional surface vessel operations. As well as nautical charting to IHO Order 1 accuracy, the high density processed ASCII digital data products underpin GIS modelling and analysis for:

- Coral Reef Management
- Fisheries and Aquaculture Management
- Mineral, Oil and Gas Resource Development
- Inshore Marine Transport
- Environmental and Waste Management
- Natural Resource Management
- Tourism

Australian Experience in the Pacific Environment:

The LADS system has been used in continuous routine survey by the Royal Australian Navy for nearly six years and has collected 45,000sq km of survey data over the Great Barrier Reef in the Pacific and in the Timor Sea. New generation LADS Mk II surveys are now being conducted commercially worldwide through LADS Corporation Limited of Australia.

In Australia, LADS data has been used for identification of new navigation routes, territorial sea and EEZ baselines, modelling of marine processes and coral reef management. Users include the Hydrographic Office, Department of Transport, AUSLIG (Land Information Group), Australian Institute of Marine Science, Great Barrier Reef Marine Park Authority, exploration companies and commercial tourist operators. It is estimated that with the use of LADS, Australia will reduce its EEZ survey backlog from 100 years to 15 years, providing critical data to these and other GIS users in the management of Australia's coastal marine resources.

LADS MK II System Operations - 900 Soundings per Second

LADS is a self contained, transportable hydrographic survey system mounted in a fixed wing aircraft which uses laser pulses to gather accurate, high density, digital depth and position data in coastal waters.

The system uses pulsed laser to provide high density soundings at 900 per second in a survey swath 240m wide independent of water depth. Each laser pulse is returned

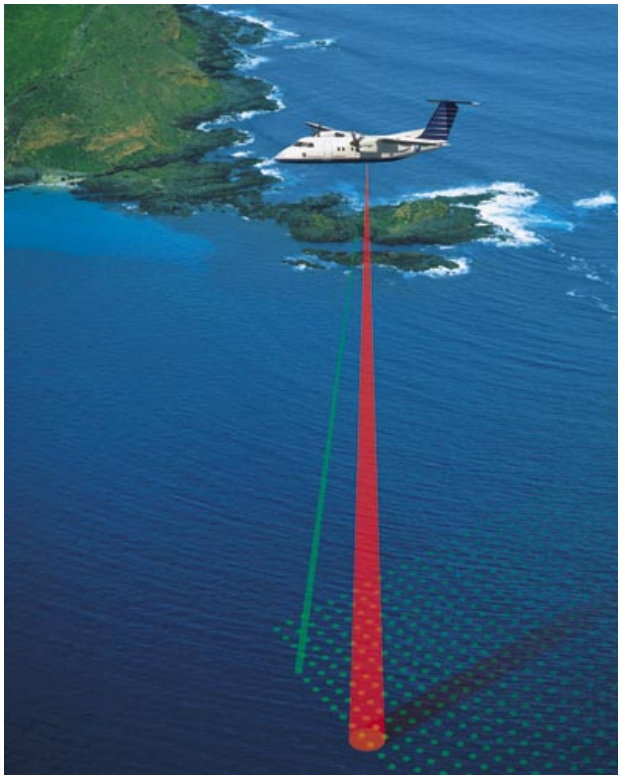


Figure 1:
LADS Aircraft with red and green laser operating

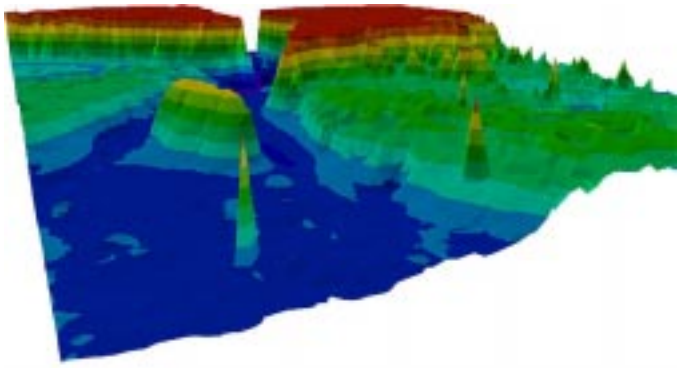


Figure 2: 3D Passage between reef

from the surface and also from the sea floor. The system works by measuring the time differential between these two returns to a high level of accuracy.

Specifically, the LADS Mk II System operating specifications are:

- Sounding Rate: 900 Hz (3.24 million soundings / hour
- Area coverage: 64 square kilometres / hour (19 sq nm / hour)
- Sounding density: 5m x 5m (2m x 2m, 3m x 3m,4m x 4m capability)
- Swath width: 240m
- Depth range: 0.5m to 70m
- Depth accuracy: S44 IHO Standard for Hydrographic Surveys – Special Publication of 4th Edition 1998, Order 1
- Position accuracy: 5m CEP 95%
- Data processing to data collection ratio: Better than 1:1
- Output: Fairsheet plots and digital data in ASCII format

The digital data products read easily into common GIS applications such as ArcInfo, Mapview and Fledermaus for GIS modelling across the full spectrum of users.

Application for Pacific Nations:

The large archipelagic maritime states of Pacific Island nations are a significant and important resource for their communities. However, hampered by hazardous coral reefs which prevent conventional survey, geographical remoteness and constraints to long term and recurrent

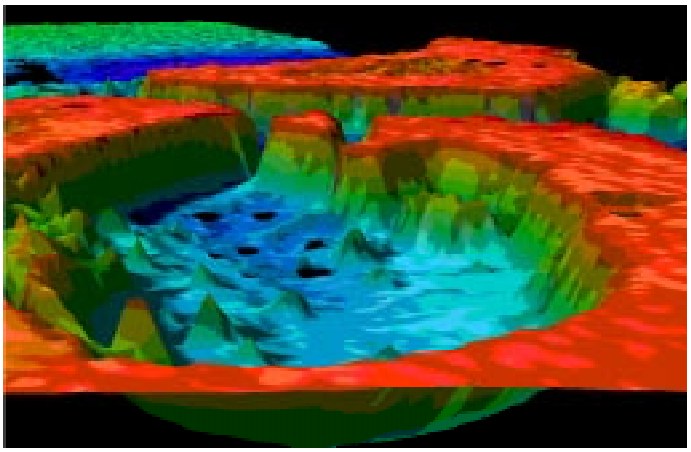


Figure 3: 3D view of coral reef enclave

funding for surface vessel operations, much of the shallow waters in these regions remain unsurveyed.

In contrast, for LADS Mk II the clear shallow seas, reef areas and remote islands of the Pacific region represent optimum conditions for survey. Using the fast fixed wing deHavilland Dash 8 aircraft which can accommodate long transits to remote areas in an 8 hour sortie, a complete set of fairsheets and high quality bathymetric data sets can be provided for GIS modelling of national coastal waters within months rather than decades. Combined with the wide capacity for usage of data in environmental and resource management and economic and regional development, a LADS Mk II survey project is therefore an attractive project option for development funding through multilateral or bilateral agencies active in the Pacific region.

Simultaneously, Pacific nations can discharge their obligations for concise survey of EEZ regions under the United Nations Convention For Law of the Sea and consolidate their legal rights and obligations for EEZ management.

LADS Corporation Limited

LADS Corporation is a multi-disciplined company dedicated to LADS activities. LADS Corporation designs, manufactures, supports and provides world wide contract survey services using the LADS Mk II System in its Dash 8-200 aircraft. LADS Corporation personnel includes engineers (computing, electronics, mechanical and optics), scientists, project development specialists and hydrographic surveyors.

Hamish Jolly is Project Development Manager with LADS Corporation Limited
Telephone: +61-8-8300 4447 FAX: +61-8-8349 7528
e-mail: Hamish.Jolly@vsl.com.au
Website: http://www.vsl.com.au/lads

Charting In Tonga

By Stuart Evans
Chief Hydrographer, Tongan Army

Tonga is a Kingdom of over 170 islands, spread over about 400 miles in a roughly NNE/SSW alignment. Some of Fiji's islands are closer to the main island of Tongatapu than the outer Tongan islands. Some of the greatest depths on Earth are to be found in the Tonga Trench to the east and some of the world's most complex volcanic and coral topography is to be found in the shallow waters and coastal zones of the Tonga Ridge.

Charting the seabed throughout this area would be challenging with even the most advanced technology. It is that much more difficult without the resources to acquire and operate new technology and equipment.

Inroads are being made though, and since its formation in 1990, the Hydrographic Unit of the Tonga Defence Services Navy has completed a major survey for a new chart of the approaches to the main port of Nuku'alofa. The Unit is currently 70% through another major survey of the approaches to Lifuka in the Ha'apai group. A number of other large-scale port, harbour and wharf approach surveys have also been completed.

The main equipment used is single beam echo sounder, with an Atlas Deso 20 installed in the Pacific Class 31.5 metre patrol vessel VOEA Savea, which has a secondary role as a survey vessel. Shallow water inshore surveys are done from a 4.5 metre outboard powered launch using a portable 208 Khz shallow water sounder. The Unit has a good range of land survey equipment for geodetic positioning and control. Dynamic positioning is normally achieved to better than 3 metre accuracy with a Del Norte Trisponder microwave positioning system or by theodolite bearings and geodimeter ranges for small area, large scale surveys.

Eleven charts currently cover Tonga's waters, but nine are mostly based on surveys carried out by the British Naval ships "Egeria" and "Penguin" in the 1880s and 1890s. Using hand leadline and sextant angles, soundings were reasonably accurate but sparse. Geographic control was established by stellar observations. Latitude was relatively easily established by observing meridian altitudes of stars. Longitude was a little more difficult and to obtain accurate time, the ships made double runs between Tonga and Auckland to establish a "chronometer rate" from the Pacific Standard Control established at Auckland.

The relationship between these early positions and WGS 84 is, however, inconsistent and cannot be accurately established for the transposition of charts to WGS 84. GPS cannot therefore be used safely when navigating on these older chart datums.

Some triangulation data, related to WGS 72, was established by the RAN in the 1980's using Transit Doppler Satellite stations, accurate to within a few metres after exhaustive processing. Subsequently, a series of stations related to the WGS 84 spheroid were established by DGPS with assistance from the Forum Fisheries Agency, for the purposes of establishing Tonga's sea area delimitation baselines.

Some perverse surveying law, however, dictates that established control points are rarely near the area of survey operation or, even if they were, have been destroyed or obliterated for one reason or another. We have devised a method obtain control positions by using hand-held standard Ensign GPS receivers. This involves analysing 480 positions recorded at half-minute intervals over a period of 4 hours. Readings with unacceptably high Dilution of Precision (DOP 4 or greater) and obviously wild positions are discarded and results are reduced and averaged by analysis of standard deviations to hopefully produce a position accurate to within a few metres.

The acquisition and processing of data by this method is very laborious and time consuming and the results can barely be considered sufficiently accurate and consistent for good geodetic control. The unit is therefore very keen (if not desperate) to obtain sub-metre accuracy DGPS for both absolute geographic control and for positioning of soundings from the survey vessel.

A possible step forward is the installation by SOPAC of a DGPS Community base station at the Tonga Electric Power Board in Nuku'alofa which was recently commissioned by Dr. Wolf Forstreuter and his team. The Unit would like to take advantage of this base station and is now seeking assistance for the provision of remote GPS receivers, radio links and a modem so that differential corrections can be transmitted and used in real time for our survey and re-charting work.

Stuart Evans is Chief Hydrographer with the Tonga Hydrographic Unit

Department of Water Works GIS in the Cook Islands

By Ben Parakoti

A planning and design project for upgrading the water supply sub-main pipeline on the eastern side of the main island, towards the northern side has been under way in the Cook Islands since June 1997. Known as "Project East", the project is supported and funded by NZODA. For the project, topographical surveys were carried out with the use of basic survey equipment and AutoCAD was used for the map plotting. Recently, however, these basic methods have been enhanced through the increased awareness of the capabilities of GIS.

During March 1998, Leslie Allison and Franck Martin from SOPAC ran a one-week GIS course in Rarotonga. The purpose of this course was to expand the use of GIS in the Cook Islands. This course was very helpful to the Department of Water Works in understanding GIS and MapInfo software and it also has enhanced our database system.

With the expanded capability and now current availability of GIS, we were able to establish MapInfo as our main database system. MapInfo was appropriate to what we were looking for in the improving the Rarotonga Water Reticulation System database. The two main software systems used were AutoCAD and MapInfo. The AutoCAD software permits the creation of accurate linework for the topographical survey data.

Because of the compatibility of this software with MapInfo and other software, we were able to transfer AutoCAD drawings across to MapInfo to establish the full spatial database. The combination of the spatial and attribute data within MapInfo gives us a increased ability to store valuable information and create tables for clarification and costing of the pipeline network.

We would like to take this opportunity thank SOPAC, Leslie and Franck for their help and support with improving the spatial database of the Rarotonga Water Reticulation System. We would also strongly recommend the use of GIS for Utilities.

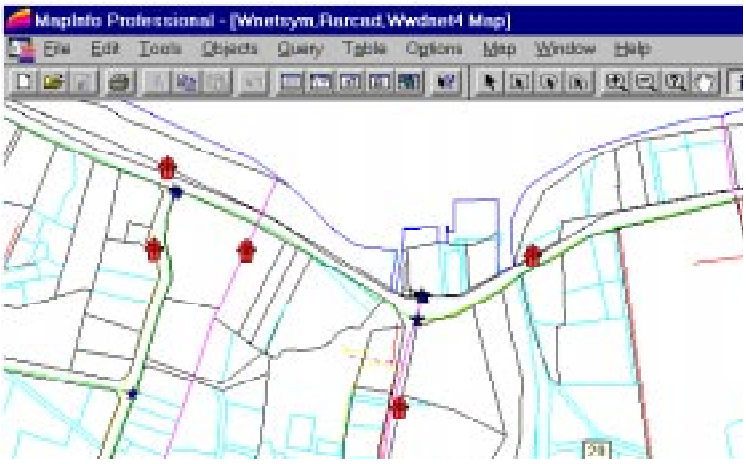


Figure 1: Typical display of Cook Islands Water Utility GIS. Hydrants, valves and pipes are stored in different layers. By clicking on them all attribute data such as size, material and last maintenance are displayed.

Tonga Water Board GIS more than just a trickle down effect

By Vince Hazell

Tonga Water Board (TWB), in conjunction with ACTEW Corporation, and as part of an ongoing AusAID regional strengthening project are working towards a complete GIS assets register. TWB engineering staff are using MapInfo to construct water supply reticulation data for the Tongan islands of Tongatapu, Lifuka, 'Eua and Vava'u. The TWB GIS data has been under construction for some time and has recently undergone a progress review by ACTEW staff to ensure the long term benefits of a GIS can be realised.

TWB supplies water to Nuku'alofa, the capital, and to three other townships: Niefu on Vava'u, Pangai and Hihifo on Lifuka and settlements 'Eua. This represents approximately 60 percent of households in Tonga, with the majority of these households being within the bounds of Nuku'alofa. Most water is produced from pumping groundwater from leased well fields and delivered to consumers by way of storage tanks and gravity feed reticulation networks. The only TWB supply system to use surface water supply is 'Eua, which has a number of intakes on a number of streams coming from caves.

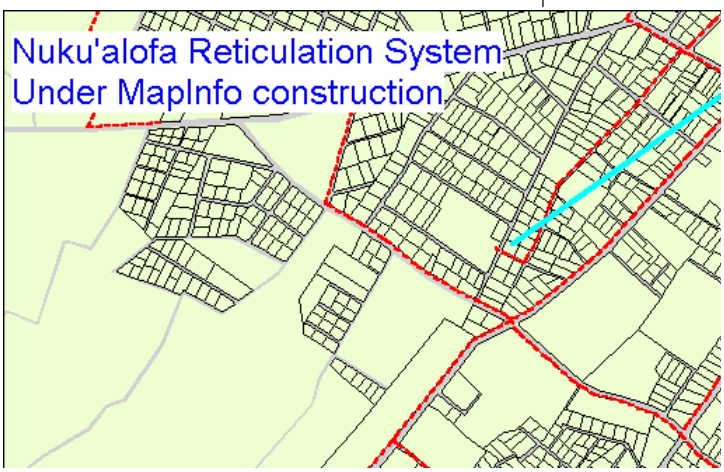
TWB water supply issues

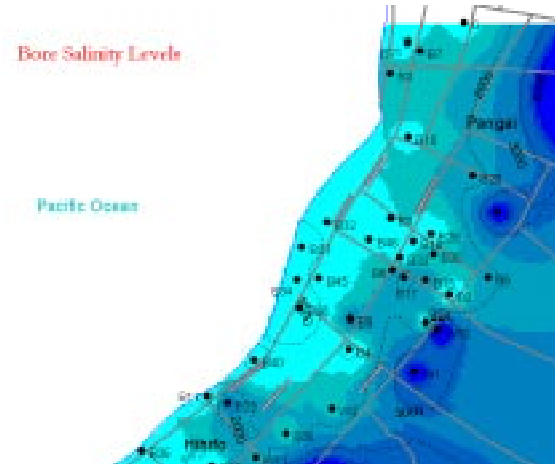
The Tonga Water Board is looking to GIS to help solve some of the issues that are arising in the supply of good quality water to its consumers. Some of the major problems currently being tackled are water quality, leak detection, low pressure zones within the reticulation systems, valve and hydrant locations, pipe locations and condition. Many of these problems can be solved or better managed with the accurate collection of reticulation system and associated data. This data is then entered into MapInfo and stored and maintained as an asset register that can be queried and analysed to help resolve water supply problems.

TWB data

Tonga Water Board is constructing MapInfo data for all reticulation systems and associated data layers. This data is being constructed from a number of sources including existing hard copy maps, site surveys and local knowledge from engineering, plumbing, maintenance and meter reading staff. The data layers being constructed consist of pipe networks, production sites, water storage tanks, district meters, valves and hydrants, pressure reading locations and customer water meter locations. TWB is not only capturing the geographic location of these assets but also attributes associated with these features. Pipe network data for example has eight fields of attribute data including pipe diameter, installation date, and depth, offset from road, condition, data quality and comments. Once these data layers are constructed with their attributes TWB will have a powerful MapInfo tool to view, map and query.

Tonga Water Board also monitors and collects water quality data from production sites to ensure the ongoing quality and viability of water supply on each island. This data will also be imported into MapInfo to increase the range of analysis that TWB can perform.





TWB also intends to link the customer meter MapInfo data layer with its new customer accounts database to help analyse customer complaints, unpaid accounts, new connections and water consumption data.

How GIS will help improve water supply

Although data collection and construction of the GIS have a way to go, TWB staff are already seeing the benefits GIS can bring to the production and supply of water. These early benefits include accurate mapping of assets and the ability to perform spatial queries of geographic features. A good example of MapInfo use is the identification of supply districts with high water loss that are to be targeted in the leak detection/control program. The use of MapInfo also gives TWB the ability to view the water reticulation system in conjunction with cadastral data from the Ministry of Lands, Survey & Natural Resources and aerial photography supplied by the Tonga Electric Power Board. This ability to view and query TWB reticulation data will prove to be a corporate asset that will help to improve the efficiency many day-to-day operations and long term projects undertaken by TWB.

Future TWB GIS developments

It is envisaged that TWB will continue to develop MapInfo applications and skills that will help solve many of the problems associated with the suppling Tongan consumers with potable water. As part of this ongoing process of developing a GIS we also hope that TWB staff will view GIS as an integral component of ongoing business improvement. This hope would also be aided by the formation of closer ties with other organisations using MapInfo within Tonga and the South Pacific Region.

Land and Marine Resource Use Planning (LMRUP) in Niue Island

By Coral Paisisi

The Environmental Planning Unit, Department of Justice, Lands and Survey (DJLS), is using GIS and GPS in generating a Land and Marine Resource Use Plan for Niue. The Unit has been using MapInfo 3.0 for GIS, mapping and registration of aerial photos to the cadastral base. About 70% of the aerial photos covering Niue have been registered with all of the coastal areas and more extensive coverage of the southern end of the Island. This provides a good base on which to Plan and for comparison of vegetation change over the years. In the centre of the Island it has been harder to register photos to as there are limited surveyed points with which to match up the photos. The GPS units have been used in this instance. GPS is also being used to map out services, conservation areas, vegetation types, heritage sites and development areas.

The GPS units being used are Magellan ProMark X, brought into Niue through the AusAID sponsored LMRUP project. They have a two to five meter accuracy using differential mode, however combining this data with Ashtech data the error can be brought down to one to two metres accuracy. Post processing is through MSTAR v2.06. The Ashtech data is in Rinex format and is from the base station set up at the DJLS in conjunction with others in the Pacific Region for the University of Hawaii to

...continued from previous page

monitor the tectonic plate movement of the Tongan trench.

Thanks to SOPAC the Unit now has MapInfo 4.5 which is going to make post-processing of GPS data with attributes much easier to dump straight into the Map base.

The Unit also have a SPOT image of the whole of Niue from 1994 (false colouring) which is registered to the cadastral base. It has 30m resolution and is a good base on which to do vegetation classification as Forestry has done some work on in the past. The Unit is currently experimenting with IDRISI, however has not found too many advantages with it as yet, so if any of you have anything special you'd like to share with us about IDRISI we are keen to learn.

Staff from DJLS and other government agencies are looking forward to the SOPAC workshop in Niue around the end of November: no doubt this will make the road a little clearer.

GPS Base Station in Tonga

By Edwin Liava'a and Paula Hemaloto
Tonga Electrical Power Board

Introduction

Through the extension of the EU-funded Pacific Regional Energy Programme, Tonga Electrical Power Board were granted GPS equipment to enhance mapping of existing assets especially for areas where insufficient maps at operational scale are available. The equipment consists of one hand-held receiver and one GPS base station. The base station was installed during the last weeks of August and tested through initial field surveys.

Installation of the Base Station

A base station is necessary to recalculate the real position whenever selected availability is switched on or signals are distorted due to atmospheric influence. The correction of wrong signals is possible because the position of the base station is known and the difference between the received position and the real one can be calculated and later used to correct the position recording of the hand-held receivers. Such a base station has more channels as a hand-held receiver and a better antenna (thus costs much more!). To utilise the full potential of such a base station, the antenna must have a clear view of the horizon. By no means should

Figure 1:
GPS antenna on top of the TEPB building in Nuku'alofa

a building or tree block its view in a 10-degrees angle above the antenna. In Nuku'alofa the antenna had to be mounted on top of a galvanised water pipe installed on the roof of the TEPB main office building. The TEPB crew selected a pipe with the outmost consideration of its strength and reliability to withstand all kinds of weather conditions. Dowels fifteen centimetre longwere used to fix it against the concrete wall of the building to avoid any movement of the antenna.

The base station receiver was linked to a 4/86 computer. This is placed in its own secure room, which is only accessible to the operators to avoid any interruption during receiving.

After installation, Tonga's Lands Department surveyed the antenna position by conventional method to obtain the exact position coordinates in WGS84. In addition to this survey the base station was operating uninterrupted during

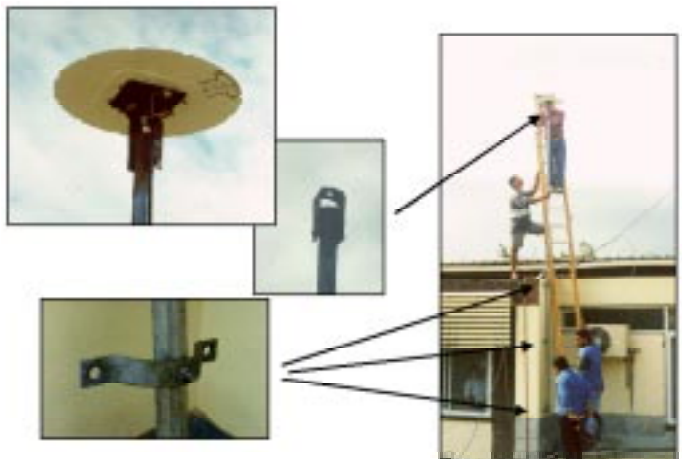


Figure 2: fixing the antenna on the building

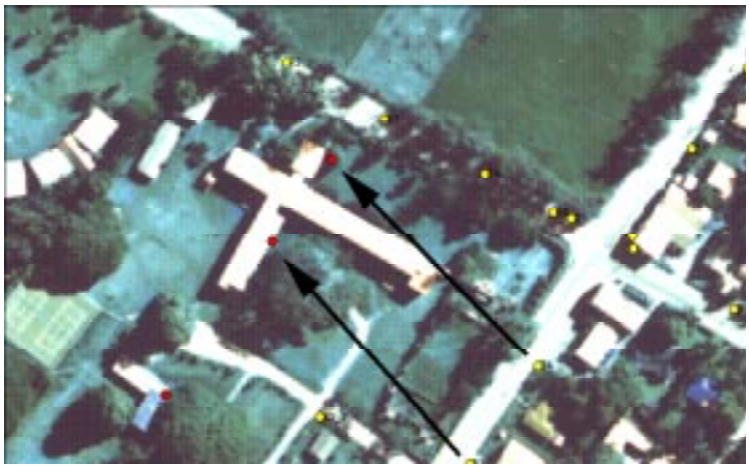


Figure 3: After importing the GPS surveyed power poles into the cadastral map an off set was visible.

the first 12 days. This allowed the averaging of all distortions and thus led to an indicated accuracy of about 2 meters.

The First Surveys

The TEPB team carried out the first surveys with the handheld unit along the main road (Taufa'ahau Rd). The software (pathfinder office) corrected the surveyed position of power poles by using the base station data recorded at the same time from the same satellites. Surprisingly all power poles were misplaced with the same shift when displayed them over the cadastral map, aerial photographs rectified to the cadastral map or existing digitised poles layers. Later, it was noticed that even the position of the base station was different compared to the cadastral map.

Investigation of Error

TEPB informed the Ministry of Lands and Survey and fortunately the source of error could be identified. The cadastral map is not based on the spheroid indicated. All trigonometric points showed the same shift as the surveyed power poles when imported to the MapInfo display of the cadastral map. The cadastral map showed the coordinates based on Hayford 1909 spheroid and not WGS84 as indicated in the map legend.

Another difference was noticed between the surveyed position of the antenna and the calculated average position after 12 days or 1,235,557 positions received by 3 September 1998.

The northing or X coordinate cannot be 7 meters out, because the system averages to an accuracy of about 2 metres. This error is still under investigation.

Conclusion and Recommendation

TEPB and Lands Department discussed the issue and agreed to base the maps of TEPB on UTM Zone1, WGS84. When the error is identified and all parameters are available to include UTM international spheroid 1924 (which is based on Hayford 1909 with a local datum), all maps can be printed out on the local grid as well. For the time being, all work will be carried out in relation to WGS84 and using the antenna position coordinates averaged from the base station readings.

This situation is normal in South Pacific Island Countries. Most islands were first surveyed during times where their own positioning capabilities were very weak. It is important to have a GPS base station and people with geodetic background who are able to spot errors, as was the case in Tonga.

		X-Direction	*Y-Direction*	*Z-*
average position	01.09.98	7,661,500.54	686,598.79	68
average position	02.09.98	7,661,500.21	686,598.76	68
average position	03.09.98	7,661,500.25	686,598.76	68
surveyed position		**7,661,507.63**	686,598.54	65

Table 1: Positional values from base station

Image Rectification Using GPS Surveyed GCPs

By Vilisi Kalou
FEA, Suva,

Introduction

The use of raster images, either from aerial photographs or satellites, as a backdrop for maps is becoming more popular. Compared to line maps, such as cadastral maps or road network maps, image backdrops show large amounts of locational data. This sort of data is very valuable in helping utilities to manage their assets. For example, planning the location of power lines and transformers is easier and more effective when the full range of possible surface objects are visible on the map. Many of these sorts of features, such as vegetation cover, small buildings, garden plots, and drainage ditches do not show up on official maps.

Currently, for local utility mapping, scanned aerial photographs are the only type of image data allowing a display of 1:5000, or larger, due to the high spatial resolution of the photographs. However, such scanned aerial photographs have to be rectified and the rectification process requires Ground Control Points (GCPs). Cadastral maps normally provide the information for the identification of X and Y coordinates of Such GCPs. However, there is a problem if image backdrop is used to replace cadastral maps. The following article describes how FEA used GPS survey in replacement of cadastral information.

GCP Requirement

Due to its central projection the scale of an aerial photograph depends on the location within the image. It proved to be impossible to rectify an aerial photograph in one only rectification process using a second degree polynomial rectification method implemented in most image analysis software packages. The scanned aerial photographs must be cut into several sub-images for which the rectification has to be performed independently before these sub-images can be stitched together again. Such a process

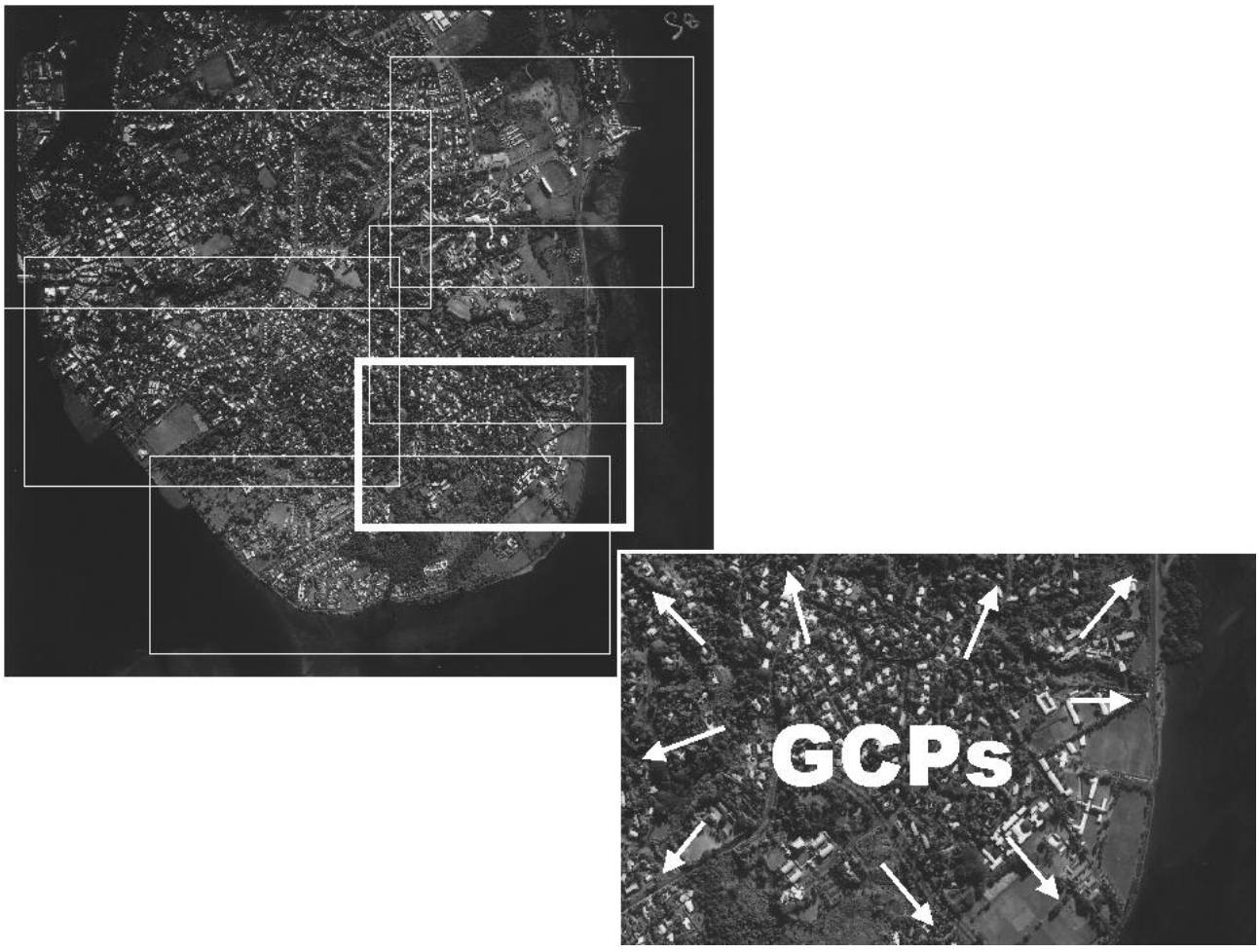


Figure 1:
aerial photographs have to be cut into several sub-images. Then every sub-image has to be corrected using 6 to 12 GCPs.

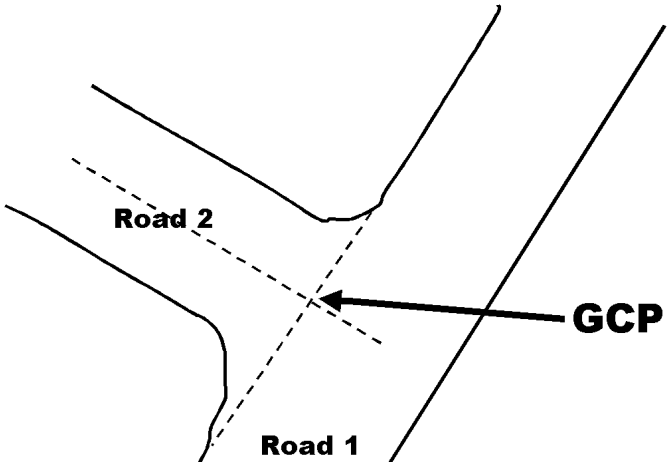


Figure 2: GCP location on road junctions.

requires 6 to 12 GCPs for every sub-image distributed all over the image with a preference on the image edges (see figure 1). It is important to identify GCPs clearly on the aerial photographs. While features such as road junctions, bridges over small creeks, single trees, etc. are ideal for this, they are, however, not always visible on the cadastral maps.

Preparation for a GPS survey of GCPs

Before going out some preparations are needed to reduce the time spent out in the field. The scanned photographs were printed at an approximate scale of 1:10,000. It is important to think about the distribution of GCPs taking into account a) the distribution within each sub-image b) the access by car. Clearly marking the GCPs on the print out makes field identification easier and helps in planning the best route to drive around to the GCP's.

The Fieldwork

During the fieldwork it was important to:
Place the GPS on a point, which can be identified clearly on the image later,
Receive 15 positions for later average,
Write a small description of the GCP location including a drawing, which enables other operators later to use the same GCPs again.

For later identification of GCP positions on road junctions, the FEA team used the estimated crossing of the first road boundary, with the middle line of the second road (see Figures 2 and 3). The receiver was switched off after storing a minimum of 20 position readings. Then one team member wrote a description containing the road names, the next power pole number and produced a drawing on the site (see figure 4).

Figure 3:
GCP coordinate recording on road junctions by FEA team

Conclusion

Using GPS assisted survey, it is possible to identify a sufficient number of GCPs for rectification of aerial photographs within a short time. This permits the replacement of cadastral maps with aerial photo image backdrop, which is essential in areas where cadastral maps are missing or an advantage over highly-priced digital cadastral maps. By the end of the year spaceborne image data will be available with 1 metre spatial resolution. This data is already in an orthogonal projection and a number of about 12 GCPs will allow rectifying large areas in one step. This will reduce time, costs and effort and further increase the utilisation of image backdrop.

Figure 4: GCP description in the field

METADATA construction: MRD case study

By Prakash Narayan
Mineral Resources Department (MRD)

Introduction

Metadata is "data about data" or more specifically, it is descriptive information about data and its availability. This broadly defined category of information encompasses a wide range of database characteristics, from descriptive summaries to detailed discussion of attribute coding schemes. Metadata often includes data processing histories, file format specification, as well as instructions for obtaining data. The whole purpose of metadata is to facilitate access and to guarantee appropriate application of data.

Objective

Large quantities of digital data information are generated from various sources and by various organizations for the land and ocean areas of a particular region or country. Knowing the currently available land and ocean coverage is very important for it helps to reduce or even eliminate duplicate coverage of a same region or zone. To assist in alleviating these difficulties, Mineral Resources Department (MRD) had embarked on a program to develop formal guidelines and supporting tools for preparing their metadata. Metadata can be difficult and time-consuming to develop, and once complete, may be difficult for other users to interpret.

Digital Spatial Data

Simple file directories give incomplete information about any kind of digital data. They give a list of file names and system specifications. Often, a separate file can be created in a directory or folder that gives a more detailed description of each file, often in more understandable terms. A common example of this would be a "readme.txt" file that accompanies original software or decompressed data files. By reading this file, the user will better understand what each file contains or does. But in the case of spatial data, the issue is more complex. We think of a certain area of coverage, Kadavu Island, for example, as one conceptual entity—"Kadavu Island". However, in a GIS system, the files that hold data related to Kadavu can, and usually do, occur in many files since each type of spatial object (or layer, if you like) will generally be stored in one file. In many cases, even single spatial data layers can be stored in several files. So, answering the question, "Which files store data about Kadavu?", means examining the descriptions of many files, not just searching for one file out of a list.

To access this complex and high volume data, it is clear that a computer database, with its ability to sort, organise, and query the entire data collection and produce formatted and summary results, is required for effective management of the spatial data holdings of any organisation or group. This article outlines the approach currently taken at MRD to produce a spatial meta-database.

Case Study: MRD's Metadata

The aim here is to identify attributes that could significantly describe the digital or even hard-copy spatial information held within MRD premises. The attributes chosen to December 1997 for MRD's metadata are listed below.

Identification

SearchWord: Words likely to be used when searching by a particular theme.
Title: This is the name given to the dataset by the custodial organisation.
Custodian: The organisation responsible for ensuring the accuracy, currency, storage, security and distribution of the dataset.
Jurisdiction: The place where the custodian of the dataset is kept
Address: MailAddress1, City, Country, Postcode
Contact Information: Telephone, Facsimile, ElectronicMailAddress
ContactOrganisation: The name of the organisation to contact in order to obtain the dataset itself, or for more detailed information about the dataset.
ContactPosition: The position title given by the contact organisation to the holder of the position who is required to answer questions about the dataset.

Data Quality

PositionalAccuracy: Is an assessment of the closeness of the location of spatial objects in the dataset in relation to their true positions on the earth's surface.
AttributeAccuracy: An assessment of the reliability of values assigned to features in the dataset in relation to their 'real world' values.
LogicalConsistency: An assessment of how well the logical relationships between items in the dataset, or spatial objects in the dataset, are maintained.
Completeness: An assessment of the extent and range of the dataset with regard to completeness of coverage,

completeness of classification and completeness of verification.

Lineage: Is a history of both the source data and the processing steps used to produce the dataset.

Access

StoredDataFormat: Description of the format in which the dataset is stored by the custodian.

AvailableFormatType: Description of the format in which the dataset is available, such as *digital* or *non-digital*.

AccessConstraint: Show any restrictions or legal prerequisites that may apply to use of the dataset such as licence or royalty agreement.

ServerFolder: Name under which this information is known, e.g. the file name.

ServerFileName: The path name leading to the directory where this information is located on the server.

BeginningDate: Date at which the phenomena in the dataset actually occurred.

EndingDate: If the dataset is ongoing, use the word "Current" to indicate that no final date is applicable.

MetaDatadate: The date on which custodian authorised changes or on which metadata custodian editorial(if any), were added to the metadata directory item.

AdditionalMetadata: An indication of where additional metadata about the dataset may be accessible

Dataset Status

Progress: The status of the process of creation of the dataset. Option "completed" for dataset collection concluded, "in progress" if collection underway and "planned" is collection proposed.

MaintenanceUpdateFrequency: The frequency of changes or additions that are made to the dataset after its initial completion.

Descripton

GeographicExtentname: Known geographic objects that would reasonably show the extent of geographic coverage of the dataset.

GeographicExtentPologon: Use a set of at least four co-ordinates (a closed polygon) to record the latitude and longitude in decimal degrees of geographic extent of the dataset.

Abstract: A characterisation of the dataset and its contents—a brief narrative, a summary, or an abstract.

Tool or Method

Elementary relational database incorporated into a query language such as Sequentially Query Language(SQL) is powerful enough to answer a great number of queries, even complex ones. An example of such a query is: display the list of files containing information at MRD for hydrogeology or seismology.

Microsoft Access, a widely used database package running under Window 95 can be used for such a database. Wizards included within the version of Access can be largely exploited.

A very elementary database application software was developed using the current version ('97) of Microsoft Access and this software is currently available to MRD staff through the existing MRD computer network system.

Advanced Metadata Systems

New technologies in GIS and network communication provide many opportunities for the development and application of metadata resources. One can easily imagine being able to browse an organisation's on-line data catalogue, or to use an interactive map display on the Internet to determine data availability for a particular area, or to identify variations in data quality over a database. The establishment and adoption of a national metadata standard will help facilitate the development of standard systems for data exchange.

Conclusion

We at MRD believe that if an easy-to-use standard is developed with supporting tools, users will be more likely to document their dataset effectively. Data exchange among users would be also greatly facilitated by the inclusion of standard metadata reports with data deliveries.

Further Reading:

ANZLIC GUIDELINES: CORE METADATA ELEMENTS version 1, Metadata for high level land and geographic data directories in Australia and New Zealand. Prepared for the Australia and New Zealand Land Information Council by the ANZLIC Working Group on Metadata, July 1996.

Prakash Narayan, April 1998, ***The Need for Homogenized and Structured Databases Containing Information on the Availability, Structure and Characteristics of Existing Spatial Data***. Fiji GIS/RS User Group Forum newsletter, issue 1998.01 April, pages 12-13.

Opportunities in GIS

Eco-Consult Pacific Seeks GIS Specialists for Future Consulting Opportunities

Eco-Consult Pacific is an independent consulting company based in Suva, Fiji, which aims to provide support to national and regional authorities and organisations in the design, implementation and evaluation of programmes towards integrated sustainable development of natural resources in its broadest scope. The areas of expertise include primary industries, environmental issues, post harvest technology, marketing and trade, rural development, institutional management and development and economics.

Eco-Consult Pacific is aware that specialist human resource development has increased significantly in the last decades, and recognises that this forms the mainstay to sustainable resource management in Pacific Island Countries. To facilitate the identification of suitable candidates for consulting opportunities, we have established a unique database with more than 170 specialists who have extensive expertise in the Pacific Islands. A considerable number have worked for international institutions such as the Asian Development Bank, the World Bank, the European Union, UNDP etc. In addition, we have developed a network of individual consulting companies we can combine resources with. We believe that the countries and peoples of the Pacific are unique to the world, as are many of their problems - which provides *Eco-Consult Pacific* with a distinct advantage to find the appropriate solutions for specific problems.

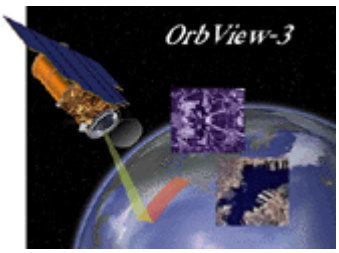
To improve on the distribution of employment opportunities for Pacific Island specialists, *Eco-Consult Pacific* established 'Pacific Vacancies' in March 1998, a unique free electronic mail service providing information on forthcoming national and regional vacancies in the areas of our expertise. This service, which is aimed at reaching specialists at remote locations, currently distributes vacancies fortnightly.

We invite specialists in GIS and other relevant areas to register with us by submitting your CV and a short summary of expertise. If you include an email address, we will add you to our 'Pacific Vacancies' mailing list. Naturally, registration is free.

For more information please contact:
Wilco Liebregts, Managing Director, Eco-Consult Pacific, P.O. Box 5406, Raiwaqa Post Office, Suva, Fiji. Tel./Fax: (679)-302 607; email <ecoconsult@is.com.fj>.

Techniques

Satellite Update



By Wolf Fosrtreuter
SOPAC

Since printing the last newsletter, there is not much update necessary. There is no additional news about **Landsat** including **IKONOS**. The newly launched **SPOT 4** recorded the images successfully including the new short-wave infrared band. One proposed satellite was not mentioned in the last newsletter, OrbView-3.

The **OrbView-3** satellite will be ORBIMAGE's first high-resolution satellite and will provide low cost, real-time imagery. The satellite will orbit at 470km above the earth and its sensor will produce 1m panchromatic and 4m multispectral images with a standard size of 8 km An on-board tape device will be able to store 4 Gbytes of image data, so recording of areas in the South Pacific is possible. The blue portion of the spectrum is covered. The company ORBIMAGE is already experienced in operating satellites and it is likely that the company will stick to scheduled launch date, the fall of 1999.

Resolution:

blue	0.450 to 0.520µm	4m
green	0.520 to 0.600µm	4m
red	0.625 to 0.695µm	4m
near-infrared	0.760 to 0.900µm	4m
panchromatic	0.450 to 0.900µm	1m

SOPAC is in the process of ordering panchromatic **IRS-1C** image data for Niue. During this purchase, SOPAC was advised by Space Imagine EOSAT that this company no longer handles image data stored on the on-board tape devices. Since August 1998, the company is only distributing data received directly by ground antennas outside India. Because nearly all South Pacific Islands Countries are outside the range of ground antennas, SOPAC is dealing directly with the National Remote Sensing Agency (NRSA) in India. Another change: in the past, EOSAT did not charge a fee for special acquisition. As long as the customer purchased image data ordered to be recorded on tape, this service was free. Now, SOPAC pays 1500 US$ for the digital image and the same amount for the special acquisition. However, since this gives us a 35 x 35 km coverage of 5m resolution data, this is still less expensive than any photo flight.