Highlights

- **RS and GIS to manage marie environment**
- **Image enhancement techniques**
- **Project news**

Highlights

- **Satellite image data available**
- **Remote Sensing Techniques**
- **Vegetation Monitoring**

Pacific Islands

GIS/RS *news*

The Newsletter of the GIS/Remote Sensing Users in the Pacific
Issue 1 /2002

GIS and Remote Sensing gains importance in marine applications

Many applications of high-resolution satellite images for vegetation change detection and mapping have continued since the last newsletter was published.

Multi-spectral QuickBird data has been ordered for the first time for Pacific Island Countries and will be used to map landslides in Rabi Island, Fiji.

IKONOS image data has been ordered for the coral coast in Fiji, the southern part of Tongatapu and Vavau in Tonga, Rarotonga and Manihiki in Cook Islands and other areas are under discussion.

EROS-A1 image data has been used for the first time in Suva, Fiji to develop a cost effective alternative to pan sharpened IKONOS multi-spectral images.

There has been new demand for image data marine applications and an article explains the use of IKONOS image data for a GIS based pearl farm management system. The IKONOS image data for Fiji's coral coast will be used to map qoliqoli areas as a first step towards sustainable management.

In addition to the high-resolution image data another category of image data is being investigated for Pacific Island Countries. These are radiometric high-resolution images and ENVISAT, a satellite recently launched, will provide hyper-spectral image data.

SOPAC is investigating the application of this data to guide local fishing vessels and during SOPAC's annual session 25 September – 2 October, Cook Islands requested assistance to investigate if such data can identifyg potential fishing grounds.

While it is not clear if this new type of remote sensing data can be used in a timely and cost effective manner, SOPAC with investigate data analysis methods for this application that can assist Pacific Island Countries with new tools to manage their fishing grounds in a sustainable way.

ENVISAT in space. This satellite will provide many different types of remote sensing data useful for sustainable management of the marine environment of the Pacific.

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ISSN 1562-4250

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QuickBird pan sharpened image data of Abudhabi Port

To save mailing costs, the newsletter is sent via air mail for further distribution to the following persons:

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Marshall Islands	*Albon Ishoda*
New-Caledonia	*Didier Lille*
PNG	*Joe Buleka*
Samoa	*James Atherton*
Solomon Islands	*Robinson Wood*
Tonga	*Edwin Liava'a*
Tuvalu	*Opetaia Simati*
Vanuatu	*Christopher Ioan*

This image is a sub-image of a data recorded by QuickBird from Abudhabi. The original multi-spectral data of 2.5m resolution is pan sharpened with the 60cm resolution panchromatic channel. The width of the power line, visible in the upper part, is below this spatial resolution. This is a characteristic of linear elements with high contrast to the background.

Managing Road Assets in Fiji

Anthony Toko, PWD Asset Management Unit

GIS played an integral part in producing a road maintenance system, and is now used to hold a wide selection of data.

The Geographic Information Systems (GIS) has played a big part in the introduction of a comprehensive Road Maintenance Management System and Road Asset Management System (RMMS-RAMS) for the island state of Fiji.

The task of implementing the scheme was awarded to New Zealand-based consultants Meritec (the new name for Worley Consultants) in March 1999 as part of the Asian Development Bank (ADB) third Fiji Road Upgrading Project.

The terms of reference called for the implementation of an operational, integrated and sustainable road maintenance and asset management system. While many similar projects have achieved the first condition (operational), and to some extent the second (integrated), it is the third condition (sustainable) that is the most difficult to attain.

With this project Meritec believes it has put in place the required hardware, software, systems, training and support to meet all of these conditions, while remaining within budget and on programme.
RMMS-RAMS covers all roads and road assets, including bridges, under the jurisdiction of the Public Works Department (PWD) comprising 900km of sealed roads, 4,300km of unsealed roads and 1,200 bridges and major culverts.

The integrated system includes bridge and road routine maintenance systems, a bridge rehabilitation and renewal system, a flexible and low-maintenance Geographical Information System (GIS) that displays location referenced data in geo-schematically format, and a pavement management system to prepare rolling programmes of periodic maintenance works based on internationally recognised highway investment analysis software (HDM-4).

Basically, GIS is the high-tech equivalent of a map over which information can be laid, and from which different sets of information can be extracted as required.

A key innovation introduced during implementation of the Fiji project included the adaptation of the CON-FIRM RMMS-RAMS software to use location referencing for all network related data. This, combined with the ability of the GIS to display in geo-schematically format any data that can be referenced using the field location reference method, makes it a very powerful tool. This allows management to review how effectively resources (plant, labour, materials) are utilized, rather than only relying on historical records of how money was spent on individual roads.

An example of a proposed development of the system that will utilise this capability is the mapping of natural hazards such as flooding and landslides, both common problems in Fiji. The data used to manage these risks will be stored in RAMS/RMMS in two ways: based on field investigations and a desk study used to classify flood risk and slope instability, and secondly to collect data on actual events, located relative to the road centre line.

***Figure 1:** Vehicle used for road condition survey including GPS survey*

Managing Road Assets in Fiji

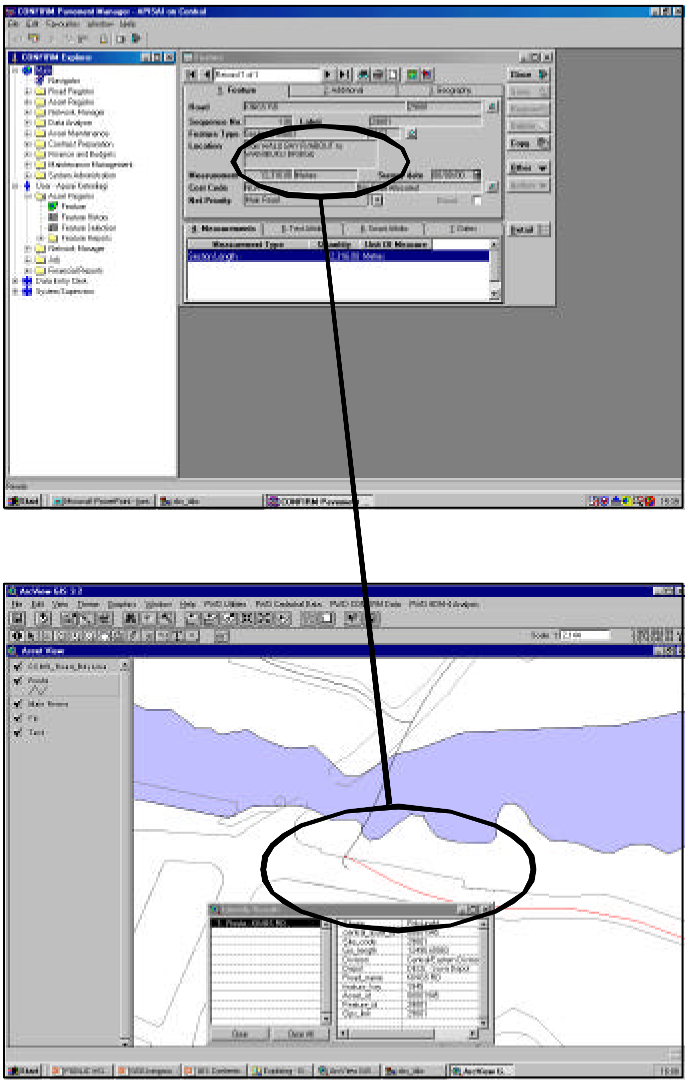

Figure 2: *The figure shows the integration between the GIS and the CONFIRM software.*

Over time this data will help the PWD identify where problems due to natural hazards are reoccurring so that appropriate mitigation measures can be taken, such as realignment or raising of a section of road.

This capability was also used to store data collected by the Initial Environmental Examination and Initial Social Assessment carried out on the roads identified by the PMS for rehabilitation and reconstruction.

Meritec says that the key to the long term success of this project is to ensure firstly, that technology transfer and training on the objectives, operation and management of the system has been successfully imparted at all levels in the recipient organisation, and secondly that adequate support and maintenance arrangements are left in place, covering all aspects of the system software and hardware, after project completion.

The provision of ongoing support following the departure of the consultant is a key factor in ensuring the sustainability of a project such as this. A two-year extension to the project has been agreed whereby Meritec periodically reviews project progress in Fiji. In addition a five-year, annually renewable, telephone and Email-based support and maintenance agreement has also been signed between the PWD and the developers of the CONFIRM RMMS-RAMS software, SBS (UK).

This project has led to the development of a fully operational, integrated and sustainable road maintenance and asset management system for Fiji. In addition to the capability to generate economically-based network maintenance programmes, the PWD will have access to centralised information on the entire Fiji road network through a highly versatile database linked to a GIS.

Fiji now has one of the most advanced asset management systems for roads and bridges in the world. The challenge for the PWD is to continue to use the system to improve and develop maintenance management strategies and practices, so optimizing the returns from scarce funds, and giving the taxpayer the best road network possible for their tax dollar.

Multi Temporal Image of Nasinu Town, Fiji

Wolf Forstreuter, Silika Tuivanuavou, Poiongo Lisati

Introduction

Nasinu, a recently declared town is located along the Kings Road between Suva City and Nausori town. The population of Nasinu has grown intensively in the past 20 years due to low cost housing built within the area. SOPAC was asked to assist after a consultant read the article “Inexpensive Land Cover Change Detection for Pacific Island Countries” in Newsletter No. 03/ 2000. As a result, the Nasinu Town Council requested for the visualisation and mapping of squatter settlements growth over the township. The work was carried out as a project involving students attending the French funded Remote Sensing lectures and exercises at USP.

Multi Temporal Image Data as GIS Backdrop

Method:

The team selected aerial black and white photographs of Nasinu of the following years, 1973, 1986 and 1998. These photographs are of different scales and subsequent different resolution, but the only image source available.

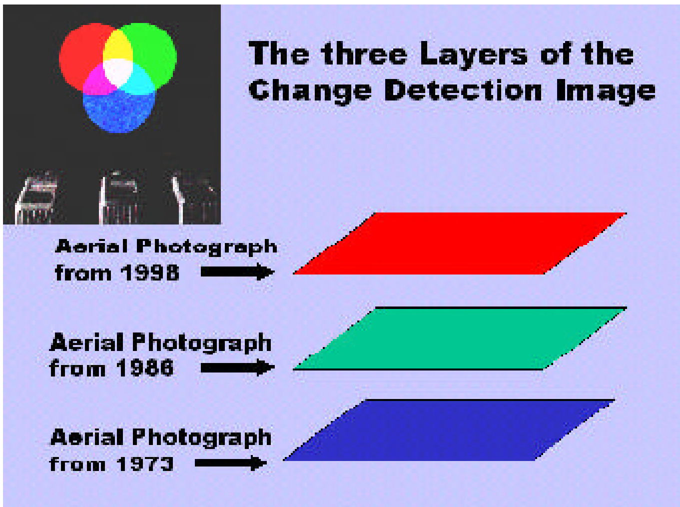

***Figure 1:** Combination of three digital black and white aerial photographs to a multi-temporal image.*

The photos were first scanned with best available resolution, which is 600 dots per inch and then geometrically rectified. The rectification process employed ERDAS rubbersheeting module whereby transformation equation for each area between three ground control points are automatically made. This allows rectifying the central perspective of an aerial photograph in one rectification process. The cadastral layers of the Fiji's Lands Department were used as reference, which were available as DXF files and displayed as ERDAS annotation layer. After rectification of the different photographs ERDAS module Mosaic stitched them together to one layer for each of the three years.

The next step was the combination of the three image layers to one three-layer image file. The corresponding ERDAS module Layer Stack requires that all image layers not only have the same projection, but they also must have the same pixel resolution. This process was already performed during the geometric correction, but is mentioned here to explain the huge file size of low-resolution images. The 1973 layer was assigned the blue band, the 1986 layer was assigned the green band and the 1998 layer was assigned the red, the colour of the display, see Figure 1.

Finally the multi temporal image and the three black and white image layers were imported to MapInfo. This allows Nasinu Town Council to carry out the analysis work in MapInfo environment. In addition it makes it easy to attach Access database storing the analysis results during the on screen digitising.

Results

The multi temporal image visualises the change of housing area. Based on the fact that a) vegetation absorbs sunlight and b) clearings and corrugated iron roofs reflects sunlight, both of the latter can be easily separated from "un-touched" and vegetation covered areas. Linking the layers to different colour displays, these areas show the colour intensive while vegetation-covered areas are shown dark. A roof, which was built between 1986 and 1998 will be shown intensive in the red channel, while this place is shown dark in the blue and in the green channel. The result is red in the multi temporal image. A roof which was built in or before 1973 will have a white colour because it has high reflection in all three colour layers which then add up to white. A roof built between 1973 and 1986 will have a high reflection in both the green and the red layer and will have a mixed colour from both layers.

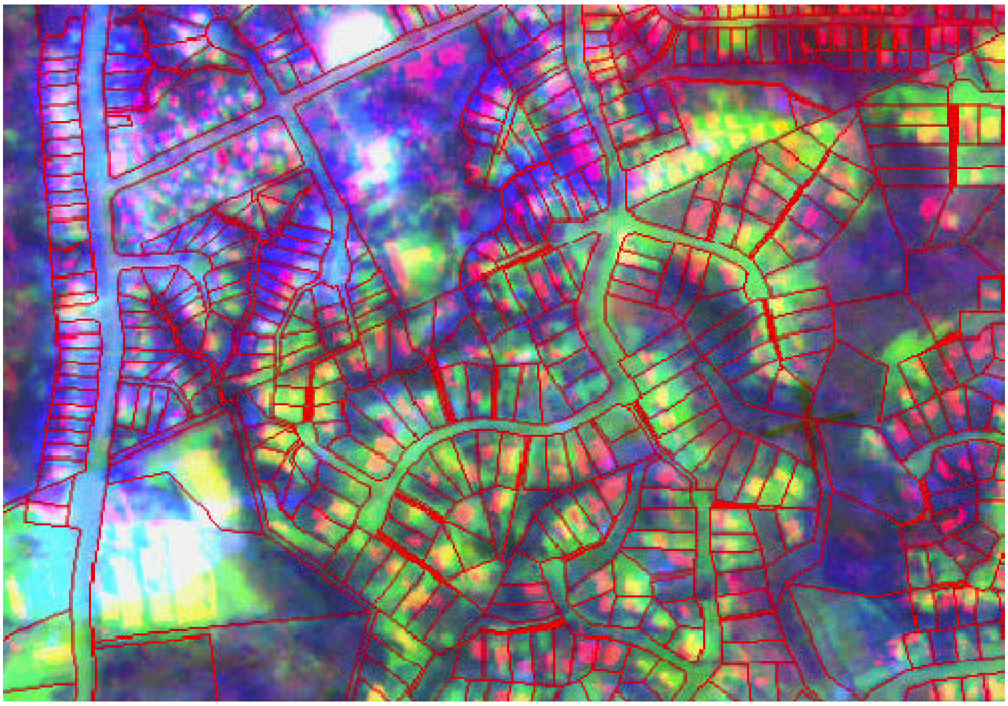

***Figure 2:** The multi-temporal image. White areas with high reflection in all three periods, green high reflection around 1973, blue high reflection around 1986 and red high reflection around 1998.*

Areas where the vegetation is cleared have a high reflection, however, the vegetation will cover the area again after a few years. This results in high reflection in the specific channel only related to one period only. Areas in green colour therefore are cleared between 1973 and 1986, areas in blue colour before 1973 and areas in red between 1986 and 1998 see figure 2.

The result is a product, which can be analysed with MapInfo software. If all single layers including the multi temporal image are loaded, an operator can screen the multi temporal image and switch to any single year layer. He is able to perform on-screen digitising and can create a clear picture of development in time.

Recommendation

Urbanisation will increase in Pacific Island Countries and analysis of controlled or uncontrolled area development will help improve planning. Multi temporal images allow quantitative analysis to be carried out with simple software. Other areas besides Nasinu should be analysed where multi temporal images will be an essential tool.

GIS & RS for Pearl Farm Management in Manihiki, Cook Islands

Quan Chung, Teina Tunatei, Emeline Veikoso

Situation in Manihiki

Late in 2000 early 2001 there was a dangerous pearl disease outbreak in Manihiki, which almost crippled the whole black pearl industry. This disease is thought to have occurred due to poor water circulation and over population of shells in farms. Limited flushing and the pollution generated from shell maintenance and cleaning contributed to a lowering in the water quality the lagoon. The occurrence of disease in Manihiki is a first since farming commenced and the source of its appearance in Manihiki is still unknown although the disease does occur naturally within the pearls, and can be circumvented through good farm management.

Manihiki lagoon is closed off to the ocean, by continuous barrier of reef and islands that encompass the whole atoll. Lagoon circulation or flushing is dependent primarily on the tide and wave energy flow across the top of the reef. Under storm conditions flushing is greater with increased exchange across the reef top. Poor water quality conditions prevailed when flushing rates where considerably reduced due to extreme calm ocean conditions leading to a deterioration in oxygen levels in the lagoon water, higher levels of biological oxygen demand linked to degradation of biological shell refuge and fouling from shell cleaning, batteries, motors, fuel and fridges that are thought to be scattered throughout the lagoon. Since the outbreak occurred the Manihiki island council wanted a better management plan to help prevent this problem from occurring again. Where the island council can better understand the circulation of the lagoon, and control farm layout and over populating individual farms. This management plan will also help the farmers manage their farms better preventing the outbreak occurring again.

The Bathymetry

Before anything can be done to understand the dynamics of the lagoon the basin shape that is the bathymetry has to known. This required a survey has to be completed. This then helps in the understanding current directions and general water flow through out the lagoon as driven by the external forces of tide and wind .

The bathymetry survey was completed using a multibeam swath mapping sounder. With DGPS for navigational control and using Hypack surveying software, for course planning and logging the sea floor of Manihiki was mapped in much detail. Using differential GPS, the data has sub meter accuracy. After the surveying the data set was processed, for tidal and sound velocity corrections.

Another aspect of the processing of multibeam data is that the data needs to be cleaned of all spurious data resulting in artificial bottom depth information. In this instance such data was generated by pearl lines, submerged floats, fish populations, turbulence and sometimes particulate matter in the water column. When the data is finally cleaned a xyz data set is then generated to represent soundings of the lagoon from which a full and accurate map reflecting the seabed morphology is presented. After the bathymetry has been completed it can be used in almost all GIS programs.

KONOS Image Rectification

The IKONOS image is a high-resolution satellite image that carries the 4 bands of red, blue, green, and infrared, which together produce a large colour photo of the interested area. This IKONOS images do come geo reference they often do not fit within the designated pacific island mapping reference frame, therefore the image is required to be rectified again. Most of the IKONOS image data received come in 11 Bit format and with most computer programs work with 8 Bit or

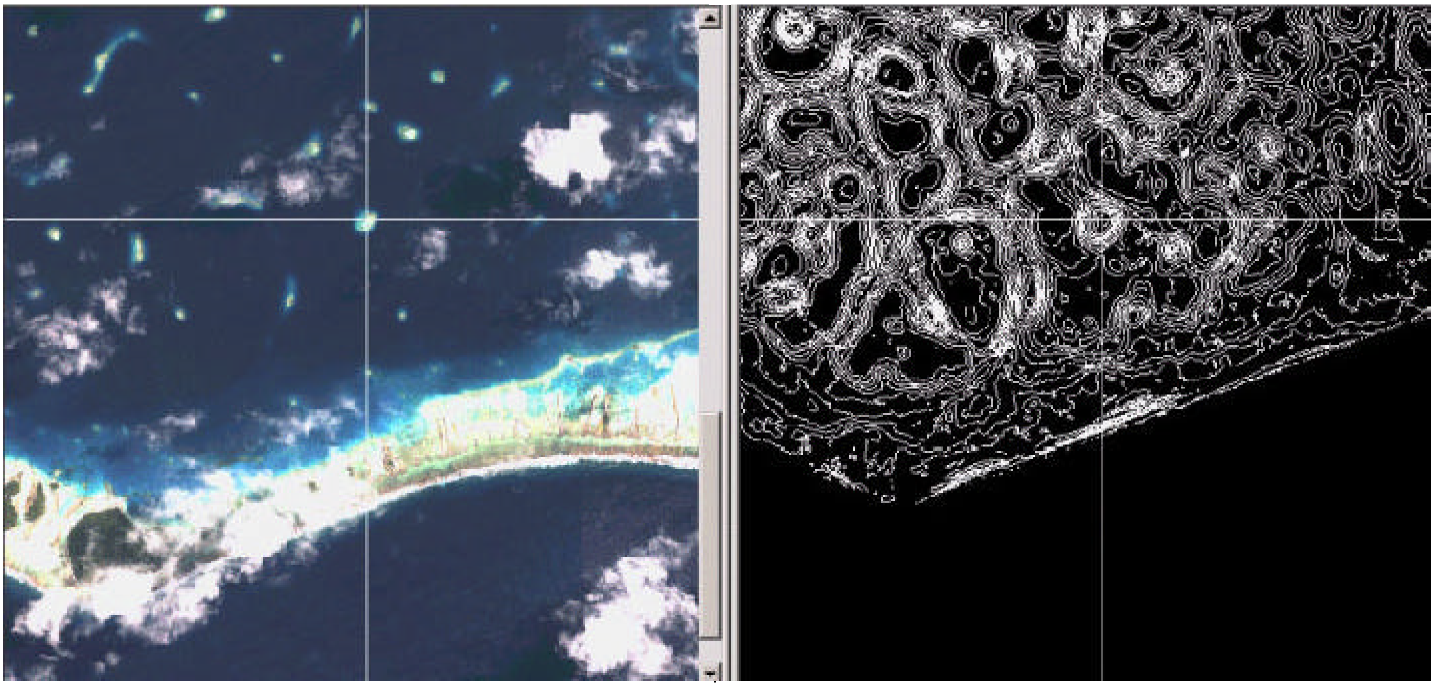

Figure 1: *There were no GCPs available for image rectification in the southern part of the lagoon. The bathymetry data created with a multibeam mapper turned out to be an ideal reference.*

16 Bit format the ability to convert the data is required. In this respect SOPAC using ERDAS software is able to read IKONOS data files and convert these to 16 Bit data range.

After the image is registered in ERDAS it has to be rectified to fit the designated mapping reference framework. In this instance Manihiki is, based on the projection parameters, WGS 84 UTM zone 4 southern hemispheres. Locating ground control points on the island or from another geo-referenced image data rectifies the image. In the case of Manihiki there are no visual ground control points apart from a Differential GPS survey of existing roads for the two villages in the northern part of the lagoon. This presented a major difficulty. Although the road network mapped could act as the ground control points for the northern part of the atoll for the remainder of the atoll there was insufficient control points to successfully rectify the southern half of the atoll. To overcome this problem the multibeam bathymetry was used as a guide to features that could be used as control points. As the many shallow reef patches mapped with the multibeam were readily identifiable both in the image data and the bathymetry they then could be used as control data for the rectification process. With some two hundred "koas" or coral reef patches spread throughout the lagoon this link between the location of the reefs and small islands seen in the image data and the multibeam bathymetric data turned out very successful. Thus the multibeam data set provided the ground control point coverage for the entire lagoon to complete the rectification process in what was otherwise a difficult situation.

Image Enhancement

After the image rectification, the enhancement of the color is done to the image, first the image is split in two, the land and water areas. This is because the pixel value of water is different to land, making it hard to enhance the water without affecting the land. So to separate the image, a mask had to be produce where all the land data is collected. The problem is to know the boundary between land and water. So level slicing (pixel value) was used to determine what pixels were manly water or land based at the waters edge. The infrared band is used to get a larger contrast between land and water, e.g. the pixel value on land would be greater than the pixel value in the water. After collecting the different pixel values between land and water the lowest value was chosen as the cut off point so we get the best split between land and water. This value was used in a modeler program in ERDAS to create a mask, which would be used for spiting the image in two. This consisted of a white layer representing the land or areas above the cut off mark, and black for the water or values under the cut off mark. The unwanted data like the clouds can be removed, using the fill control with layer 1 data (water). These 2 layers will form the basis of the images separating the land data from the water.

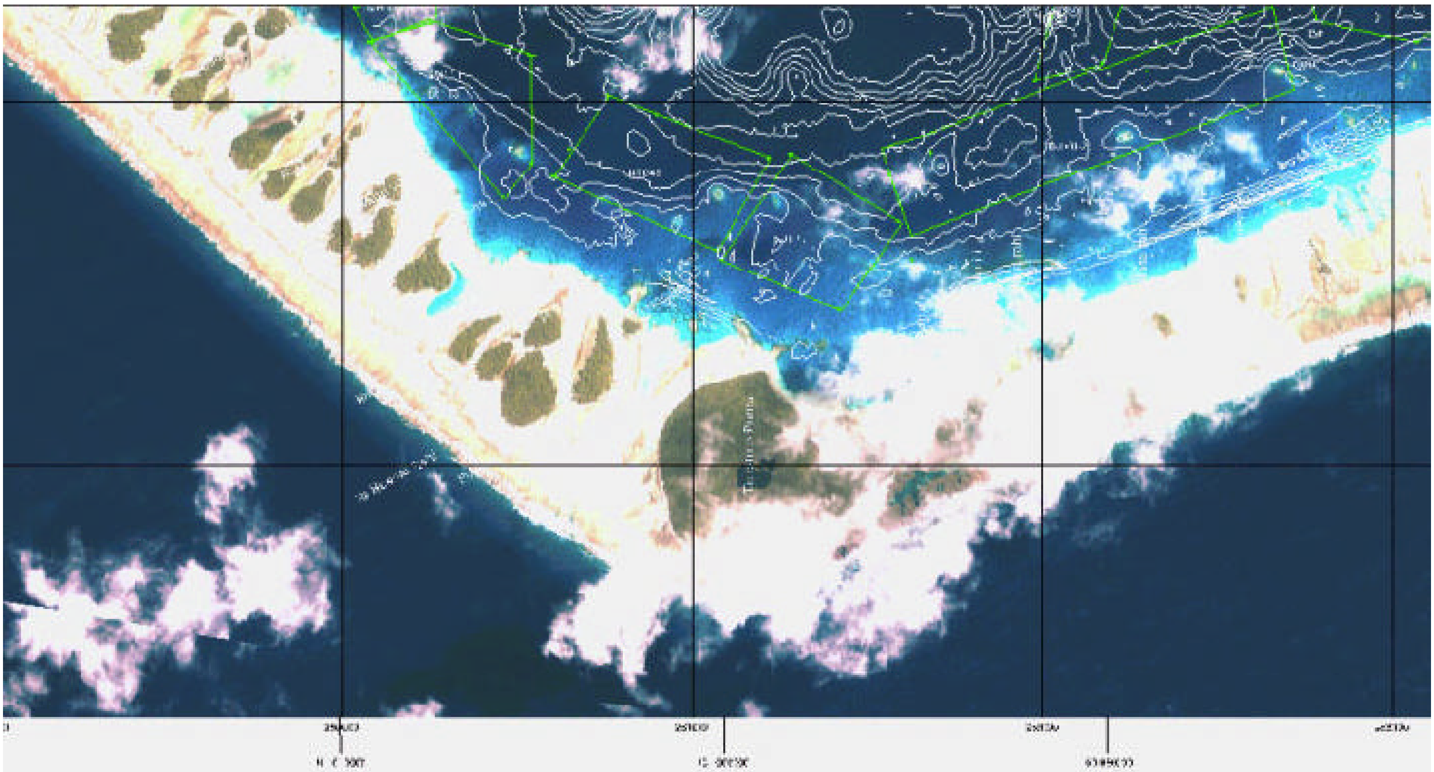

***Figure 2:** The image shows a part of the map which combines IKONOS image data, sea bottom contour lines, farm boundaries, local names, UTM grid and lat long WGS84 marks.*

After the images are separated, then they can be enhanced, using break points control to change the colours, in all bands of red, blue and green. For an example each pixel has different amounts of red, blue and green that makes up its color, so different areas need different break off points to produce a more enhanced image. Then when the 2 images are improved it is joined together in the modeler program. These two images should have exactly the same pixel number and file size, if there is a difference the image will not fit back together correctly. After the images are joined it is still in 16 Bit data range, so it has to be converted to 8 Bit to be read in other programs. The easiest way to convert from 16 to 8 Bit data is to save the viewer as an IMG file, which converts it directly from 16 Bit to 8 Bit data. The IKONOS image can now be exported to other programs.

Farm Boundaries

There were about 200 farm boundaries surveyed in manihiki lagoon using differential GPS. These were recorded and placed into MapInfo, as polygons so there is a better understand of the area that each farm covers. After all the farms are located and correctly named, all the data related to each farm were tabulated and linked to the MapInfo map using access, creating a manageable database.

This database was produced to improve the understanding on the practices that occur in each farm, this will help improve the industry and protect the environment, reducing the chance of a fatal pearl disease occurring again. Apart from the farm boundary location all the original names or the islands and reefs have to map and correctly named, so people don't get confused on boundary location.

Producing a Large Scale Map

Using the enhanced Ikonos image, and annotation layers of the bathymetry, farm boundaries, and the island names. We can produce a large-scale map showing the lagoon in great detail. This was done using the Ikonos image as a backdrop and all the needed attributes to produce a good quality map. The map is then plotted using a good quality printer showing all the layers. This map is the basis of the project and is the main item in helping manage the black pearl industry in Manihiki. From this map and current modeling, and the pearl farm database is produced which helps in the planning on how to prevent major problems from occurring again. This also give the island council better understanding on what practice the farmers are using and at what depth there shells are grown, as this is for the safety of the farmers and so the island council knows the number and quality of the pearl shells in the lagoon, as this is another factor that will contribute to the success of the industry.

Analysis of geological data using GIS, an example from the Naboro landfill site, south east Viti Levu, Fiji

Tariq Rahiman
Mineral Resources Department

The Mineral Resources Department recently completed a geological/geotechnical survey at Naboro Landfill site in which GIS was used as a means of portrayal of geological data.

The survey was carried out at the request of the Ministry of Local Government, Housing and Environment, to provide the consultant engineers with landfill design parameters. The Naboro Landfill site is located approximately 23 kilometres along the Queens Road towards Navua from central Suva. The aim of the survey was determine character of overburden soil, produce a three dimensional topographic model for the landfill site and produce a bedrock level contour map.

MapInfo ver 5.5, Discover ver 3.0, Vertical Mapper ver 2.5 and Bore Hole Mapper ver 1.01 were GIS based softwares that were used to record, integrate and analyse topographic and subsurface geological data.

To produce the three dimensional topographic model, topographic data (X, Y, Z coordinates) were acquired from topographic surveys done by Wood and Jepsen and the Survey Department. The co-ordinate and elevation data files in AutoCAD format were imported into MapInfo to produce a layer of points representing topography (Figure 1). These points were gridded using Vertical Mapper to produce a topographic contour map. The 3D viewer tool in Vertical Mapper was used to create a 3D model from the gridded map (Figure 2).

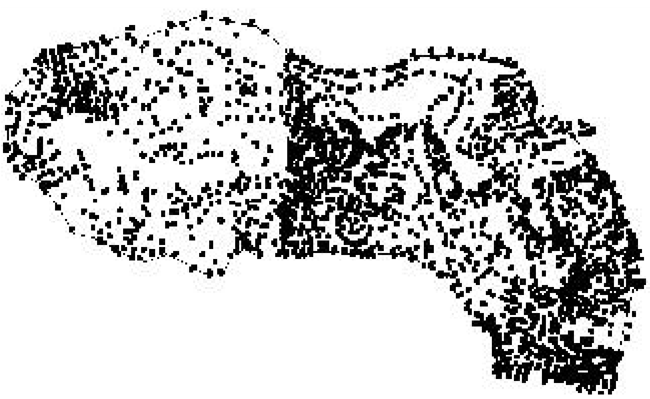

Figure 1: *Plan of Naboro landfill site in MapInfo, the points hold elevation data imported from AutoCAD.*

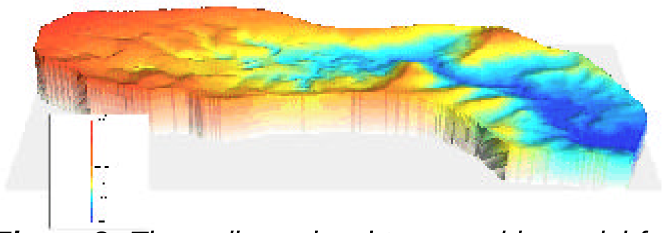

Figure 2: *Three dimensional topographic model for the Naboro landfill site.*

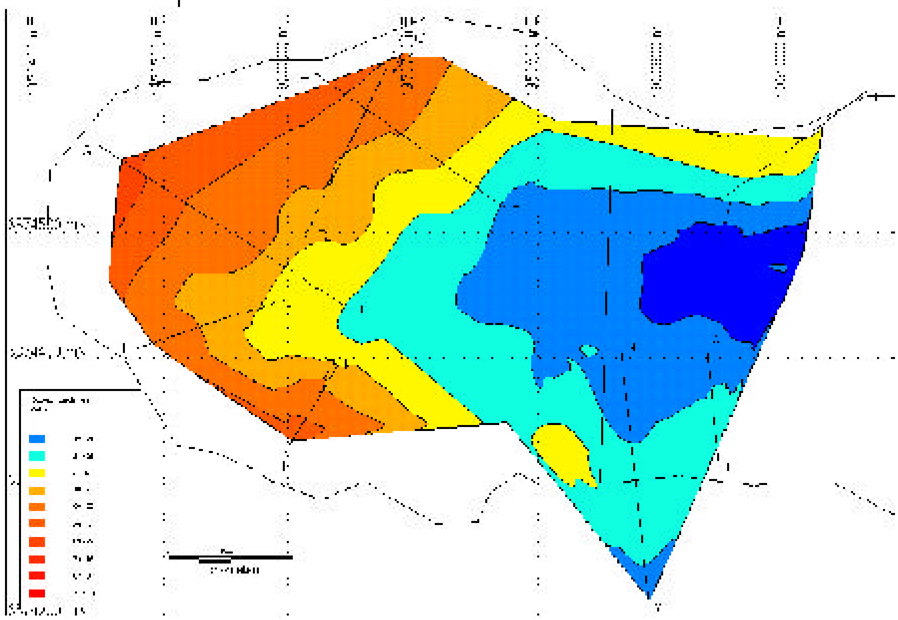

Figure 3: *Bedrock level contour map produced using the gridding tool.*

Bedrock levels were acquired by a variety of survey methods that included geological mapping, seismic-refraction profiling and hand augering. The Trimble GeoExplorer 1 Global Positioning System was used to record co-ordinate location at survey points.

Bedrock level data from each of the survey methods were extracted in the X, Y, Z co-ordinate and elevation (bedrock height) format and entered into separate MapInfo layers. These separate layers were combined into a single layer containing points representing bedrock level data. The points were gridded in Vertical Mapper to produce a contour map of bedrock levels (Figure 3).

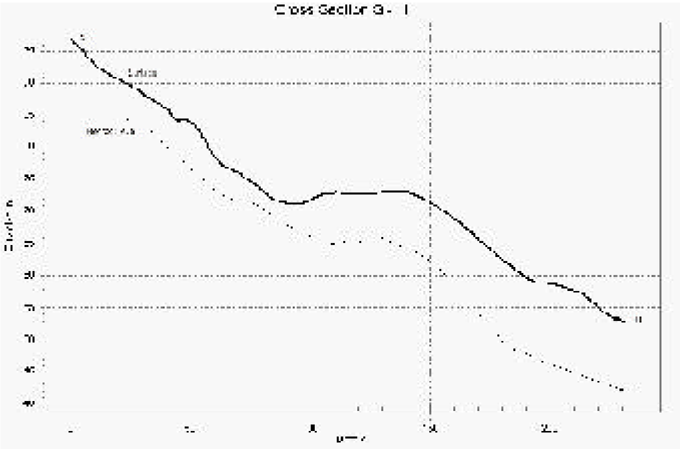

Figure 4: *An example of cross section generated using the cross section tool in Vertical Mapper*

The gridded topographic surface layer was overlaid on the bedrock level contour map and the cross section tool in Vertical Mapper was used to create surface and bedrock level cross sections at various places in the landfill site (Figure 4).

In conclusion, the geological study and the Naboro landfill site shows that GIS is a useful tool for:

- recording surface geological data
- integrating various types geological data (mapping, drill hole and geophysical)
- manipulating geological data into useful forms - 3D models and generating cross sections.

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The National Mapping Bureau and its Influence Directly and Indirectly in Papua New Guinea's Development

Peter Rogers
Chairman PNG GIS User Group

The National Mapping Bureau (NMB) prepares and maintains a number of mapping products in PNG. Some are funded by the PNG government; some by aid agencies and some information is supplied by other industries within PNG and abroad. They range from small scale maps showing all of PNG on one sheet down to highly accurate detailed maps showing Section and Lot numbers of much of the suburban areas. Topographical Maps, Aerial and Satellite imagery all are products supplied by the NMB.This information is extremely important to the development of many industries and government services within PNG. Places like the health department use this information as part of its base map that tracks many aspects of heath services in PNG. It is being used for sorting census information and for the mapping of Local Level Government boundaries for the upcoming elections. Local level government uses their maps for the basis of many of their own mapsand records.

NMB maps are used by the PNG military and the police for the internal and external protection of the civilian population of this country. Fire and Ambulance services use road maps all with links to the NMB.

Aid agencies use maps for tracking projects planning projects and storing information. The tourist industry uses products from the NMB. Information on roads, bridges are all stored on maps whose base has it roots in NMB maps.

In times of National disaster, maps produced by NMB are imperative for the planning of relief and rescue as at Aitape. Without maps, planning these operations would be severely hampered and it could cause unnecessary loss of life if delays are caused in the early planning of relief at these times.

The grassroots citizen of this country use maps for many different reasons, tracking village boundaries planning roads and possible land use.

Government owned agencies, Telikom, Eda Ranu, Elcom, The Survey Office, The Heath Department (previously mentioned) and Forestry all use products prepared by NMB.

Land Developers, Aviation Industry, The Mining and Petroleum industries, Surveyors, other mapping firms, Growers and many others use the NMB products.

It is important that the Government realises the importance of this relatively small agency. The government must be shown that if this agency is not properly funded it will cause additional costs and delays in many projects are to be funded by them and the private sector as well. This will in turn have an impact as a whole that will face extra financial and social cost.

SOPAC and EU Announce New Project

Russell Howorth, SOPAC

A new project to be implemented by the South Pacific Applied Geoscience Commission (SOPAC) and largely funded by the European Union from the 8th European Development Fund began on April 1st and is now in its inception phase.

The Project addresses vulnerability reduction in the Pacific ACP States through the development of an integrated planning and management system (Island Systems Management) in the sectors impacting on hazards, aggregates and water and sanitation. The Project strengthens integrated development in Pacific ACP States (Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu) by concentrating on three major and essential focal areas in the island system: hazard mitigation and risk assessment; aggregates for construction; and water resources supply and sanitation. The Project will address problems such as: unavailability of accurate, sound, and timely data; weak human resource base; limited resources (money and infrastructure); and lack of appropriate management plans, policies and regulatory frameworks to deal with these three focal areas.

Spread through the eight Pacific ACP States, field surveys in selected onshore areas and coastal harbours, lagoons, bays and shallow waters will form the basis of the Project. User-friendly spatial databases will be developed from these surveys areas (together with up-to-date air photos and satellite images) through application of Geographic Positioning Systems (GPS), and Geographic Information Systems/Remote Sensing (GIS/RS) tools. Access for all stakeholders to these common spatial databases via effective communications networks will be established.

For each country, this information will support the development of a knowledge base in these three focal areas thereby enabling the production of planning and management tools such as codes of practice, guidelines and draft legislation, to enhance integrated development for selected geographic areas or nation-wide.

Coastal communities in the Pacific ACP, in particular the smaller island countries, will be targeted as principal beneficiaries. Other beneficiaries will include governments, utility organisations, statutory bodies, non-government organisations, the commercial sector, civil society and intergovernmental bodies.

The Project is consistent with UN Agenda 21, the Barbados Programme of Action for Small Island Developing States (SIDS) and recent initiatives of the UN Economic and Social Commission (ECOSOC), that recognise the vulnerability of small island states and emphasise the role of information technology in assisting such countries in resource development. The Project is also consistent with the draft Plan of Action to be considered at the World Summit on Sustainable Development to be held in Johannesburg, South Africa in late August.

Annual GIS&RS User's Conference 2001

Michael Govorov

The first three Annual User Conferences of the Fiji GIS/ Remote Sensing User Forum were held at The University of the South Pacific (USP) in late 1998, 1999 and 2000. User surveys conducted at all conferences and follow-up surveys indicated a high level of satisfaction in and recognition of the importance of the conference series. After preliminary discussions at the monthly meetings of the Fiji GIS and Remote Sensing User Forum in early 2001 it was agreed to proceed with a conference this year.

The main objective of the annual User Conference is to allow as many practicing GIS personnel as possible to meet and exchange information on the progress and challenges in implementing GIS, Remote Sensing and related technologies in Fiji, as well as other Pacific Island Countries. While the monthly User Forum is a good venue for such information sharing, not all staff attends these meetings. It is hoped (and experience is showing) that a greater level of interaction between the different members of the user community would increase the skills and knowledge base among workers in the Geo-information industry. Experience in countries where GIS is more established has shown that informal and user-focussed information sharing events are key for human resource and system development.

The specific objectives of this year's User Conference, based on feedback from 2001 and input at the monthly user Forum meetings was to highlight user perspectives on GIS/RS development. The other aim was to increase participation in the wrap-up "challenges to implementation" session. To meet these objectives, various users and managers were asked to contribute to a special discussion session and participants were broken up into small working groups for the "challenges" session.

A request for financial assistance saw responses from several agencies. As in past years, the Lands and Surveys Department, Telecom Fiji lent financial support and Geo-Systems Ltd. The French Embassy, Critchlow Associates of New Zealand, and Intergraph of New Zealand were new financial supporters this year. USP again agreed to underwrite some of the conference expenses. Given the level of contributions, it was possible to run the conference without having to set up a registration and fee process.

The conference began with a welcome from the University given by the Head of the School of Social and Economic Development, Doctor Imam Ali. Besides offering a welcome on behalf of the University, Doctor Ali quickly outlined the ongoing commitment to GIS development at USP. He noted how the concept of the University is to explore and discuss ideas and asked the conference participants to use their time at the university wisely to come up with new ideas to guide the Fiji GIS community forward. He wished all participants a good conference.

Ratu Naiqama Lalabalavu, Honourable Minister for Lands & Mineral Resources, officially opened the conference. In his speech he noted the potential for GIS as well as the problems it presents in its implementation. He suggested that cooperation was needed in order to implement GIS more widely and that this conference had been an example of this sort of sharing. He asked each and every participant to think about what they had learned at the conference and to try hard to implement any good technique they had seen.

Over the three days of the conference, approximately 175 people attended at different times, including 100 at the opening ceremony. Guests were present from the Land Use Planning Office of the Université de La Rochelle of France, IRD ESPACE Laboratory of New Caledonia, University of New Caledonia, National GeoScience Information Centre, Korea Institute of GeoScience and Mineral Resources, Cadastre of New Zealand, Intergraph of New Zealand, Geo-Systems Ltd., Critchlow Associates, and Lukemine Enterprises of New Zealand, Beca Carter Hollings & Ferner Ltd of New Zealand, Solomon Telekom Company Limited.

Mr. Winston Thompson, Managing Director of Telecom Fiji, made the closing address. In his closing address, he outlined the history of GIS at Telecom. He indicated that GIS implementation at Telecom had been very successful and GIS was still a high priority. While they had implemented a good system, the use of GIS was lower than expected, and he indicated a need to increase the profile of GIS within the organization. He said that Telecom committed to assisting the local GIS community in its future development. He wished the participants the best of luck with the conference, and hoped that attendees would develop useful plans. He wished everyone the best of luck in their future work and declared the 2001 User Conference closed.

The conference should be considered a success. Attendance was up considerable from the 2000 conference, there was a good turn in of people. The format of the conference was improved over 2000 and participants felt they had more opportunity to contribute. Exhibition / Poster Sessions was introduced. There were many presentation from oversees. Negative aspects, which were pointed out during previous 2000 conference, were considered.

Geo-correction of Images in the Marine Environment

Liza Phillips

This project required an image mosaic of Nukubuco reef in order to interpret the seagrass beds for the four species found there. The species were Syringodium isoetifolium, Halodule uninervis, Halodule pinifolia and Halophyla spp.

The development of ground control networks is essential to the proper geo-correction of imagery for spatial analysis within a GIS (Welch and Remillard, 1992). The geometric correction is essential where images are compared to in situ data, maps or other spatial data within a GIS. However, there are cases where adequate ground control cannot be obtained easily after the imagery has been acquired. For instance, in the marine environment, there are often not enough permanent ground features which can be selected as ground control points.

The raw images were geocorrected using the Fiji Map Grid (FMG) co-ordinates.

In this project, the study area was Nukubuco reef, part of the barrier reef system off the Suva peninsula. The 1997 colour aerial photographs used were a series of three photographs at a scale of 1:10,000. The photographs covered only the reef and adjacent lagoonal and open ocean waters. There were no other coastal features captured in the photographs which could be used to select an adequate ground control network.

In this case, biotic features such as seagrass and algal beds were used as these features provided the best edge contrast to neighbouring features. However, one limitation here is that biotic features can change temporally and it may lower the accuracy of the image geo-correction. As a result the procedure may not be adequate when geo-correcting image data for temporal change analysis where area comparisons have to be made pixel wise.

Geo-correction of the Color Aerial Photographs to Use as Backdrops

The 1:10,000 scale photographs were scanned using an AGFA snapscan 1236 flat-bed scanner at an (optical) resolution of 300 dots per inch (dpi). The scanned images were stored as 24-bit TIFF files. The images were 16 million colour display and had 2484 x 2616 pixels (8.28 x 8.72 inches) as the digital image dimension.

The scale of the original aerial photographs and the scanning resolution determined the effective resolution of the imagery. This resolution, the 'nominal pixel width', is defined using the following formula:

Nominal pixel width (m) = scale of aerial photography x 0.0254   Scanning resolution (dpi)

Using this formula, the nominal pixel width for the 1:10,000 scale photographs was 0.85m. Ideally the geo-reference points should be relatively permanent fixtures and evenly located across the imagery. However, in this coral reef environment permanent features could not be located easily. The Landsat 7ETM image was used to geo-correct the colour aerial photographs. By choosing image featureswhich could be identified on both the Lansdat 7 ETM image and the colour aerial photograph, it was possible to identify ground control points.

(The Landsat image was geo-corrected using the scanned digital version of the Fiji Topographic map as the base map). Image to image correction was utilsed in ERDAS-Imagine. The ground control network selection was done in a fully-interactive manner by keeping both the Landsat 7 ETM image and the aerial photographs open simultaneously and selecting photo-points which could be clearly identified on both images.

The features used included:

(1) sinuous edge points of the seagrass beds
(2) tips of protruding reef edge features
(3) tips of dark patches on the reef flat
(4) Nukulau island vegetation patch
(5) dark patches at the reef crest – macroalgal zone (patches)
(6) sharp edges of the sandbank on the west end of Nukubuco reef and
(7) Nukulau and Makuluva islands

The 'Rubbersheeting' operation for geo-correction was used in ERDAS-Imagine remote sensing software. This method takes ground control points (three) to triangulate and interpolate intermediate values. The photos were then resampled to a pixel resolution of 1.0 m.

Mosaicing the Aerial Photographs

The aerial photographs were then mosaicked. The original photos had an overlap of 60% and this photo size was retained in the image mosaic (edges of photos were not removed). An associated TAB file was created in order to view the mosaic in MapInfo Professional 4.1.

The mosaic was used as the backdrop for all thematic maps in the GIS using MapInfo Professional 4.1. This helped to give a visual representation of the surface cover and textural patterns of the seagrass beds for which the geocoded in situ seagrass abundance data were mapped. The GIS was the key link between the in situ data and the photo-interpretation involved in developing the Selective Photo-interpretation Key.

The Selective Photo-interpretation Key classified the homogeneous and heterogeneous patch types of the four seagrass species which were found in the backreef seagrass beds. Three homogeneous patch types and two heterogeneous patch types were classified using polygons in ENVI software (Environment for Visual Imaging).

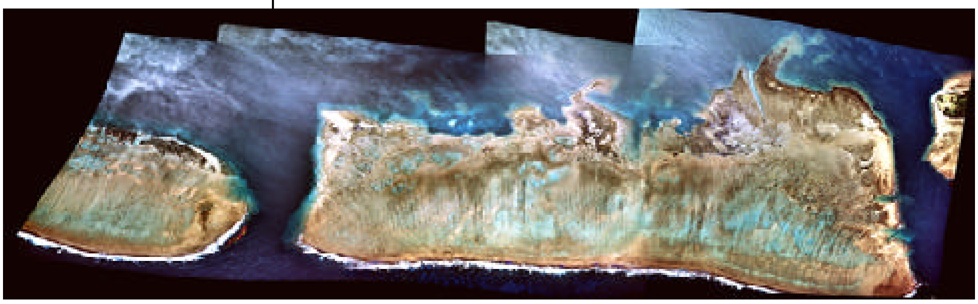


Figure 1: *Nukubuco reef, geo-corrected and mosaiced aerial photographs.*

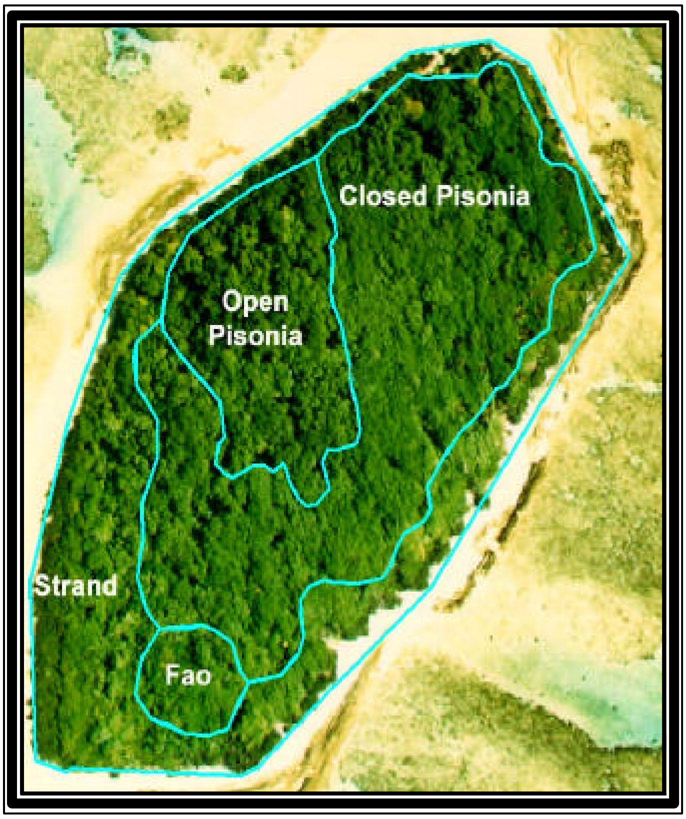
Area Measurement of Maninita Island, Vavau, Tonga

Dick Watling

Maninita, is a small coral cay the southernmost island of the Kingdom of Tonga's Vava'u group. Maninita is an important seabird nesting site and a proposed national protected area as originally identified by the Government of Tonga's Environment Section, Ministry of Lands, Survey and Natural Resources. The Tonga NZODA Nature Tourism Programme has responded to this and the increasing interest in the island from Vava'u's tourism sector by including a Maninita initiative as a component of its overall programme.

The initiative has undertaken a Preliminary Survey of Maninita in May 2001, followed by a Baseline Survey in November 2001. The latter required an accurate analysis of the overall forested area of the island as well as the different vegetation habitats to enable the stratified sampling of breeding birds as well as reptile counts to be extrapolated for total numbers.

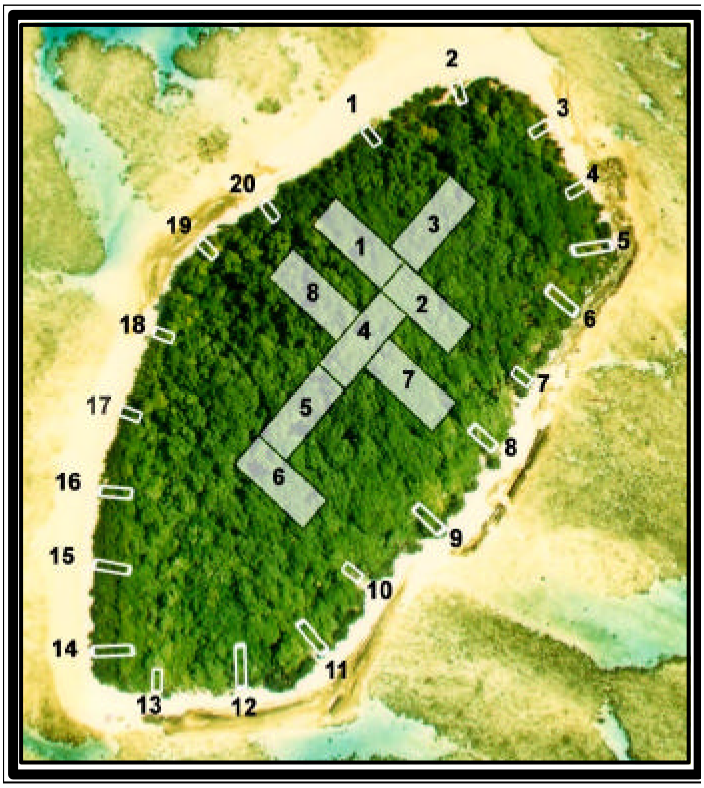
A standard colour aerial photograph was available (24 May 1990), which was used as the base for all area calculations.



Firstly a high-resolution scan was prepared to enable vegetation stratification and area calculation to be undertaken.

On the basis of notes taken on the first visit to Maninita, initial stratification of the vegetation was superimposed on an image and field-truthed on the second visit. Four vegetation types were distinguished (upper plate):

- Closed-canopy puko (*Pisonia grandis*) forest;
- Open-canopy puko (*Pisonia grandis*) forest;
- Fao (*Neisosperma oppisitifolia*) dominated forest; and,
- Mixed strand forest.



The circumference of vegetation of the roughly circular island was measured with a Hip Chain and Thread, and found to be 899m.

Twenty Strand plots (5 x 10-20m) and eight Woodland plots (20 x 50m) were enumerated for all species present with regeneration distinguished.

On returning to the office, the total area of vegetation and the four vegetation habitat types were calculated by GIS analysis. There were no ground control points because it was impossible to carry out an appropriate GPS survey. To get the image rectified a different method was used. Then, the outline including all polygon points was reestablished on the screen display of the aerial photograph using image analysis software. Because the area is plain and the aerial photograph was recorded in nadir view the image had only to be adjusted to the right scale to fit exactly the measured circumference. This was performed by an affine transformation, which is an image analysis function. Finally, GIS backdrop was established, which allowed the on screen stratification and delineation. The area computation is a GIS function and does not require manual calculation.

On the basis of the vegetation area calculation and those of the four habitat types, the following could be accurately calculated:

Vegetation: Area contribution of the different forest types on the island.

Nesting seabirds: Numbers of breeding gogo (*Anous stolidus, A.minutus*) data from plot sampling showed that only Mixed strand forest should be distinguished from the other vegetation types which were lumped. Transects data rather than plot sampling was used to estimate tala (*Gygis alba*) nesting density, again distinguishing only strand forest from the others vegetation types.

Reptiles: Transects showed that Closed-canopy puko needed to be distinguished to obtain relative density figures for the pili, copper-tailed skink *Emoia impar*.

Conclusions: Without the accurate area calculations made possible through using remote-sensing methodology, the calculation of densities of the breeding seabirds and skink distribution would have been much cruder. Furthermore, stratification as a result of differing vegetation type would not have been possible, even though the field work showed that vegetation differences were of real biological significance in certain cases.

In January 2002, Cyclone Waka devastated the island of Maninita, less than two months after the Baseline Survey. We will, therefore have good data to measure the impacts of the Cyclone on both the vegetation and the fauna.

In June 2002, rats were removed from the island and in the future it will be possible to see if rats were having a limiting effect on the numbers of breeding seabirds as well as changes in vegetation types and frequencies of different tree species. Monitoring the effect of removing rats from the island was the original purpose of undertaking the Baseline Survey[1]

[1] For the full Baseline Report see www.pacificbirds.com Go to Noticeboard and click on Maninita Preliminary Baseline

Report - downloadable in pdf format.

GIS&RS Workshops bring skills into Pacific Island Countries

SOPAC conducted several GIS&RS workshops throughout the Pacific. In Vanuatu, participants from different government departments and the private sector received theoretical and hands-on training financed by AusAID. For the different regions in Fiji, ADB financed 10 workshops of one week each for hands-on training in GPS data capture, data enhancement and map editing. In Cook Islands AusAID funded ten days GIS&RS training for pearl farm management.

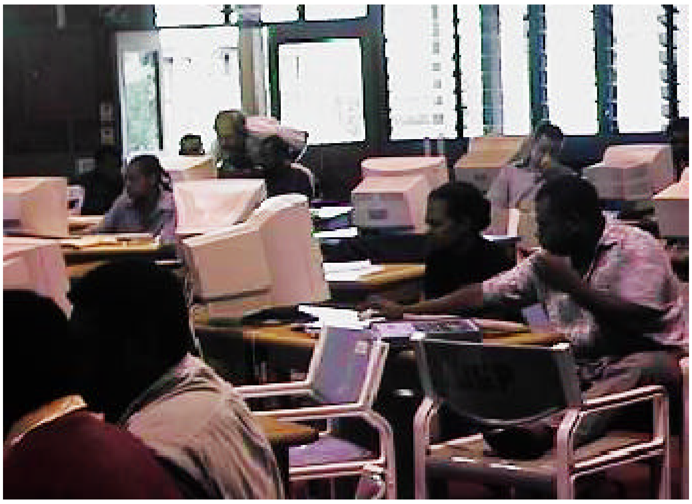


Figure 1: *In Vanuatu more than 20 destop computers were brought by the participants to the national GIS&RS workshop ensuring that always two had computer access during the hands-on exercises.*

Figure 2: *Participants of a workshop on GIS for GIS and IOKONOS image backdrop application for pearl farm management in the Cook Islands.*

ENVISAT: a new Source of Remote Sensing Data

Wolf Forstreuter

Introduction

ENVISAT was successfully launched on 1 March 2002. This satellite is an advanced polar-orbiting Earth observation satellite, which will provide measurements of the atmosphere, ocean, land, and ice over a five-year period. Figure 1 shows an artist's view of the satellite in orbit.

***Figure 1:** Artist's view of the ENVISAT in orbit.*

ENVISAT carries 10 different systems on board of which the most important are as follows:

1) ASAR provides radar images, independent of the underlying weather conditions, to monitor the tiniest changes of the earth surface, useful for the characterisation of man-made or natural disasters;

2) GOMOS is a precision monitor of ozone distribution all over the globe;

3) MIPAS and 4) SCIAMACHY create global, three-dimensional maps of most trace gases in the atmosphere, particularly the greenhouse gases, like methane and carbon monoxide;

5) AATSR creates the most accurate global picture of sea-surface temperature;

6) MERIS observes the "colour" of the ocean over a wide range of wavelengths to provide precise marine biology information and vital insight into global warming by mapping the distribution of phytoplankton, which accounts for half of the absorption of greenhouse carbon dioxide by our planet's biosphere;

7) The Radar Altimeter monitors the smallest changes in sea level and in the topography of polar ice caps.

For Pacific Island Countries the practical application of the science is of greatest importance. A very useful application would be the potential to guide local fishing fleets. Sea-surface temperature (see AATSR sensor) in combination with ocean colour indicating the phytoplankton rich waters (see MERIS sensor) and ocean current calculated from sea-surface height (see Radar Altimeter) could be used as indicators of nutrient-enriched waters and areas of higher concentration of fish stocks.

The article (including all images) is based on information available on the European Space Agency's (ESA) web site. SOPAC currently is in contact with ESA and Radarsat International as ENVISAT data distributor and ocean remote sensing specialists to study the feasibility of a fishery fleet guiding system for Cook Islands and Fiji.

The rest of the article catalogues the most important sensors onboard of ENVISAT and the applications of the data acquired by each:

MEdium Resolution Imaging Spectrometer Instrument (MERIS)

The MEdium Resolution Imaging Spectrometer Instrument (MERIS) is a 68.5^{o} field-of-view pushbroom imaging spectrometer that measures the solar radiation reflected by the Earth, at a ground spatial resolution of 300m, in 15 spectral bands, programmable in width and position, in the visible and near infra-red. MERIS allows global coverage of the Earth in 3 days.

Given the high importance of fisheries management in Pacific Island Countries the bands that are of particular interest for this application are:

- the measurement of photosynthetic potential by detection of phytoplankton (algae);
- the detection of yellow substance (dissolved organic material);
- the detection of suspended matter (re-suspended or river-borne sediments);

Apart from the above three major observable features, it should also be possible to detect special plankton blooms, for example red tides through their absorption feature near 520 nm. In addition investigations on water quality, the monitoring of extended pollution areas and topographic observations (such as coastal erosion), should also be possible. MERIS is, also capable of retrieving cloud-top height, water vapour total column, and aerosol load over land.

An important capability of the instrument is the provision of overviews of dynamic upwelling areas of

Nr.	Band centre [NM]	Bandwidth [NM]	Potential Applications
1	412.5	10	Yellow substance and detrital pigments
2	442.5	10	Chlorophyll absorption maximum
3	490	10	Chlorophyll and other pigments
4	510	10	Suspended sediment, red tides
5	560	10	Chlorophyll absorption minimum
6	620	10	Suspended sediment
7	665	10	Chlorophyll absorption and fluo. reference
8	681.25	7.5	Chlorophyll fluorescence peak
9	708.75	10	Fluo. Reference, atmospheric corrections
10	753.75	7.5	Vegetation, cloud
11	760.625	3.75	Oxygen absorption R-branch
12	778.75	15	Atmosphere corrections
13	865	20	Vegetation, water vapour reference
14	885	10	Atmosphere corrections
15	900	10	Water vapour, land

Table 1: *The different MERIS bands and their applications. Bands with direct implication to ocean colour are highlighted in yellow*

the ocean and their primary production. This information helps in the management of fish stocks as the main fishing grounds are in upwelling areas. Figure 3 recorded 28 March 2002 shows the huge phytoplankton patch produced by the upwelling mechanism along the Mauritanian coast. In such upwelling areas northeast trade winds bring deep and nutrient-rich water to the surface, feeding phytoplankton. This is the beginning of the marine food chain where fish concentrate.

Advanced Along Track Scanning Radiometer (AATSR)

One of the objectives of the **A**dvanced **A**long **T**rack **S**canning **R**adiometer (AATSR) is to establish continuity of the ATSR-1 and ATSR-2 data sets of precise sea-surface temperature (SST), with an accuracy of (0.3 K). The AATSR can be switched to 1-km resolution and lower resolution if more area has to be covered. AATSR is uses an on-board calibration system for basic radiometric accuracy and also uses a two-angle viewing technique to obtain accurate atmospheric corrections. The image in Figure 2 was recorded during a day-time pass of the Gulf of California.

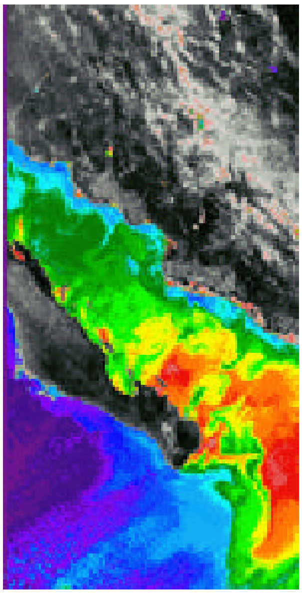


Figure 2: *AATSR image, gulf of California*

The hottest areas (shown in grey) are mostly land. The cooler sea-surface temperatures are shown using purple (coolest) to red (warmest). The range of temperatures shown in the image is approximately 280 Kelvin to 300 Kelvin.

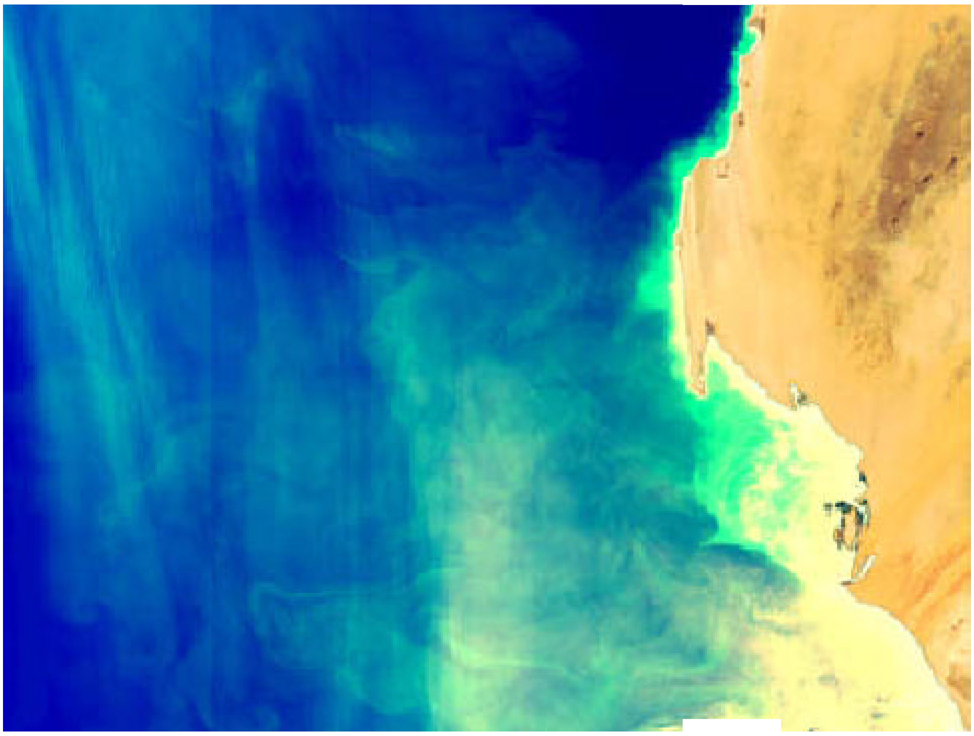


Figure 3: *Upwelling areas near West-Africa. These phytoplankton-rich waters are attractive to many fish species.*

Radar Altimeter 2 (RA-2)

The **R**adar **A**ltimeter 2 (RA-2) is an instrument for determining the two-way delay of the radar echo from the Earth's surface to a high-precision: less-than-a-nanosecond. It also measures the power and the shape of the reflected radar pulses.

The Radar Altimeter is able to measure the mean ocean height, wave heights and wind speed at the surface of the ocean.

Furthermore, the RA-2 is able to map and monitor sea ice, polar ice sheets, and most land surfaces.

Measurement of the radar echo power and shape enables the determination of wind speed and significant wave height at sea, thus supporting weather and sea state forecasting.

Advanced Synthetic Aperture Radar (ASAR)

ASAR is operating at C-band and ensures continuity with the image mode synthetic Aperture Radar (SAR) and the wave mode of the ERS-1/2 AMI. It features enhanced capability in terms of coverage, range of incidence angles, polarisation, and modes of operation. The resulting improvements in image and wave mode beam elevation steerage allow the selection of different swaths, providing a swath coverage of over 400-km wide using ScanSAR techniques. In alternating polarisation mode, transmitted and received polarisation can be selected allowing scenes to be imaged simultaneously in two polarisations.

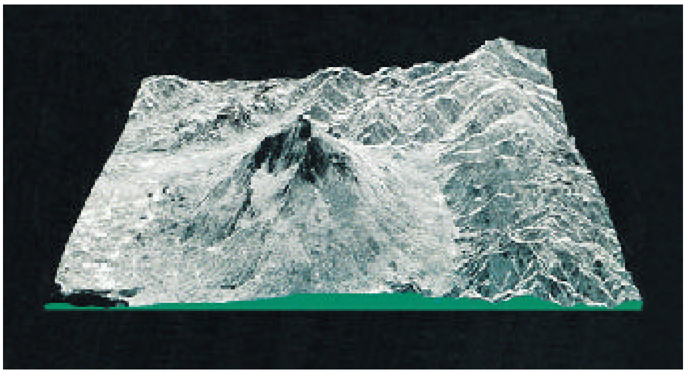


Figure 4: *Digital terrain model image of the ETNA volcano built from ERS SAR data by ESA; with the ASAS in the ENVISAT, even better data is expected.*

The practical applications of ASAR data could be the preparation of Digital Terrain Models (DTM) for Pacific Island Countries. Figure 4 shows an example of a DTM created from ERS 1 and 2 data from Mount Etna in Italy. Similar applications would be feasible for Pacific Island Countries. Another application would be the mapping of flooded areas after cyclones. Radar sensors can record the surface through cloud cover and distinguish between water and land, which is not covered by flooding.

Radar can visualise different surface roughness. This allows the detection of oil spills on the ocean which is useful for pollution control (see Figure 5).

Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS)

DORIS is a tracking system providing range-rate measurements of signals from a dense network of ground-based beacons. These data are precision processed on the ground providing the satellite orbit with accuracy in the order of centimetres. They are also processed on board to provide real-time satellite positions with an accuracy of some tens of centimetres.

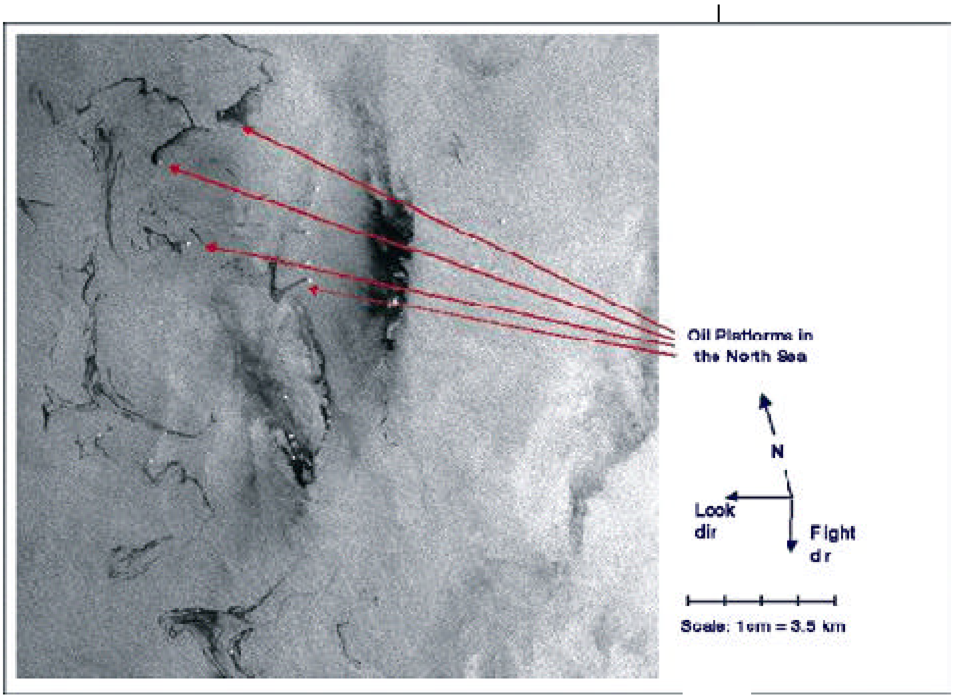


Figure 5: *ENVISAT's radar instruments can detect oil spills of as little as some hundreds of litres on any water surface around the world, day and night, even through the clouds. The image shows oil spills in the North Sea visualised by ERS data.*

For further information see ESA's ENVISAT web site:

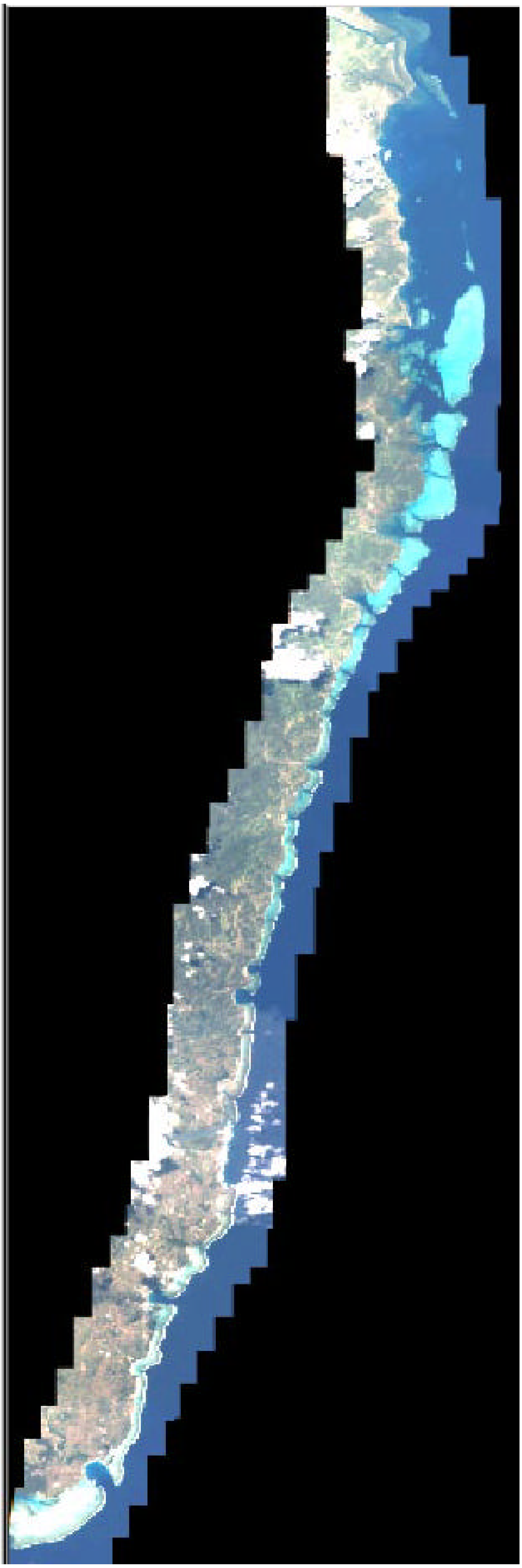
http://envisat.esa.int/

SOPAC will inform you about the status of establishing a link between satellite data providers and users in Pacific Island Countries' fisheries departments via GIS-PacNet.

To subscribe to GIS-PacNet use the automatic procedure or send an e-mail to wolf@sopac.org or jim@sopac.org.

High resolution Ikonos image of the south east coast of Viti Levu

As part of a joint USP-MRD SOPAC initiative a high-resolution IKONOS image covering the south east coast of viti levu from the mouth of the Navaua river through to Momi Passage was recently acquired. The image is an integral part of an integrated coastal management study that will not only examine the physical, geological and coastal processes of the area but will also look at the social aspects, the 'qoliqoli', and the conflicts that often arise with competing demands on natural resource use.



High-resolution IKONOS image covering the southeast coast of Viti Levu from the mouth of the Navua River through to Momi. This image is an enlargement to show detail of the coastline from the image below.

IKONOS, EROS-A1 and Merged Image

Picture top left: IKONOS image bands red, green and blue recoded from Suva harbour / Lami area. The image has 4m spatial resolution. The user currently has to pay about $US 21 per square km when purchasing through SOPAC. Space Imaging the company which operates IKONOS programmed the satellite to record this data.

Picture middle left: EROS-A1 image of the same area. This panchromatic image data has 1.8m resolution which is delivered resampled to 2m. the satellite is a Israeli military satellite, but the images are available on the market. SOPAC purchased this data for $US 5 per square km as this data was already available in ImageSat International archive.

Picture lower left: IHS merge of both images. The IKONOS multi spectral image was first converted from red, green, blue (RGB) into the image components intensity, hue and saturation (IHS). Then the intensity channel was replaced by the EROS-A1 image and reconverted into RGB. The same method is used for pan sharpened IKONOS or QuickBird images, where the panchromatic channel of the same satellite is utilised. EROS-A1 data could be a cost-effective alternative.