Pacific Islands
GIS&RS news

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GIS&Remote Sensing
Users in the Pacific
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EU Support for GIS&RS Shows Promising Results ....

The 2005 Regional GIS&RS Conference clearly was a milestone in the development of Geographic Information System (GIS), Remote Sensing (RS) and Global Positioning Systems (GPS) in the Pacific Region. For the first time this Conference brought together a very large variety of public and private sector participants and a record number of GIS&RS technicians from Pacific Island Countries. In a lively atmosphere software and data providers shared experiences with specialised user groups and associations. The profile of the conference was also raised by the first time attendance of the International Society for Photogrammetry and Remote Sensing (ISPRS). ISPRS sent the Vice Director, Professor John Trinder.

Conference participation and presentations also demonstrated that the technology has now emerged from an insider dominated small circle attracting substantial interest from users who want to get problems solved. And indeed we are now in the position to offer GIS/RS/GPS applications that are customised to the scope and scale of typical Pacific Island Country conditions where limited capacities and lack of resources call for smart and cost effective ICT solutions. The presentations showed that GIS technology has now gone beyond data collection, administration and display and is increasingly used as a support tool for utilities, natural resource management and infrastructure development. With assistance through the EU Project "Reducing Vulnerability of Pacific ACP States" Pacific utilities in particular have adopted GIS as a tool that facilitates asset management, system expansion planning, maintence and risk management. The link between GIS and better customer service has become obvious as response to fault reports are handled in a quicker and more efficient way.

The SOPAC-EU Project has been extended for two additional years and now covers 6 additional countries. The Project flexibly responds to training needs of established and emerging GIS&RS units. It also provides high-resolution satellite data and installs MapServers that create a common map basis and facilitate data sharing. Michel Gauche from the EU Delegation attended the conference to convey ideas of the EU/EDF as the major donor in GIS&RS development in the Pacific. Michel Gauche explained the policy of the EU regarding contributions to the Pacific, where he suggested practical applications and cooperation with other initiatives in the Region. With respect to these cooperative efforts, major progress has been achieved in the last year: 1) Through joint activities of the EU Project and the SOPAC CocoGen Project, a resource assessment for biofuel production was performed for the Samoan Electricity Company EPC and 2) Cooperation between the Energy Planning Project, PIEPSAP, and the EU Project resulted in the establishment of a fully-fledged GIS/MIS for the Tuvalu Electricity Corporation are two areas of cooperation. Future joint initiatives are planned where the GIS will not only be a data management tool but also a binding element that allows harnessing synergies through cross-sectoral cooperation.

John Trinder (ISPRS), Wolf Forstreuter (Fiji GIS&RS User Group) and Les Allinson (PICISOC) guiding the discussion on GIS&RS method development for Pacific Island Countries

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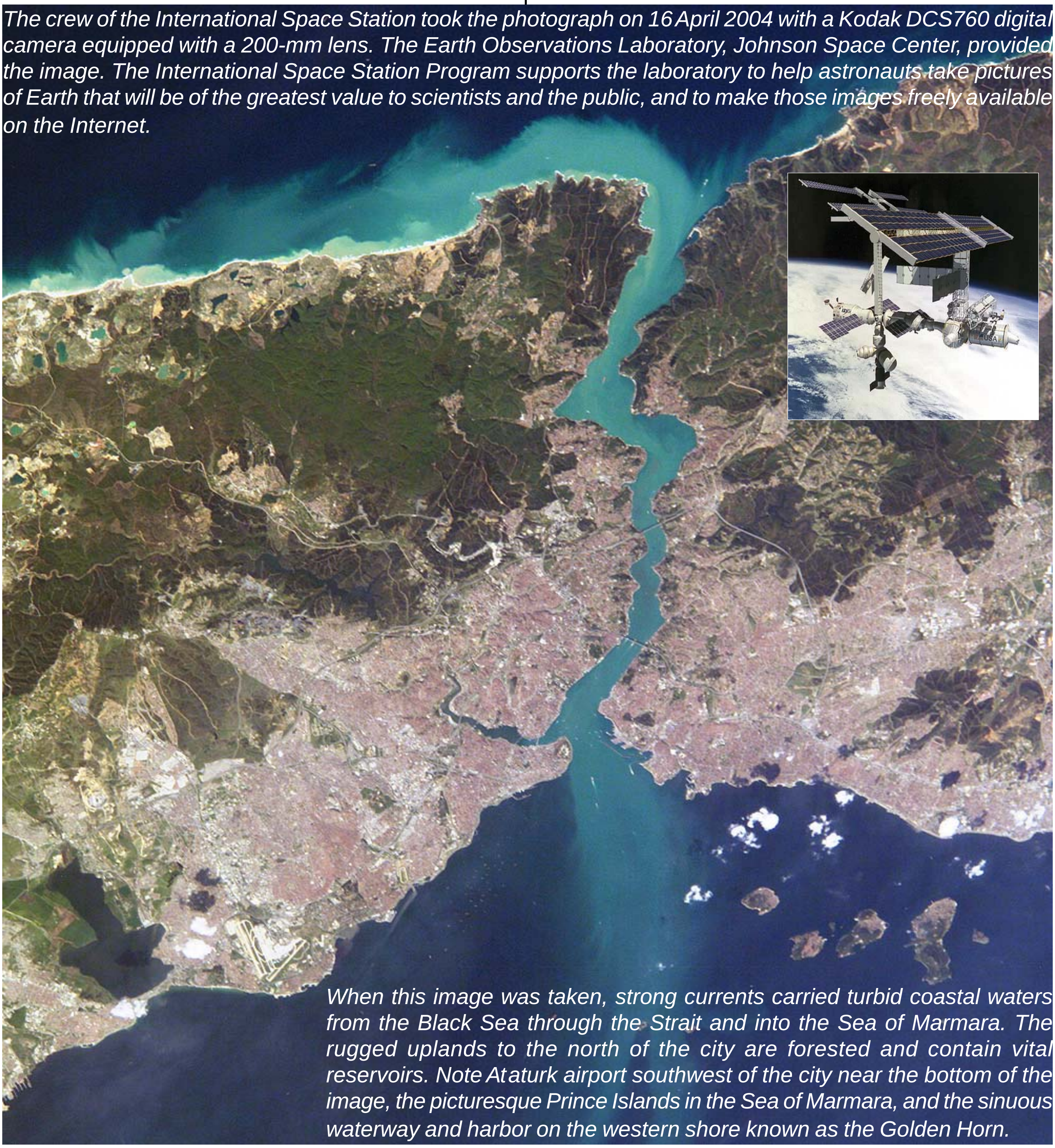

The crew of the International Space Station took the photograph on 16 April 2004 with a Kodak DCS760 digital camera equipped with a 200-mm lens. The Earth Observations Laboratory, Johnson Space Center, provided the image. The International Space Station Program supports the laboratory to help astronauts take pictures of Earth that will be of the greatest value to scientists and the public, and to make those images freely available on the Internet.

When this image was taken, strong currents carried turbid coastal waters from the Black Sea through the Strait and into the Sea of Marmara. The rugged uplands to the north of the city are forested and contain vital reservoirs. Note Ataturk airport southwest of the city near the bottom of the image, the picturesque Prince Islands in the Sea of Marmara, and the sinuous waterway and harbor on the western shore known as the Golden Horn.

GIS Making a Difference: 2005 PIC Conference Overview

Joy Papao, Emily Artack
SOPAC

The 2006 Annual Pacific Island Countries GIS/RS User Conference was organised by the Fiji GIS/RS User Group Committee from the 23rd to 25th of November 2005 and attracted more than 250 participants from most Pacific Island Countries. It was held at the Marine Studies Complex of the University of the South Pacific (USP), in Suva, Fiji. Despite the limited funding, the conference proved to be a huge success with more than last year participants and presenters. The total number of presentations had to be reduced and the time shortened for all of the ten sessions. The conference days probably needs to be extended to the increased number of presentations.

Participants travelled from Samoa, Vanuatu, Papua New Guinea, Solomon Islands, Tuvalu, Tonga and the Marshall Islands. The SOPAC-EU Project partly funded technicians to attend and present on the GIS/RS activities and updates from their countries.

Special guest speakers at the conference were Mr John Trinder, the President of the International Society of Photogrammetry and Remote Sensing (ISPRS), Mr Les Allinson, Secretary of the Pacific Islands Chapter of the Internet Society (PICISOC) and Mr Michel Gauche from the EU Delegation.

There was a broad coverage of presentations from the applications of GIS/RS, utilities sectors, institutions and software hardware companies. Osea Tuinivanua from the Fisheries Department for example presented ongoing investigations on enhancing the Vessel Monitoring System using space-borne radar data.

Representatives of software and data vendors were at the conference to present on the software developments from the various companies. These included the representatives of Critchlow New Zealand (MapInfo distributor for the Pacific), Radarsat International, ESRI Company and Intergraph, New Zealand Limited. The presentation by Radarsat (now known as MDA) was quite interesting as they have been one of the main data distributors of satellite images in the Pacific for the last three years. There was a noted increase in the number of companies present at the conference, which is a result of the growing interest in the region.

USP students presented their final year projects on new methods of GIS/RS applications.

Discussions were held in the final session, on method development that will be at an affordable cost to the Pacific Island Countries. Representatives of ISPRS, PICISOC and the conference committee guided the discussion. The article by Wolf Forstreuter in this newsletter will detail the outcomes of the discussions.

One of the major highlights of the conference has always been the social activity (opening and closing cocktails) that are organised by the committee. This serves as an opportunity for overseas visitors and regional participants to socialise and network over the week.

There was no media coverage throughout the conference and this is one of the main priority that will be adressed by the organising committee for year 2006.

This conference hosted a traditional Fijian welcome ceremony for the overseas guests and they had a chance to taste the traditional 'kava' drink. There was a surprise *Haka* performance from the visitors from New Zealand and various national anthems sung across the room with their national pride!

***Figure 2:** Welcoming overseas participants in a Fijian kava ceremony.*

A picnic was organised at the sandbank on the Suva reef as a final farewell to the visitors and the group thoroughly enjoyed themselves.

Overall, the conference was well organised with the various interesting presentations that covered a broad range of GIS/RS applications. It was visible that the impact of the EU-funded Project at SOPAC increased the GIS/RS applications in the Pacific region.

***Figure 3:** Picnic at the sandbank to farewell the participants*

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Now the expectation that follows is that there will be progress on the outcomes from the conference and this shall benefit the Pacific Islands region as a whole.

We shall be looking forward to the next Annual Pacific Islands GIS/RS User Conference, which promises to be a more exciting and a bigger event!!

Discussion: Demand for Method Development in GIS and RS to Apply in Pacific Island Countries

Wolf Forstreuter, SOPAC

During the Annual GIS&RS User's Conference, GIS officers from most of the Pacific Island Countries met at the last day and discussed most of the 9 topics listed below. During the preparation period of the conference the organising committee had identified these topics as areas, where methods have to be developed for the Pacific needs. These topics were already distributed via GIS-PacNet and partly discussed via e-mail and some topics were also added during this pre-discussion. The final list of topics were printed and included in the conference folder.

John Trinder, Vice President of ISPRS, Les Allinson, of PICISOC Management and Wolf Forstreuter of the Conference Committee guided the discussions. Although it was the last hours of the three day conference, 80 people came for the discussion. This is the largest discussion group of people involved in GIS and Remote Sensing in Pacific Island Countries.

ISPRS(International Society for Photogrammetry and Remote Sensing) and the GIS&RS interest group of PICISOC (Pacific Island Chapter of the Internet Society) are avenues to:

a) Assist in method development through networking with organisations outside the Pacific, b) Coordinate activities and c) Highlight problems at the international level.

Creation of Digital Terrain Models (DTMs) at 1:10,000 Scales with sub-metre Contour Lines.

Sand or beach movements of atoll islands cause major problems for housing and infrastructure. It is important to monitor where the sand drifts away and where beach is building up. The reasons for these shoreline movements are still not fully known. More understanding would allow a forecast to reduce negative impact. Contour lines of sub-metre accuracy are required to map the shape of the beach, which can be mapped using laser technology, kinematic GPS analysis could also be implemented.

During the discussion the possibility of LIDAR (Light Detection and Ranging) was mentioned. LIDAR is an interesting tool and example applications show the potential to monitor beach movements over time. The disadvantages are the high investment cost and the expense of flying a special plane from Australia or New Zealand. Also it will be difficult to base the system in the Pacific and therefore Pacific Island Countries rely on overseas companies.

Space-borne radar data can be used to show beach movements. Examples have indicated earth movements in decimetre range in areas where coal mining has caused landscape sinking. The system is weather independent and no planes have to be brought to the islands. However, an extremely high computer power is required to analyse radar data for this purpose and very specialised staff to operate corresponding software. To use such a system a regional organisation even would need to set up a new section. In addition, such analysis would require a huge number of radar scenes, which adds to the costs.

Figure 01: *John Trinder Vice President of ISPRS explains how ISPRS could contribute to network Pacific Island Countries with institutions outside the region for GIS and RS application developments.*

Large-scale aerial photography using balloons should be investigated, as a potential tool in islands, particular since photogrammetric software utilising digital images is becoming less expensive.

Kinematic GPS is one way to create DTMs with suitable vertical accuracy. The technique is easy to handle and software requirements are low. ERDAS is distributed in most Pacific Island Countries, which is sufficient to create DTMs from the data sets and calculate the change. The test carried out in August in Betio, Kiribati was not very successful due to failure of old equipment (see corresponding article in this newsletter), however, the technique as such is convincing. New equipment would be able to create a DTM within short time; staff of Pacific Island Countries could carry out the job and the equipment can be packed into small suitcases. However, a successful demonstration is still required.

Bathymetry of Shallow Water

SOPAC has two swath mapper systems, which are almost permanently in use. The data produced by the which are necessary for near shore fishery, navigation and other purposes. However, the boats carrying the swath mapper cannot drive in shallow waters, which leave a gap between the contour lines on land and in deeper water. Space Borne image data could be analysed to map this shallow water areas between 0 and 5 meter water depth. Maps of 1:10,000 scale are required, which restricts the analysis to multi-spectral, high-resolution satellite images. These image data are seldom available in nadir recording and the data are patched with recordings of different view angles and atmospheric conditions. Atmospheric correction of the image data will be necessary.

Wolf Forstreuter said that SOPAC's Director made a statement that funds would be made available to finance a student investigating methods to develop bathymetry of shallow water utilising the existing data sets.

More Frequent Space Borne Image Data (Mobil Ground Receiving Station)

With the exception of PNG all Pacific Island Countries are outside the footprint of any ground receiving station. For every image recording, on-board tape space has to be booked. Last minute decision related to cloud cover is therefore impossible in the Pacific. A mobile ground receiving station would provide faster and more cloud- free image data. The participants suggested that there must be new ways to bring this topic to regional decision maker level. John Trinder suggested that UN organisations such as UNDP or FAO could be an additional source of support to distribute the idea besides ISPRS.

Ocean Colour Monitoring

The observation of ocean colour, wave height, ocean temperature and wind speed can be carried out utilising space borne sensors. The data show where nutrient-rich water attracts fish and therefore has potential economic benefits to the Pacific Island Countries. Remotely-sensed images of open water also allows for the improved guiding of the local fishing fleets, as well as indicating areas where foreign fishing vessels could fish within the EEZ. No fishing or navigational department in the Pacific has implemented these technologies. Use of this information is being addressed in the immediate term under the auspices of the Pacific Islands Global Ocean Observing System (PI-GOOS) based at SOPAC. The PI-GOOS Program is working towards conducting workshops in country in 2006-2007 that will demonstrate the use and value of ocean colour monitoring and other remotely sensed images of open water in the Pacific Island EEZs. Other ongoing activities at SOPAC include the implementation of hardware, software and training programs in the fishery departments of Pacific Island Countries.

John Trinder mentioned that there is an ISPRS working group taking care of activities in this area and that he will network with institutions of the Pacific.

Fishing Vessel Detection and Monitoring

The Vessel Monitoring System was established years ago at the Forum Fisheries Agency in Honiara. Some Pacific Island Countries want to have their own monitoring system in addition to the central one. Vessel detection and monitoring will be one of the target areas in research and method development for the next few years.

Fiji's Fisheries Department and SOPAC together with the Joint Research Centre of the EU Commission currently investigate the potential of radar data to enhance the Vessel Monitoring System.

Open Source Software

GIS and remote sensing units in Pacific Island Countries work with a very limited budget. For this reason investment and maintenance of software are serious financial issues. One solution would be to switch to open-source software as soon as such products are available in a quality allowing application for a "normal" user. It is expected that such products will be available within the next few years for a) database management, b) GIS application and c) image enhancement and analysis. Such software has to be tested at SOPAC and USP before being implementing it in Pacific Island Countries.

The University of the South Pacific stated that they will not move into open-source software teaching within the next 3 years. Instead, their focus will be to develop new information systems and open-source software investigations will be only carried out as student projects. Les Allinson mentioned that funding would be available through ISOC for research and development.

Monitoring Biodiversity

Pacific Island Countries have a high biodiversity, which refers to the number of species in the water and on land. Remote sensing data and GIS will help to monitor the biodiversity; however, new methods have to be developed where statistically sound monitoring is applied to a large geographical area.

Inventory and Monitoring Palm Cover

Many Pacific Island Countries are 100% dependent on imported fuels. At the same time world market prices dictate the earnings from major export production coconut oil or copra. Currently there is a cross over of diesel supply cost and net earnings for copra. The coconut resource was neglected during the last decades. Coconut could potentially substitute diesel; but for this to occur, it is essential that inventories have to be carried out to estimate the amount of available resource. High-resolution space-

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borne satellite images have proven to be ideal tool to map the coconut cover. Methods have to be developed to map and monitor the coconut resource in a statistically sound way. During the discussion it was recommended that SOPAC take responsibility for the investigating and implementing new methods of palm monitoring.

Data Sharing and GeoCMS

Users have indicated the need to make data sharing easier between organisations. For this to occur, it is important to have policies of public data accessibility. Such datasets can then improve economic development. Data, which are publishable, can be accessed through a Geospatial Content Management System (GeoCMS) that provides maps, geographic data and metadata via a wiki system. Such a system is already being deployed in the Pacific Islands: http://maps.tikiwiki.org/

There will be further development at SOPAC to make the system more user friendly. It was also recommended that SPC demographic data should be included.

Early Detection of Landslides

Landslides create major damage on roads and houses in volcanic Islands like Samoa, Vanuatu and Fiji. Mapping potential landslides employing remote sensing methods would helpful for such islands. It should be investigated how far GIS&RS can be utilised.

The group of people interested in the topic had left already the room and there was no further discussion:

Summary:

The participants of the discussion stated that:

- the discussion should continue via GIS-PacNet;
- through ISPRS and GIS&RS interest group of PICISOC networking will link to information sources outside the Pacific;
- that such a discussion has to involve technicians, which never were contacted by organisations such as PCGIAP or ESCAP;
- that ISPRS and the GIS&RS interest group of PICISOC should monitor activities to avoid duplication of effort.

FEA GIS: Separating Spatial Data and Tabular Data

Etika Naitini

Fiji Electricity Authority

Introduction

Over the last year the GIS office at the Fiji Electricity Authority has been working on setting up a database of its distribution assets. As a proven planning and analysis tool, the introduction of GIS into FEA should increase efficiency by providing users easier access to the Authority's distribution data, which can be queried to provide meaningful information. The emphasis of this article is on separating spatial and tabular data between MapInfo and Access Database and also the database setup. One of the duties of the GIS office at FEA,formerly known as the Drawing Office is to store, update and disseminate data and drawings regarding our distribution assets. A fair share of our distribution data are still in hard copy drawings. The primary aim for setting up a GIS database was to improve the mode of service provided by the GIS office by transferring all our distribution data which are still in hardcopy, into digital format and setting up a database. With reduction in office staff and new extensions to our distribution lines everyday, setting up a GIS database was seen as the solution to efficiently store, retrieve and update our distribution drawings and making data easily accessible to users

Data Analysis: MapInfo

Once corrected, field data is imported into MapInfo, the selected GIS software for this project. In MapInfo, routine analysis of data is carried out. This includes tasks such as cross checking and supplementing field data with information from drawings and office records and separating of spatial layers. Small programs are written in MapBasic to perform repetitive tasks like modifying table structure, grouping like data together, calculation of line spans and also assigning a unique ID to assets captured in the field. Once data analysis is done, the tables are then exported to Access database where tabular data is stored whilst spatia data is kept in MapInfo.

Tabular data: Microsoft Access Database

We are using Microsoft Access as the database to store tabular data. Relationships are created between datasets to show how assets are linked to each other. Library tables are created to group together similar data, this would also help simplify querying and editing records in the database. Forms are also created for easy navigation through the database and for simplifying data-entry purposes.

and Tabular Data

After the field data is analyzed in MapInfo, the table is imported into the Access database. Before new tables can be appended to the main tables, we run queries to update these imported tables so that each field has a corresponding entry in the library tables. Access will not allow new tables to be appended to the main tables if any field of the new tables do not have a corresponding entry in the library tables or if the unique ID is repeated. After the imported tables have been successfully appended to the main tables, we then run to create output tables that will be called into MapInfo.

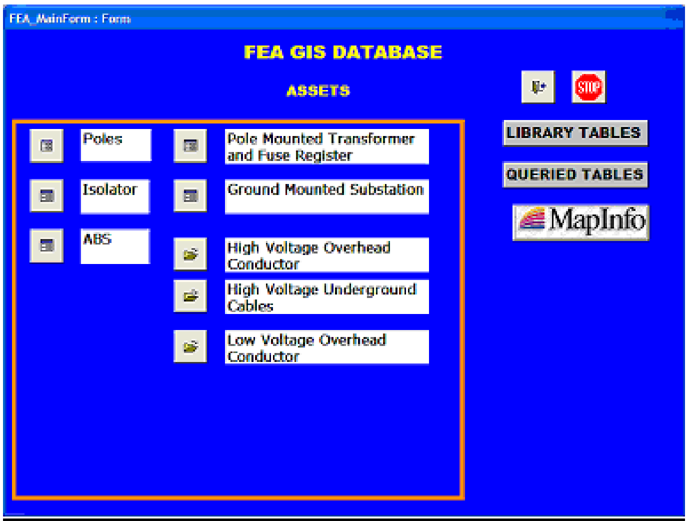

Figure 1: *GIS database in Access. Asset details are viewed through the use of forms. A customised version of MapInfo is executed from this Access by clicking on the MapInfo icon.*

When the user is viewing the forms in Access, he is viewing data based on the main tables, but when the same information is being viewed in MapInfo, the user is viewing data in the Access database through the output tables or queried tables.

The GIS database is set up in Microsoft Access and it is here where the user can access all data they need. MapInfo is activated from Access database when users want to view their queries in a spatial environment.

Customising MapInfo: MapBasic Programming

Writing programs in MapBasic is done to customize MapInfo. For users new to the MapInfo environment, customizing makes it easier to run certain queries by selecting from a list on a drop-down menu (see Figure 2). It is when these queries are run that spatial layers in MapInfo are linked through the unique ID with queried tables in Access Database. Queries include locating assets in the field like power poles along a particular street or a transformer. Not only can these assets be located on their geographical location but being linked to the database, we can access details regarding the condition of these assets. However when details of these assets change or is updated in the field, updating of the database has to be done in Access by designated personnel only. Also important is that linking the database with spatial layers allows for the display of thematic maps, for example showing which area is

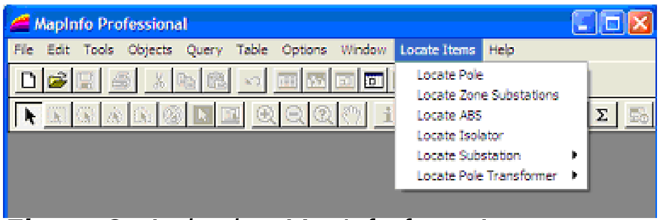

Figure 2: *Activating MapInfo from Access opens a customized version of MapInfo. Here users can select from a drop-down menu what queries they would like to run.*

supplied from which transformer or all the areas being supplied from a Zone Substation.

Results

The GIS database we have put together so far, although not fully complete is already producing some positive results. From assisting our National Control Centre with load analysis data to providing our Network Design section with relevant data to design extensions and upgrades of our distribution network. It has also improved efficiency in meeting requests from within and outside FEA regarding locations of our underground cables and other assets in the field. Where we would normally have to search through hardcopy drawings, find the selected area of interest before making photocopies of these maps, now we can easily select the area of interest from the GIS and print it saving a lot of time. In addition we have found that updating of our distribution data through the GIS database is much faster than it would have been if we were still maintaining our drawings in hardcopy format.

During the process of capturing field data, our field team is also providing our maintenance teams with defects they come across. By highlighting these areas on a map with pictures attached, our maintenance teams are provided with location and type of defects and can quickly respond to them. The use of GPS technology has also gathered interest from departments in-house. Our ICT division has used the services of our field team to conduct gps surveys of their proposed fibre optic cable routes between our zone substations in the central and in the western districts.

Conclusion

Field data capture for the central region is complete and our gps survey has continued to the Western district. We hope to complete all relevant work on the

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GIS database for the central district by the end of December. Plans are in place to purchase more MapInfo licenses, where the database will be placed on the server giving trial access to a few selected users. Options are being considered on accessing the GIS through a web browser on the local intranet. Our technical people who work in the field are also being taken into account, being able to work online so they can access the GIS from their laptops in the field would be a real advantage. They will only need to connect to the server when they need to update the database on their local drive. Details about other assets like consumer meters will also be added soon. Furthermore, the increasing size of our database means that we might have to migrate to other Database Management Systems that can handle all our data. With GIS being a proven planning, management and analysis tool, it will contribute significantly to increasing efficiency within the GIS office at FEA and in future we hope to be able to link the GIS database to other databases in other departments.

Figure 3: *An example of a defect captured in the field. Cross arm of the power pole pictured above is broken and should be replaced.*

Most of the GIS units in the utilities of Pacific Island Countries show the static analysis of the situation. The next step would be to show as graphic display "what happens if the power line is cut at point x, y, which customers are without electricity?" or "which consumers have no water if we close valve x and valve y?"

Such programming in Access Basic and MapBasic could be trained in a regional workshop, where utility GIS operators stay together for one week.

A possible workshop of the SOPAC-EU Project would now be co-financed by PIESAP and possibly other programmes. If we start to plan a workshop be held by end of this year we need a list of interested GIS operators now. Please indicate interest through an e-mail to either Wolf Forstreuter wforstreuter@yahoo.co.uk or Gerhard Zieroth Gerhard@sopac.org or Elizabeth Whippy Elizabeth@sopac.org

1:10000 DTM for Atoll Islands Utilising Kinematic GPS

Wolf Forstreuter & Naomi Atauea

Introduction

It is important for atoll islands to monitor, where sand is drifting away from a beach and where on an island beach is building up. The reason for coastal change is not fully known yet, however, it is essential to predict in time as accurately as possible which housing areas and infrastructure elements could be in danger.

Techniques to Monitor Coastal Change

SOPAC has been assisting member countries for many years to monitor coastal change. One method to keep track of such changes are beach profiles, where the beach contour is measured at regular intervals with survey equipment. However, the observation must be extrapolated from a few survey lines to area and volume change of the island.

Another method is coastline change detection, where historical aerial photographs are referenced towards recent high-resolution satellite data. It is possible to gather quantitative data of area change, however, it is difficult to calculate the volume of sand, which is re-located.

Laser technique (LIDAR = Light Detection and Ranging) allows creating digital terrain models (DTM), which provide, when repeated a clear picture of volume change. However, these survey techniques are extremely expensive and inaffordable for small island states as a special plane has to be brought to the islands.

Now, it is also possible using kinematic GPS to create DTMs of required accuracy; and if the DTM production is repeated, change of volume can be calculated. The application of kinematic GPS was tested under real conditions in Kiribati.

Utilising Kinematic GPS

An eight-channel 4600LS and a twelve channel 4600LS unit was supposed to be utilised as base station where a solar panel powered a battery to keep the base station permanently running. The base station was installed on a church tower to avoid palm trees obstructing the view. Although installed in fenced environment children managed to access the base station and stopped the recording. It was then decided to use an existing base station from the South Pacific Sea Level and Climate Monitoring Project. The system had to be changed from 30-second interval-recording to 5 seconds interval-recording. Several days of GPS recordings could not be differentially corrected due to the loss of base station files.

1:10000 DTM for Atoll Islands Utilising Kinematic GPS

A ProXR and a ProXR Trimble rover unit were used to capture data. Both units had the required accuracy and both units were operated through a pocket PC, which allowed monitoring of the survey lines (see figure 1). The design of the beach survey followed the principle of maximum point capture in areas of maximum relief change. The operator followed the contour lines, which were clearly visible through the flotsam (see figure 2). On the upper part of the beach the survey lines were closed together and further apart at the shallow area covered with water during the high tide (see figure 3). Control lines were captured at 90 degree angle to the contour lines. The survey areas had a rectangular shape and a size of about 50 x 30 meter. Smaller areas created problems when closing the file as there were insufficient carrier data recorded. The same problems occurred if the area was too large, and the reason is still not fully known. The control lines were necessary to check the accuracy of data recording and differential correction.

The data display was first done with Vertical Mapper, which is an add-on software to MapInfo. Later, ERDAS was employed for the DTM production, which allows the manipulating of data sets using ERDAS own programming language.

Although the investigation is still incomplete several recommendations can be made for repeating activities:

- It is crucial to own a base station and create a DTM on daily basis to check the quality of data recording, which requires 1) the base station data for the differential correction on a daily basis, 2) someone who is trained to run through all steps of data handling.
- The locations of the base station have to be planned before starting the survey as two conditions have to be employed 1) 360 degree free view and 2) protection from curious people.
- A survey team must have 1) someone who talks the local language to ask permission directly before entering property at the beach, 2) someone who does the data recording, and 3) someone who protects the GPS operator from attacking dogs.
- The survey area should be of rectangular shape the walk from the car to the survey area cannot be included in the DTM later.
- The survey area should not be smaller than 50 x 30m as a minimum time is required to have sufficient carrier data; there were also problems if the area was too large.
- The survey design must have control lines which enable a check of accurate differential correction and data recording.
- The survey areas should overlap as the overlap area can be used as additional check.

Figure 1: *While following the contour lines at the beach the operator can monitor the survey on the display.*

Figure 2: *Contour lines only decimetre difference are clearly visible on the beach.*

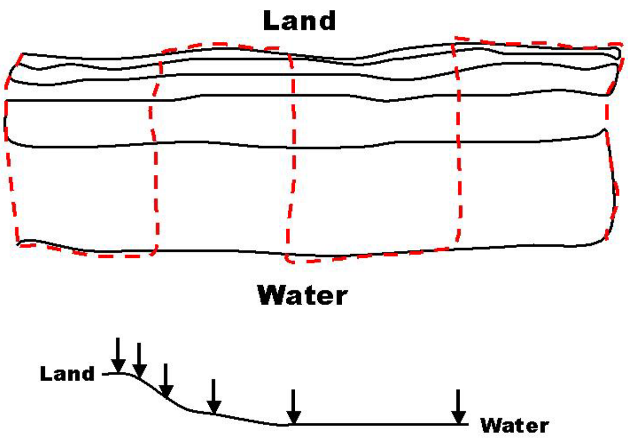

Figure 3: *The distance of the survey lines was closer on the upper part of the beach than of the flat part covered by water during high tide. Control lines (hatched) show if data recording or differential correction had problems.*

Application of GIS in the Samoa Water Authority Utility

John Tagiilima
Assets Engineer
Samoa Water Authority

Samoa Water Authority adopted phase 1 of the Geographic Information System (GIS) program in 1990. It was used in an Apia Urban Water Consolidation Project conducted by Dorch Consultant of Germany. Initially ArcView (ESRI) was used to superimpose pipeline systems onto satellite images, available from the Ministry of Natural Resources and Environment. It was later used to provided plans and detailed schematic presentations of proposed pipeline Scheme Pipe2000 (KYPIPE) was then introduced (pipe simulation and modelling software). ArcView and Pipe2000 developed a high level of hydraulic expertise in pipeline model development using advanced computer-engineering design and graphical interface. This allowed pipeline networks to be overlaid on aerial photographs making design task easier because of the reality of what is in the field is being seen on the screen.

Ten years on from this introduction, an Australian funded Project under an Institutional Strengthening Project (ISP) developed an Asset Management System called Samoa Water Authority Assets Management System (SWAMS) using Microsoft Access based software ConQuest (Conquest Solutions Pty Ltd). The ISP Project then introduced MapInfo (MapInfo Cooperation), with a schematic overview of Samoa Water Authority pipelines and assets. This allowed all assets in MapInfo to be interfaced with ConQuest providing asset details and locations. Data for both applications is backed up and stored in its hard copy format.

In 2005 a pipeline simulation program, Pipe++ (Watercom.com Pty. Ltd) was introduced to recreate the interface between the pipeline simulation model and the current GIS program (MapINFO). Pipes++ also has the ability to simulate larger sections of the Samoa Water Authority system but without the aerial images as a background layer. The simple interface allows hydraulic grade lines, pressure, elevation information, flows and demands information to be viewed in MapInfo and further down the track in Conquest.

The benefit of this system is that it creates a total interaction between the pipeline simulation program, the GIS system and the asset management program meaning that detailed asset information can be provided for maintenance purposes. An example would be that pressure rating requirements and asset location information (GIS coordinates) can be viewed on a work sheet ensuring that the correct asset is repaired using the correct class / rating of fitting.

SWA has MapInfo and ArcView as GIS Packages with Pipe2000 and Pipe ++ as modelling and simulation Software's together with Conquest to complete the Assets Management and coordination within the cooperation.

The future of GIS in Samoa Water Authority as a whole depends on the capacity building, training, and hands on experience of its technical staff in order to fully utilise these GIS applications. GIS has been and continues to be a vital role in asset management at Samoa Water Authority.

A 3D Physical Model of the SE Coastline of Viti Levu, Fiji

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As part of one of the SOPAC/EU tasks of establishing effective Project information delivery at community and all stakeholder levels, some students from the International School in Suva were assisted to build a 3-D physical model of part of the SE coastline of SE Viti Levu. This model is based on the IKONOS satellite imagery, DTM and Swath Bathymetry that the Project scientists are collating. As well as benefiting the students own education, this exercise is targeted at further enabling Project advocacy through future community awareness and school education meetings. We believe this is going to be particularly valuable for the ordinary villager, child, etc, who, no matter how pretty the picture or contour diagram we put in front of them, cannot necessarily interpret, visualise or relate to the 3-dimensional aspects of, for example, the deeply incised submarine canyons that extend offshore, the continuity of land and submarine surfaces and their integrated ecosystems. With the 3-d model, they get both a "bird's-eye" view and a "fish's-eye" view.

Discussions and planning began in mid-April'04, with a view to involving some Year 11 students from the International School in Suva as part of their International Baccalaureate (IB) "Community Service" requirements. During a presentation to the school by Project staff, it was stressed that building a 3-D Physical Model will involve most curriculum areas within the IB programme, in particular:-

Discussions and planning began in mid-April'04, with

A3D Physical Model of the South East Coastline of Vitilevu, Fiji

Figure 1: *ISS Students adding final touches to the 3D Model*

a view to involving some Year 11 students from the International School in Suva as part of their International Baccalaureate (IB) "Community Service" requirements. During a presentation to the school by Project staff, it was stressed that building a 3-D Physical Model will involve most curriculum areas within the IB programme, in particular:-
Applied Mathematics – consideration of model scaling factors and dimensionsSciences - geology, oceanography, biology, ecosystems, fisheries
Information Technology – introduction to the applications of GIS,
Design Technology – model design, choice and working techniques of different
construction materialsVisual Arts - painting, aestheticsHumanities - Physical & Human Geography, History.
The resultant enthusiasm saw the start of serious

Figure 2: *During a presentation to the school by SOPAC/EU Project Staffs*

planning and decisions on the area, scale and material requirements in late April, 2004. The students selected an area within the lower Southeast coast of Vitilevu extending from Pacific Harbour to Naboro. It extends offshore almost reaching Beqa Island. The students chose to use a horizontal scale of 1:15,000, a much higher scale of 1:5,000 was used vertically. The base map that was produced had a contour interval of 50m. Since, Styrofoam was used to build the "blank model", it had a thickness of 5mm. A "blank model" does not have secondary information such road networks, river, water bodies, etc. The dimension of the model was 1.6m by 1.8m.
Building the 3-D model of the lower Navua catchment and associated offshore areas, based on the DTM,

Figure 3: *An Image of the blank model*

bathymetry and satellite imagery, was immediately initiated under the guidance of Project Staff. Although all materials for the model construction have been funded and supplied by the SOPAC/EU Project, the labour has primarily involved 4-6 students who have probably input a total of well over 150 hours of dedicated work during the past 4 months on this endeavour.
It is recognized that such models form an ideal advocacy and visual educational tool to take into community and school-level meetings. Such a model provides stakeholders with an efficient, user-friendly and relatively accurate spatial research, planning and management tool, the information from which can be extracted and further elaborated by the GIS. The 3-D modelling process and its output (the scaled relief model) are the foundations upon which participatory

GIS can release its full potential.

An enormous amount of information is collated, gets on permanent display and is readily accessible to al l stakeholders, local residents and outsiders. Relief models are useful for teaching local geography and to enhance people's interest in conserving and restoring natural resources. Relief models provide stakeholders and local authorities with a powerful medium for easing

➡*continuation page 12*

communication and language barriers and create common grounds for discussion, raise local awareness of interlocked ecosystems and delineate intellectual ownership of the territory.

Acknowledgements:-*International Secondary School Students,* Ms Rebecca Becker-Khan, Ms Yih Jiuan, Mr Faraz Ali, Ms Esther Sue, Mr Edward Boydell, Mr Martin Hyuk, Ms Talei Cole, Ms Alitia Temo.

International Secondary School Staff Members, Mrs Dianne Korare, Principal; Mr Peter Lyon, Design & Technology Teacher; Ms Milika Waqainabete, Head of Department (Humanities); Ms Sereana Baleilevuka, Geography Teacher.

References:- Rambaldi, Giacomo & Callosa-Tarr, Jasmin. 2002. **Participatory 3-Dimensional. Modelling: Guiding Principles & Applications**. ASEAN Regional Centre for Biodiversity Conservation (ARCBC), Los Banos, Philippines

Geological Mapping of Kioa

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The geological mapping of Kioa is basically the pilot project for the geological remapping of Vanua Levu. To date much of the interest in mineral exploration in Fiji has been centred on Viti Levu namely the Vuda-Rakiraki mineralized belt, Wainivesi, Naqalimare and just recently the Namosi Copper Porphyry Deposit.

The project was initiated in 2004 with 3 geological mapping excursions to Kioa involving detailed geological mapping of the island which included the collection of rock samples for Geochemical and petrographical analysis. 8 weeks of fieldwork were carried out in Kioa where 26 grab samples were collected and made into thin sections for petrographic analysis. Of the 26 samples, 10 were sent to the University of Canterbury in New Zealand for Geochemical analysis.

Initial base maps and terrain analysis utilised FLIS topographic data with coarse digital terrain models provided by the Australian Geological Survey Organisation in 1997. Other preparations included aerial photograph interpretations of the island using aerial photographs from FLIS, which were rectified and registered in Erdas and MapInfo for basic structural, landslide and major landform recognition.

A preliminary geophysical interpretation was carried out using Airborne Geophysical Data. For magnetic

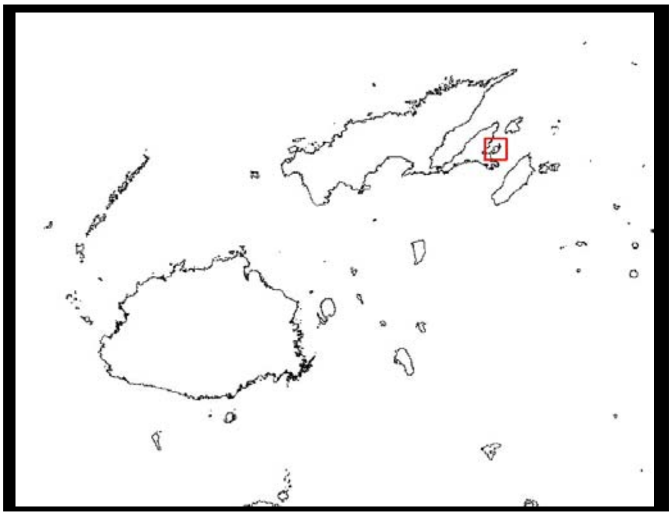

Figure 1: *Location Map for Kioa*

characterisation and major structure identification, both Total Magnetic Intensity and Reduced to the Pole images were used to compensate for anomaly asymmetry caused by the inclination of the earth's magnetic field. First Vertical Derivative images were also used to reduce anomaly interference.

Magnetic zones were identified and delineated into three zones - low, medium and high magnetic intensity.

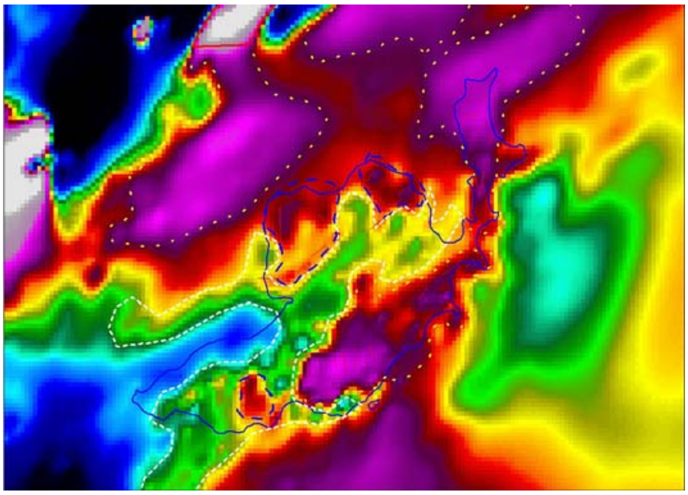

Figure 2: *Total Magnetic Intensity image for Kioa*

These zones were ground truthed in the field to see if the magnetic responses correlated to specific geological units.

For Radiometrics, the different plot images for Thorium, Uranium and Potassium were used mainly for indications of the distribution in an area.

The ration images of these elements are most useful for interpreting geological features and units while lows in the Potassium/Thorium image are normally a good indication of mineralized areas.

GPS locations of sample locations and geologic features were added in the final digitization of the geological map (see figure 2). The final geological map

***Figure 2:** GPS Sample Locations overlaid on rectified aerial topography.*

was produced by onscreen digitising of the hard copy draft map (see figure 3).

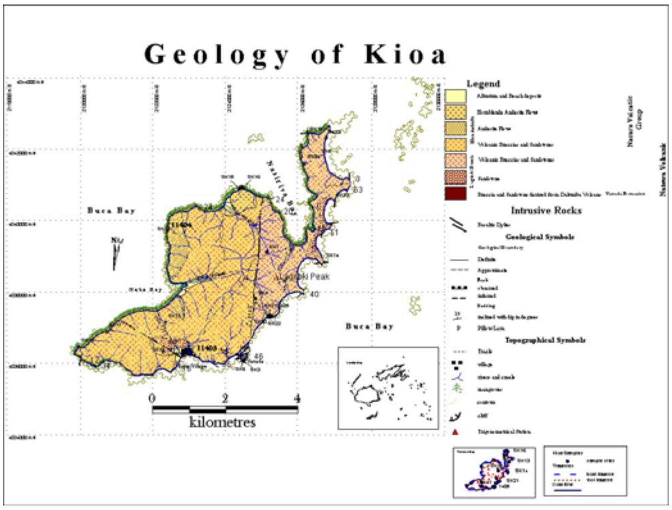

***Figure 3:** Geological Map of Kioa*

Coastal Landform and Landuse Study and their Changes Using Multi-Temporal Remote Sensing Data in the South Andaman Island

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Mineral Resources Department

Introduction

Remote sensing has been extensively used in various marine science applications and has become a very useful tool in studying and understanding marine environments and its geological, physical, chemical and dynamics. Coastal remote sensing is crucial for development purposes more so in island nations as it provides a window for greater understanding of the processes within, hence a better sustainable management practice for coastal dwellers. Coastal areas are dynamic in nature, equally favored by human as well as marine organisms for their livelihood . The areas as popular as they are, are subjected to ever-changing coastal processes. In high-energy coasts these changes can happen overnight, dictating landform and land use of such region. Due to the continuous changes of coastal landform and the complex dynamics of processes that took place within this region, remote sensing technology has become a resourceful tool in monitoring such changes and understanding these processes.

This paper focuses on a study that was conducted to identify coastal landform and land use in the South Andaman Island using multi-temporal remote sensing data. The satellite images used were Landsat image (1997) and IRS 1D – LISS III image (2000). The study also looks in to methods (algorithms) of detecting changes that transpire within the subject area in a three-year period. Analysis using image processing Erdas software of the two images identifies typical coastal landform features like mangrove, estuaries, coral reefs, mudflats, sea grass that are typical to coastal island topography. Image classification (unsupervised and supervised) with the help of field survey data was carried out for quantitative identification of various landforms in the region. In addition, various algorithms were tried for mangrove identification and delineation. Change detection analysis (Post-Classification comparison) of the two images within the three-year period was also carried out which reveal significant changes of various coastal landform and land use classes.

Rectification/Geo-referencing Data

Satellite images of Landsat TM and IRS - 1C LISS III data set acquired on 1997 and March 2002 respectively were used for this study. Both data sets were first downloaded and imported to ERDAS for image processing. IRS - 1C PAN data was also imported for first-hand geo-referencing because of its high resolution (5.8m). A Hydrographic Chart (Bathymetry map) of the South Andaman Island was provided to geometrically rectify the images. The map itself is prepared to international Latitude, Longitude coordinates to a scale of 1:150,000, by the India National Hydrographic Office, Dehradun on July 2003.

Using Erdas software, Pan 1998 high-resolution image of South Andaman was geo-rectified to this bathymetry map with total EMS error of 0.001 and the subset of the study area was created. Landsat TM and IRS – 1C LISS III images were then geo-corrected to the rectified Pan Image (image to image geo-rectification) preserving the same total error of 0.001.

The geometric correction processes (Eradas) used:

➨continuation page 14

Projection: Geographic Lat/Long,Spheroid: WGS 84

Datum: WGS 84

Unsupervised and Supervised Classification

Prior to ground-truthing, unsupervised classifications were performed on both Landsat TM and LISS III images. Erdas grouped pixels of the same pixel values together in clusters and organized them into classes according to their reflectance using nearest neighborhood method. The images were then used during the ground truthing process to confirm and locate landforms and land use that appears contradictory in the images.

Recorded data from the field survey (GPS and Radiometric) were used for supervise classification. Eradas classify coastal landform and land use features manually (test sites) highlighted by analyst according to the GPS reading and radiometric data collected for each respective area. With the help of the bathymetry map each class were accurately confirmed and entered to Eradas for the final supervised classified image. Both Image (Landsat TM and LISS III) were classified using the same classes that are common to both from the false color composite (FCC) of the raw image

Landform Identification

Using unsupervised classification image, coastal landforms that appear to be represented perfectly are identified while other landforms needed confirmation by ground investigation. Such were done by taking GPS reading of landform locations with radiometric measurements and plotted on the image using Erdas Imagine processing software.

Mangrove Delineation (Landsat TM Data (1997)

A number of algorithms were investigated; with the best suited algorithms for this particular TM data found to be by Grey (1990). The procedures include stacking band 3, 4 and 5 followed by 3/5 and 5/4. These stacked layers were then analyzed in Principal Analysis Component for Spectral Enhancement. The first three principal components were then used for supervised classification for the final thematic map.

IRS – 1C LISS III, IRS – 1C LISS III image was processed using band ratio method. Three ratio was generated – RED/NIR, RED/MIR, and NIR/MIR. These ratioed images were stacked along with raw bands of Red, NIR and MIR, which was then stacked and used as an input for the generation of Principal Component Image. The 2, 3, 4 Principal Components were again stacked and the output image was used for supervised classification.

Change Detection Analysis

Three change detection analysis techniques were studied for this project:

- Uni-variate image difference
- Image ratioing
- Post-classification comparison.

The Post classification technique was used due to its suitability towards the two different images (Landsat TM (1997) and IRS – 1C LISS III (2000).

The procedure includes comparing the two supervised images of Landsat TM and LISS III, classified independently, by properly coding the classes that are common in both images. A comparison of area covered by each class using pixel value converted to square kilometers was assessed to monitor changes within the three-year period of the two data sets.

Results:

Coastal Landform and Land use Quantification

The supervised classified image of Landsat image highlights coastal landform identified within the study area of South Andaman. Coastal landforms that are typically observed in such climatic conditions include mangrove, estuaries, sandy beaches and coral reefs. Quantifying coastal landforms can be an exhausting practice because of the vast area of the open ocean, whereas land uses on the other hand have definite area of coverage; however using remote sensing technologies, one is certain that such a study can be possible without too much strenuous work.

Conclusion

Throughout time it is expected that the amount of pressure on coastal areas will grow rapidly with the increasing rates in population and consequently further expansion in development.There is no denying the coastal areas are among the most vulnerable on earth. In order to properly maintain, protect and solve the problems of such places, environmental changes and alterations that cause such changes should be closely monitored. One of the most useful tools that can be used in this kind of investigation is remote sensing.

The present study has shown that Landsat TM data has the capability to be used for coastal landform identification and quantification through unsupervised and supervised classification. It also has potential to discriminate each class (mangrove delineation) by applying relevant algorithm best suited for respective images. It is also possible to conduct change detection analysis on such images while considering the telling factors that do influence changes analysis.

Finally, it is critical to be reminded of the capability of remote sensing as a complementing tool and to consider with open mind the relevant issues associated within such a tool in any application.

Table 1: *Area (km²) of classes of coastal landforms and land use identified using supervised classification of the two images Landsat TM (1997) and IRS – 1C LISS III (2000) of the study area.*

	Change Detection Analysis							
		Number of Pixels		Area km²		Percentage Area		
	Classes	Landsat TM	Liss III	Landsat TM	Liss III	Landsat TM	Liss III	
1	Forests	251080	355942	225.97	196.57	62.28	56.15	-6.13
2	Agriculture	75289	157656	67.76	87.07	18.67	24.87	6.19
3	Mangrove	28453	48894	25.61	27.00	7.06	7.71	0.65
4	Township/Settlements	35021	66329	31.52	36.63	8.69	10.46	1.78
5	Sand/Beaches	13312	5137	11.98	2.84	3.30	0.81	-2.49
6	Mudflats/Sea grass	3585	14569	3.23	8.05	0.89	2.30	1.41
7	Shallow Coastal Waters	60448	115570	54.40	63.82	14.99	18.23	3.24
8	Coral Reefs	40054	29240	36.05	16.15	9.94	4.61	-5.32
9	Deep Ocean Waters	676945	1064413	609.25	587.82			
			Land Total	362.84	350.10			
			Ocean Total	702.93	675.84			

**(Mangrove class quantification is from the mangrove delineation image)*

**(Percentage area is calculated differently for land (red) and ocean (blue) and last column denotes if changes increases (+tive) and decreases (-tive).*

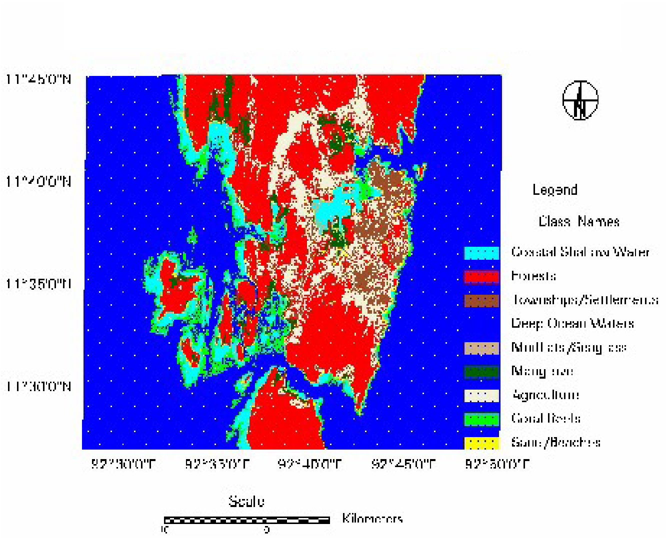

Figure 1: *Lansat TM (1997) Supervised Classified Image*

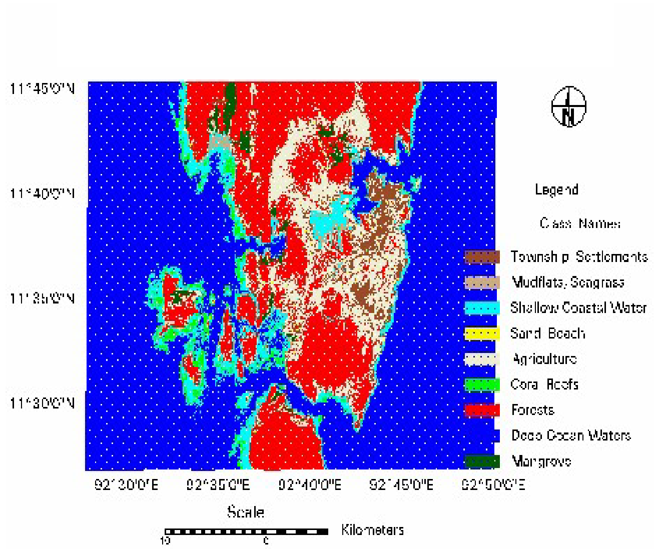

Figure 2: *IRS 1D LISS UI (2004) Supervised Classified Image*

GIS Contributes to the better management of SIEA

Robinson Wood
SIEA

The Solomon Islands Electricity Authority had experienced revenue losses for the past years although customer audit has been carried out for customers with zero readings, the billing system has yet to locate other meters with wrong billing addresses. The SOPAC/EU Project has provided a Quick Bird high-resolution image backdrop that the

Figure 1: *Customer temparing the meter at Betikama High School.*

authority has utilised to identify the meters with wrong addresses and locations.

The new backdrop also helps to provide a bar chat that displays consumers with meter temparing eg. illegal connection.This has made life easier and saved time and money for the Authority and the Utilities. Likewise, the Solomon Islands Water Authority has also confirmed that the same problem has been faced with their customers when addressed during the User group meeting. (Where meter number in the record hasn't bill to the consumer in the record instead bill to other consumer in other locations.)

The Utilities Management has once again assigned a team to carry out customer audit on cycle by cycle to identify the following causes: (Meter tempering, Meter Status, Meter Seal not present, Meter Card present or not) after viewing with these tools. The Authority has also prosecuted consumers that continuing practicing meter temparing with wrong means using a wire instead of a proper fusing or bypassing the meter.The Solomon Islands Electricity Authority is now using a

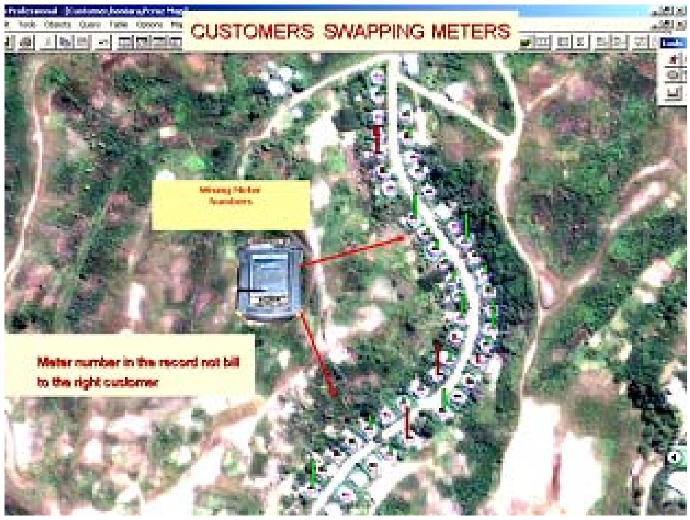

Figure 2: *Reading show customers swapping*

proper way of recording meters with a Hand held unit that will provide accurate readings for each customer's and will also provide accurate bar chart of average five month consumption with the present consumption when displayed on the new high resolution image Backdrop. The meter readers will no longer be guessing any reading for the Unix system otherwise; they have to go on site to obtain a proper reading.It was agreed between the Utilities to share information's and ideas that help to provide better management; as the practice of sharing of site plan, print out of project maps, plans and more visibility with the new image backdrop has ben greatly successful.