Highlights

- **Remote Sensing for Reef Mapping**
- **GIS for Timber Flow Monitoring**
- **Regional Cooperation in Remote Sensing**

Highlights

- **Remote Sensing Mapping Draught Effects**
- **Potential of Linux for Remote Sensing**
- **Remote Sensing for Forest Mapping**

Fiji South Pacific and GIS/RS news

The Newsletter of the GIS/Remote Sensing User Forums
Issue 00/01
April 2000

Remote Sensing an important tool for GIS......

This newsletter looks at several articles about coral habitats protection of the coasts of Pacific Island Countries. These habitats are recognised worldwide as biosystems under stress. Coral bleaching adds to the pollution of the atmosphere causing a higher-than-normal sea temperature. The newsletter shows that different types of remotely-sensed image data such as space-borne image data, underwater video images and SOPAC's multi beam mapper are an ideal tool for monitoring coral behaviour. These data could be combined to a multiphase, multistage inventory design.

The newsletter also highlights the increasing use of satellite data for vegetation monitoring. The plant stress caused by the El Niño drought of 1998 in Fiji was mapped employing the new SPOT image data. The article on page 15 explains the technique, which could easily be applied in other Pacific Island Countries. For monitoring the spread of the single species Raintree another sensor, Landsat-7 TM, provided suitable images. Since Landsat-7 has been in space, the price for image data dropped enormously from more than $US 1000 for a SPOT scene covering 60 x 60 km to $US 600 for a digital Landsat TM image covering 9 times more area and providing a better radiometric resolution. This was also an argument in using Landsat for mapping the tidal wave-affected island of Pentecost by the Pacific Disaster Center in Hawaii.

Another subject is forestry, where the genetic resource of Pacific Island Countries gets worldwide attention. The key words for sustainable use are certification and labelling and the article demonstrates that Information Technology and GIS play a major role.

A very interesting additional article explains the potential of the operating system Linux replacing Microsoft Windows and NT together with the package StarOffice which could replace Office 95. There is still application software missing in the fields of GIS and Remote Sensing, however, SOPAC participates in their development. There is a chance that Pacific Islanders will get stable software free of charge.

Regular features include one chapter explaining the development of space-borne data available for Pacific Island Countries suitable for medium-mapping scale. For many years SPOT was the only space-borne image data source. Now, many sensors are based on different satellites providing data. This fact together with regional cooperation highlighted by three articles will increase the application of such data and enable Pacific Island States to monitor their environment more effectively.

We hope to bring out the next newsletter soon and we will reflect the development of GIS and Remote Sensing in the different Pacific Island Countries. Therefore we appreciate contributions from the GIS operators of the different countries.

Wolf

Download your coloured version from SOPAC's web site ..!

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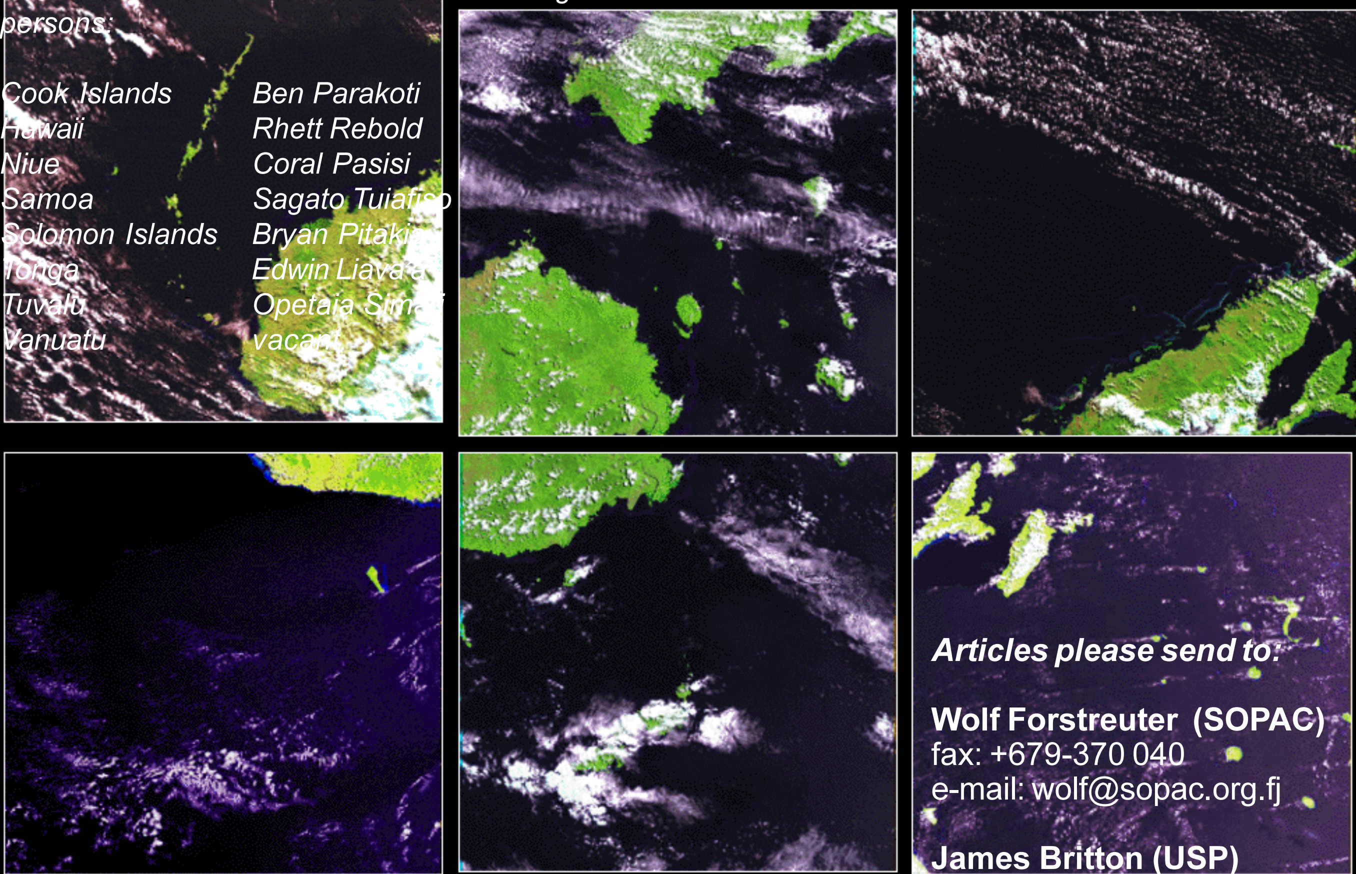
Landsat 7 images available for Fiji



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

Cook Islands	*Ben Parakoti*
Hawaii	*Rhett Rebold*
Niue	*Coral Pasisi*
Samoa	*Sagato Tuiafiso*
Solomon Islands	*Bryan Pitakia*
Tonga	*Edwin Liava'a*
Tuvalu	*Opetaia Simati*
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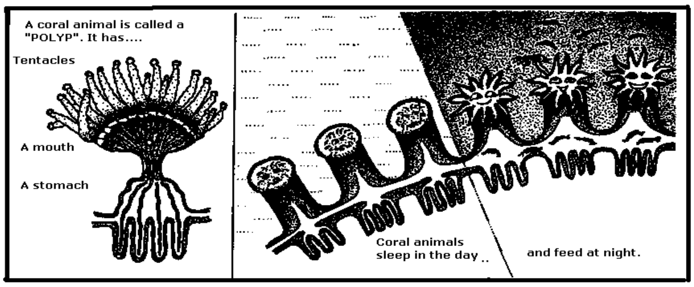
Bleaching on the Coral Reefs of the Fiji Islands April 2000

Helen R. Sykes, Resort Support

Introduction:

A coral reef is a huge colony of tiny animals, each making an external skeleton of white calcium carbonate. These skeletons are joined together in large formations, which are often perceived as dead rocks, although nothing could be further from the truth.

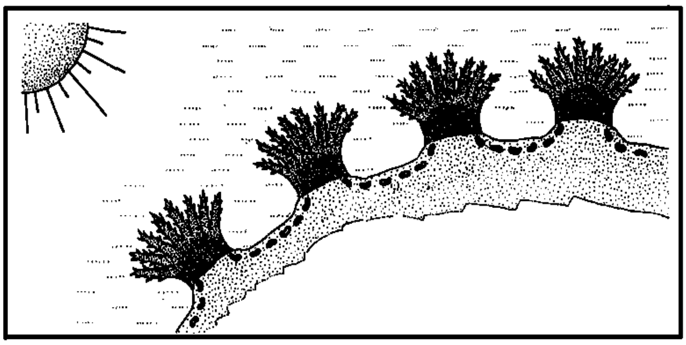
The coloured parts of a coral reef are all made of living animals.



The grey parts are where the animals died, leaving only the walls of the skeletons.

Small one-celled plants (algae), known as "zooxanthellae" live on the outer skin of the corals. These are what give the reef it's colour. These planets are also provide food and oxygen for the coral animals. Just like all plants, these algae use sunlight to make food, so coral needs to live in clean water that will let the sunlight through.

There are many different kinds of corals, but they are made up of the same type of animals, and have algae



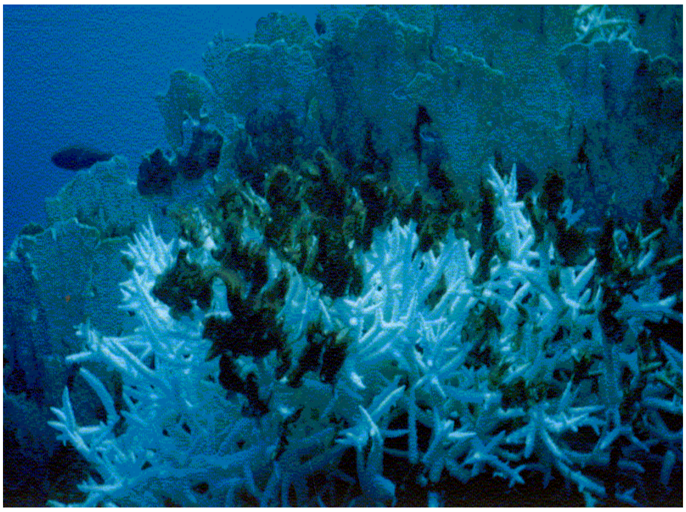
living with them. Different kinds of algae make corals different colours.

There are some diseases or other problems that can kill the algae, but not the coral animals. When this happens, the coral goes white or very pale blue and pink. This is called "CORAL BLEACHING".

The coral animals are still alive, but they cannot live for very long without their algae. If white coral does not get it's coloured algae back in time, the coral animals will die too. It is not known how long the coral animals can live without the algae, but it seems likely that the likelihood of recovery drops quickly after one or two months of bleaching.

What is Happening to the Fiji Reefs at the Moment

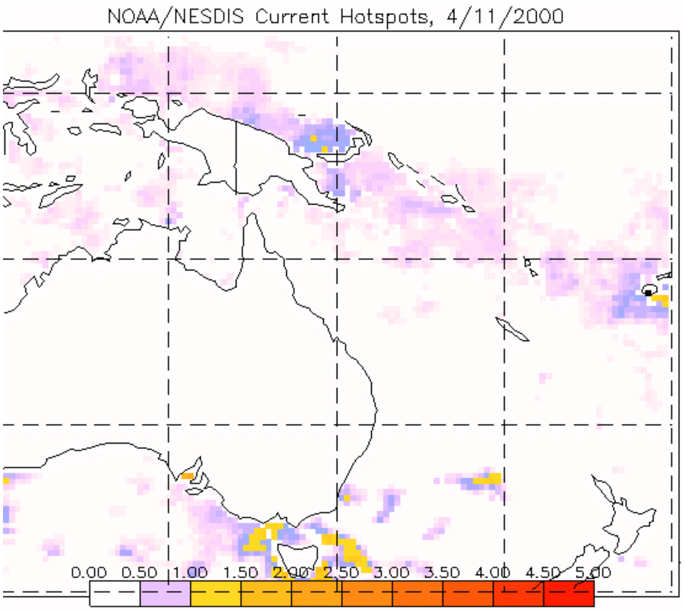
Some parts of Fiji have reef-monitoring programmes set up to see how much damage is being done to the reef by anchoring boats, reef walking, diving, fishing etc. There is information available about what does the most damage. However, in March and April this year a much larger problem than any of these has been seen. The coral reefs all over Fiji are "Bleaching"; coral is going white all over the reefs, as algae on it dies. In many places, the algae have been missing long enough that the coral animals have started to die too, and the dead reef is overgrown by larger sea weeds. Coral that this happens to cannot recover.



Bleached branching coral with overgrowing algae

The reason for this seems to be that the oceans have been much warmer this year than normal. If the water temperatures regularly reach over 32 degrees Centigrade, the corals push the algae out of their skeletons. This has been seen in many parts of the tropics. The same thing happened in 1995 in the Caribbean. In that "Mass Bleaching Event" the reef was very lucky; the water temperature dropped quickly, and about 75% of the corals grew back their algae and recovered. The reef involved in another "Mass Bleaching Event" in Palau two years ago was not so lucky, and remains dead to this day. That reef today looks like the rocks on a dry river-bed. Tourism and fishing have all stopped in that area.

It seems that these very warm water conditions are



Web display of overheated water surface, see article "Spaceborn Image Data News"

happening because of the El Niño/La Nina weather patterns that we have heard so much about in the last few years. At the moment, the South West coast of Australia, Papua New Guinea, Fiji, Tonga and Samoa, are in the middle of patches of ocean that are much warmer than usual. In the map below, areas that are one to two degrees hotter than normal for this time of year are shown in yellow.

Current Monitoring Methods

Currently bleaching events are monitored in quite small-scale surveys. Transects, usually 20-30 metres long, are laid down on the reef by SCUBA divers who then measure the proportions of Live / Bleached / Recently dead / Long dead corals by recording the areas of such patches on a slate, or with a video camera. Since the advent of digital video, this method is preferred as the data can be easily analysed by computer. These methods give good detailed information of which species are more or less susceptible to bleaching, and which are more likely to recover, but can only cover small portions of the reef system.

Larger scale surveys are done by taking aerial photographs and video from low-flying planes. This method can give information as to the extent of a bleaching event, and can help identify areas of high and low risk, but is expensive and subject to image distortion.

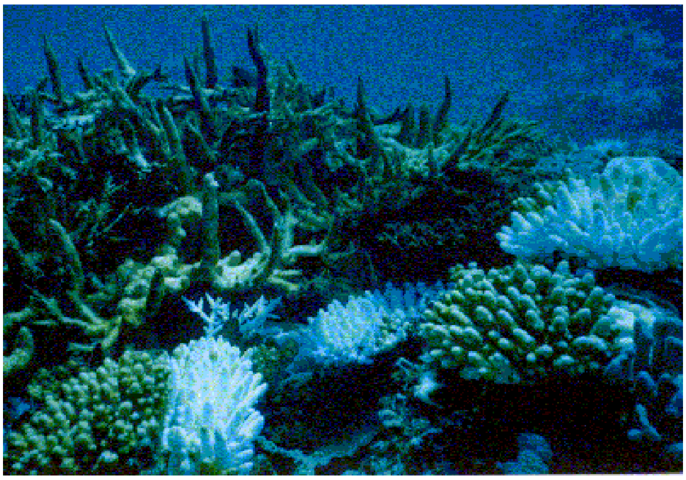
Discussion

The coral reef in Fiji, as in many of the islands around us, has suffered a big blow to it's health due to very warm waters. This is due to a world-wide weather pattern that we cannot change, and which seems to occur every 3 or 4 years.

At the moment, all that can be done is to watch and learn more about what makes bleaching happen and what makes the difference as to whether a reef recovers or dies completely. As long as enough coral survives to "spawn" (breed) in the season (usually November) later this year, there is a good chance that reefs will eventually grow back. However, there is also the possibility that reefs may not recover, and there may be a major problem. If the reef dies and does not recover, the following problems face Fiji:

- Tourism may drop.
- Fishing may become less productive
- Dying reefs may break up and stop sheltering village from storms.

Although Coral Mass Bleaching Events have been reported somewhere in the world roughly every 3-4 years since 1979, there is still comparatively little data about the progression of, and more importantly the recovery after, these events.



Bleached and overgrown finger corals

Usually a bleaching event is well underway before divers start to notice the effects and begin to take measurements. At this point, measurements can only be small scale and very localised. An area of coral selected for regular recording may die, and the area next to it, not selected for monitoring, may be the very area that survives.

Facilities and finances for flying planes over the entire reef system on a regular basis are very limited, and so aerial photography is usually only undertaken after a bleaching event has already been recognised, and cannot be utilised on regular “fly-bys” when there is no observable problem.

An ideal tool for monitoring coral reef health would seem to be satellite imaging, providing suitable resolution can be achieved. Certainly current technology is sufficient to identify large areas of white corals along reef edges. The ideal situation would be if data could be gathered on a monthly basis throughout the year, and tied in with ocean temperature data that is already available. This would give data at the start and end of bleaching events, not just in the middle of these events, as well as building up a picture of the health of the reef during normal years.

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Mapping of Lagoon Areas Using Landsat TM Images

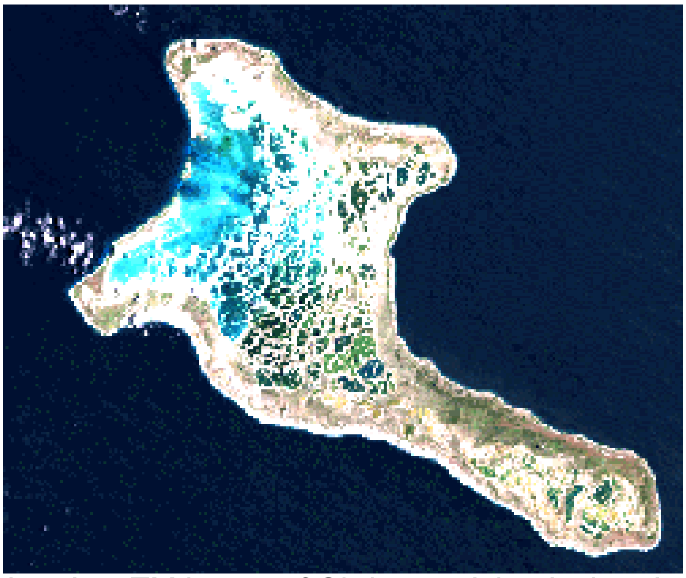
Wolf Forstreuter, SOPAC

Introduction

The government of Kiribati required a map update of the Christmas Island lagoon for a later monitoring and water circulation modelling. This will result in determination of sites for aqua cultures. SOPAC staff using a swath mapper currently carried out the mapping of most parts of the lagoon. The image will help in navigation and, once calibrated, in water-depth mapping.

The Landsat 7 Image

The Landsat Image was recorded by Landsat 7 satellite on 16 September 1999. The Image has 8 bands, three bands cover the visible spectrum, 3 bands cover the near, short wave and middle infrared, one band covers the thermal infrared and another channel provides panchromatic information with high resolution. The blue channel records the reflection of light between 450 and 515 nm. Knowing that water allows penetration of light best at 470nm, this channel is best suit-



Landsat TM image of Christmas Islands, bands blue, green, red

able for mapping features beneath the water surface. In clear water, sandy areas up to 15m can be recognised in some cases even up to 20m. The second Landsat 7 channel covers the green part of the spectrum between 525 and 605 nm. Green light disappears already after about 7 to 8m. In the red channel the water is mostly recorded as black, reflecting high absorption after a few meters.

The coverage of the blue spectrum is an advantage compared with SPOT images, which do not cover the blue light. The Landsat scene costs USD 600, covers an area of 170 x 180km and can be delivered in GeoTIFF a format known by many application software.

Creating an Image Map

There was a map available for Christmas Islands at 1:50,000 scale. This map was produced by using aerial photographs recorded in 1957/1958. The process for scanning the map required separate scanning of several parts due to the size limitation of the A3 flat-bed scanner. Image analysis software was used to rectify the parts and stitch them together to one map image. This map image has three layers RGB and contains the geographic reference. The map image is available as a MapInfo backdrop through a corresponding TAB file, as GeoTIFF and as ERDAS IMG file. The scanning process will be improved in future projects by using a new map without any folds and placing the map absolutely flat on the scanner to avoid additional colour differences.

The image analysis software allows a geographical

Merge of scanned map and Landsat TM image. The blue colour of the map indicating sea water is replaced by bands 1, 2, 3 of the Landsat TM image. Such a "map" helps navigation and coral monitoring.

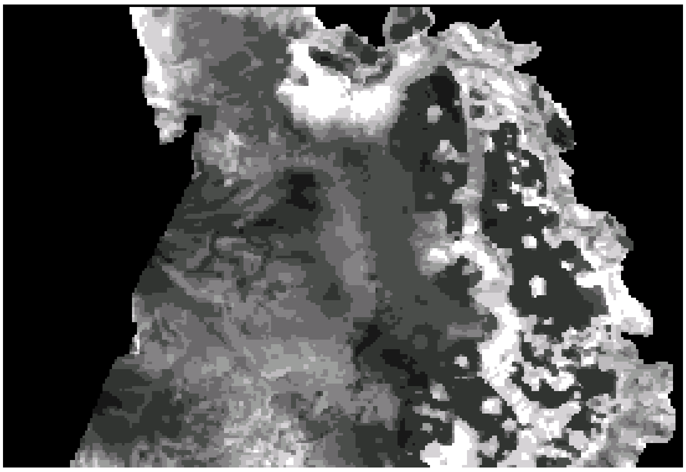
link of image map and geometrically-referenced satellite image, which forces the cursor to move correspondingly in the right image while moving it in the left one or vice versa. It was noticeable that the information provided by the map is out-dated. The map does not show many of the shallow areas and information which can be important for navigating a ship. It is necessary to update the map with information provided by the satellite image.

Both spatial information sources a) the satellite image and b) the map are available as raster data files. The classical way is digitising the sea-water area of the map and replace this area digitally by picture elements of the satellite image. The intermediate product is a digital mask derived from the digitising process, which provides the information on seawater or onshore area. To avoid the digitising of many small polygons representing small water areas and small islands within the seawater body the colour information of the map image was used. All pixels coloured in light blue indicating seawater on the map image were replaced by the satellite image. A further improvement created a mask as an intermediate step, which was then cleaned of noise of wrongly-identified pixels. Influence from poor scanning was minimised by this process.

Zooming into the satellite-image-map shows that the original grid is still visible, the description and the land area. Water is replaced by an image providing the information on which part is shallow and which part is deep water. The visual impression of a natural colour image does not need any legend, the user automatically associates deep blue with deep water and sandy colour with shallow areas. Visually he can distinguish between different surface cover underneath the water, what would be difficult by digital analysis of the blue channel only (see next chapter). The merge of different pixel size is also visible by this zoom factor. The map was digitised with a resolution comparable with 5m on the ground. The Landsat TM image was recorded with 30m.

Analysing the Blue Channel

Light behaves differently in water than in the air. Water absorbs most light after 15m. Technically it is a mixture of absorption and diffuse reflection by the water molecules. Only light which is reflected directly back to the sensor will be recorded, all other will be mirrored at the water surface. The water absorption takes place exponentially in relation to depth, however, there is also the influence of all sediments in the water which



Result of density slicing. The blue channel of the Landsat TM image is grouped into similar reflection related to water depth. This allows production of a contour map.

affect the absorption. These sediments can be sand after heavy rain near river mouths or from sandy seabed bodies after storms. It also can be organic material such as plankton. Finally the ground underneath the water influences the reflectance. Sandy parts reflect highly and parts covered by sea-grass absorb more than they reflect. Corals differ in reflection due to their colour, surface and other phenomena.

Assuming that a) water visibility is equal all over the image and b) the seabed is covered equally by sand, the reflection of the blue Landsat channel would tell the water depth directly. The process called “density slicing” classes the range of reflection values into a defined number of groups. It converts the image into areas of depth ranges such as contour lines of a map. The employed density slicing used 10 linear stretched classes. In a further approach, an exponential classification will be used and less classes.

Conclusion

Most parts of the lagoon will be surveyed employing a swath mapper, which will allow calibrating the density-sliced image. Having an accurate underwater DTM and assuming that sediments are equal all over the image, any change in colour will be linked to change of coral. This would allow coral monitoring.

In Pacific Island Countries, many maps are out-dated or do not show water depth. Landsat TM images would be an affordable tool for mapping large areas at 1:50,000 scale. Available maps can be used as image layer, which avoids expensive and time-consuming digitising of the map content. By just replacing the map information, “open seawater” with the Landsat image the exercise becomes cheap. Analysis of the blue channel can mean more features such as coral behaviour can be monitored for large areas, as one image covers 180 170km and only costs USD 600. This also allows a frequent coverage and change detection.

The method of replacing one map colour indicating a land cover type by satellite image information can also be applied to agriculture or forestry.

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GPS-based Underwater Video Mapping and Application for Coral Reef Management

Dr. Paul Ayers and Sarah Legoza

Abstract

An Underwater Video Mapping System (UVMS) was developed to examine underwater ecosystems and record their location using Differentially Corrected Global Positioning System (DGPS). The UVMS provides geo-referenced visual images that can easily be incorporated into a Geographic Information System (GIS). The UVMS incorporates a Splash Cam underwater camera, a Sony Digital Video Camera, a VMS 200 (Video Mapping System 200), and a Trimble AgGPS 132 Receiver. Applications to Coral Reef Management are presented.

Introduction

The VMS 200 is a spatial multimedia system: a tool that creates “video maps,” and interactively displays pictures or video footage of your mapped locations. The system includes hardware that embeds GPS data on videotape, and software that automatically builds maps using the videotaped data. The VMS 200 can be used with an external camera. The VMS 200 allows the GPS position to be recorded on each frame of the digital videotape, thus georegistering all recorded images. The visual images provide a site-specific record of an existing condition and pertinent data or information can be extracted from the image.

Equipment

The Splash-Cam II is a compact underwater camera. An adjustable strain relief allows the operator to adjust for viewing at any angle. The underwater camera also has a stabiliser fin and underwater lighting pod. It has a cable length of 200 feet and a cable breaking strength of 700 pounds. A colour monitor allows the operator to see the underwater images, and adjust the length of the cable if necessary.

The Trimble AgGPS 132 is a 12-channel, high-performance sub-meter GPS receiver. It has a combination of a GPS receiver, a Coast Guard Beacon and a satellite differential correction receiver in the same housing.

The Sony Digital camera DCR-TRV310 features audio/video input and output. The audio/video input makes it possible to use the VMS 200 and the underwater camera.

Data Collection

This system was tested in Fort Collins, Colorado (USA) on Horsetooth Reservoir on June 3rd 1999. Several hours of georeferenced videotapes were acquired in a variety of modes, including parallel swathing, transects and drop-down point acquisition. The equipment was operated to a depth of 144 feet, at which camera lights were used to obtain usable images.

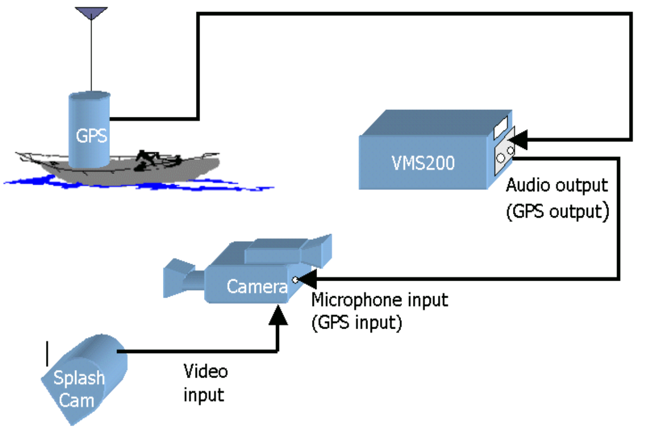

Figure 1: *Configuration of the data collection equipment*

For most of the footage, the Splash-Cam underwater camera was mounted on a telescopic rod and lowered to the bottom of the reservoir for mapping. The Trimble AgGPS 132 was set up to receive the VTG, GGA, and RMC strings. These are all NMEA 0183 strings. The receiver was then connected to the VMS 200 using an RS 232 connection. The underwater camera and the VMS 200 were connected to the Sony Digital Camera, which acted as a video recorder. The VMS 200 converts the GPS position into an audible signal so the Sony Digital camera can record it on the left audio channel. On the video channel, the digital camera recorded the images from the underwater camera. A diagram of the set-up can be seen in Figure 1.

Data Analysis

The videotapes were then brought back to the Agricultural Engineering Research Center at Colorado State University. To analyse the data, the software for the VMS 200 was used. For the program to run properly, the computer must have a capture card installed. To begin the analysis the hardware was connected. A LanC cable was connected from the camera to the VMS 200; this allows the computer to control the camera. A video cable was connected from the video output on the camera to the capture card; this allows the computer to capture and save the images stored on the videotape. Another cable was connected from the audio output on the video camera to the audio input on the VMS 200; this transfers the GPS information stored on the tapes to the VMS 200. The VMS 200 is then connected to the serial port on the computer; this transfers the GPS data to the computer. A diagram of the set-up is shown below in Figure 2.

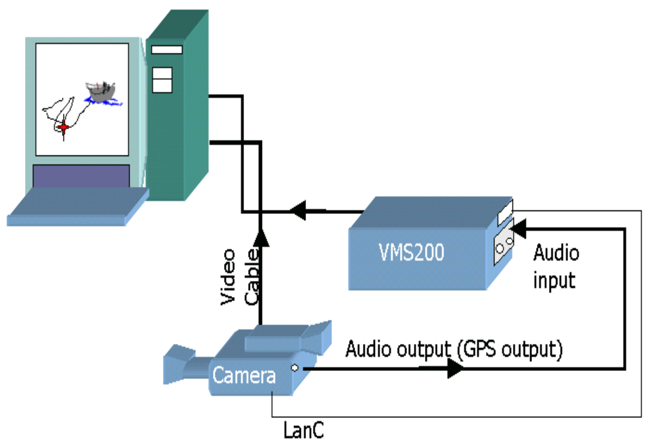

Figure 2: *Configuration of image capture hardware*

To begin the data analysis, the videotapes were indexed using the VMS 200 video player software. During the indexing process, GPS data was translated from the videotape to the computer, and a tape index was created. The computer associates each GPS data point with the corresponding time code on the videotape. During indexing, the index layer displays points for each GPS-referenced location where video was recorded. It also creates a database file, which contains latitude, longitude, altitude, date and time in co-ordinated universal time (UTC), videotape time code, geoidal separation, course, azimuth, speed, satellites in use, and dilution of precision (DOP). Once the videotapes were indexed, they could be viewed in playback mode. This is also the mode used to capture still images, video clips, and sound files. The still images have the option of overlaying the latitude, longitude, and UTC. When a feature is captured, the VMS software creates a database file, which stores latitude, longitude, altitude, UTC, name, pathname, the videotape time code, and azimuth. Markers, which locate each captured feature, are overlaid on the index layer. The user can then click on the marker to view the feature. Some of the images collected include wildlife, vegetation, rocks and bottom structures. An example of each can be seen below in figures 3 a-d. The videotape indexing and image capturing procedures are conducted in the Map X GIS environment. Exporting to ArcView (also possible in MapInfo), a map was generated illustrating the path of the boat and icons hotlinked to the still images. The hotlink feature allows for the development of an ArcView layer of georeferenced images in a variety of categories. The georeferenced hotlink image layers could be overlaid on other GIS layers such as aerial photographs or remote sensing date to provide ground-truthing. An ArcView layer with a georeferenced hotlinked image is shown in figure 4 overlaid on a USGS 7.5 min quadrangle map. The GIS layers (and hotlinks) developed by the VMS are also exportable in HTML format and suitable for Webpage insertion.

Figure 3-a: *Fish habitat*

Figure 3-b: *Vegetation*

Figure 3-c: *Bottom structure*

Figure 3-d: *Bottom structure*

Applications to Coral Reef Management

The UVMS provides the capability of acquiring, storing and databasing georeferenced images of underwater objects. This technology could be useful in mapping and managing coral reefs. Camera images could be used to georegister coral type, health, and population. Temporal (time-related) images could be incorporated in the GIS layers to look at changing characteristics. Site-specific bathymetric sensor data (i.e. temperature, water quality, depth) can also be monitored and stored on the videotape for analysis. The visual images can provide ground truthing opportunities for Remote Sensing and Aerial Photography.

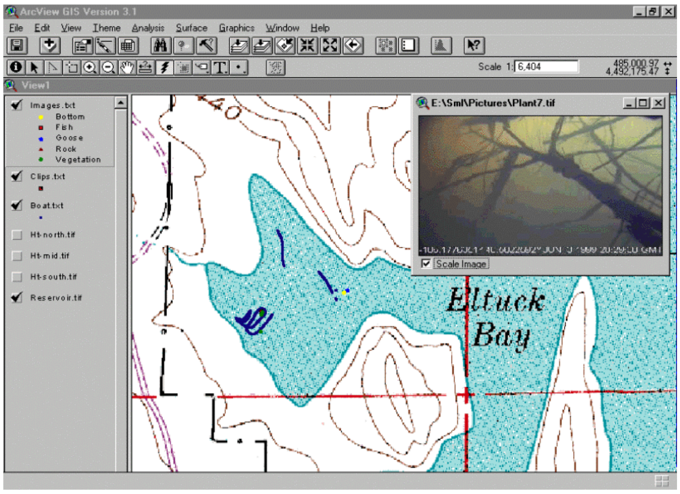

Figure 4: *ArcView GIS with hotlinked image*

Future Plans and Improvements

The first attempt of using the Subaqueous Video Mapping System was very successful, however there are many things that can be changed and added to make it more efficient. The biggest problem is limiting the depth by using a telescopic rod. The telescopic rod was 11-ft (3.4-m), so at depths greater then 15-ft (4.6-m) the bottom surface could not be seen in the turbid water. This can be improved by taking the Splash-Cam off the telescopic pole and using the stabilizing fin and a weight to keep the camera straight and below the boat. The cable on the camera has a length of 200-ft (61-m); however, because of blowback the depth will be slightly less than 200-ft. A Cannon Digitrol IV can be used to manually adjust the depth of the underwater camera.

To obtain a complete coverage, a parallel swathing option should be added to the GPS receiver. This provides a light bar display to allow the boat operator to line up parallel to the last track. This will avoid covering the same area twice and it avoids gaps in the coverage.

Sensors can be attached to the underwater camera to provide additional information too the georeferenced images. Possible sensors include dissolved O_2, pH, temperature, and turbidity. A depth monitor could also be added to record the water level. All of the sensors would be connected to a 21X data logger to record the data.

A console is being constructed to keep the equipment in order. It will contain the Cannon Digitrol IV, the Sony digital camera with LCD screen, VMS 200, 21X data logger, Trimble GPS receiver, 12-V battery, and the light bar. A set up the pontoon boat with all the current and proposed equipment is illustrated in Figure 5.

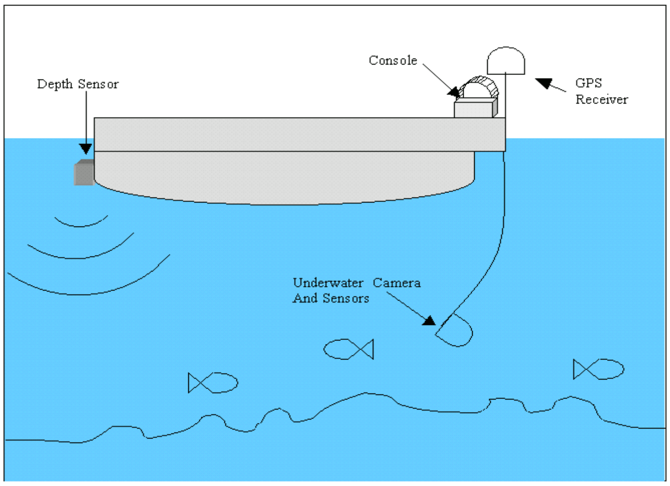

Figure 5: *Configuration of UVMS equipment*

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Multibeam Mapping in Reef Environments

Robert Smith, SOPAC

Introduction

In March of 1999 SOPAC added to its remote sensing capabilities a Reson 8101 portable multibeam swath mapping system. The Reson 8101 is a very sophisticated multibeam echo sounder that is capable of mapping large tracts of the seafloor with a range accuracy of 5 cm and to depths of up to 300 m. To date eight surveys have been completed in Fiji, New Caledonia and Vanuatu.

The system as shown in Figure 1 is comprised of a number of different sensors. The main unit is the sub-surface head or transducer which is mounted on a pole and held fixed in a vertical position. Interfaced to the transducer is a central processing unit that controls

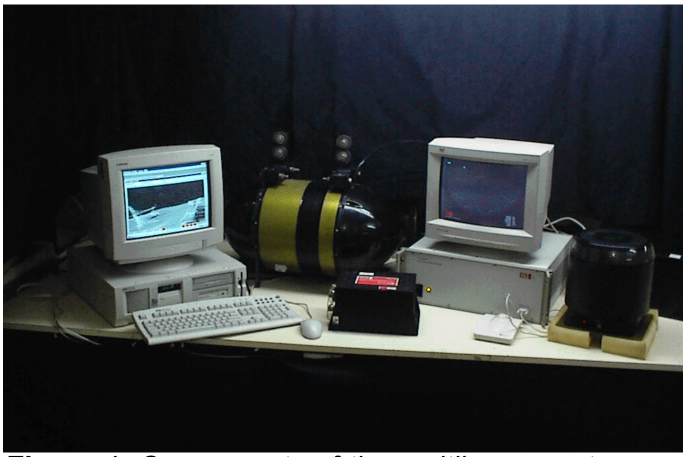


Figure 1: Components of the multibeam system

For example a 30 minute swath profile in water depths of 5 - to 30m for a ping rate of 15 times a second can generate 20mB of raw data.

Editing these datasets to produce detailed digital seabed models is accomplished with multibeam processing software such as HYSWEEP. A typical rule of thumb for data processing is 2:1 that is for one hour of data consider two hours of processing. However the results a worth it. This can be seen in the rendered images for Kone passage a deep water passage within a barrier reef complex. Figure 2 shows the morphology of the passage as viewed from the south west. No vertical exaggeration has been applied to the elevation model.

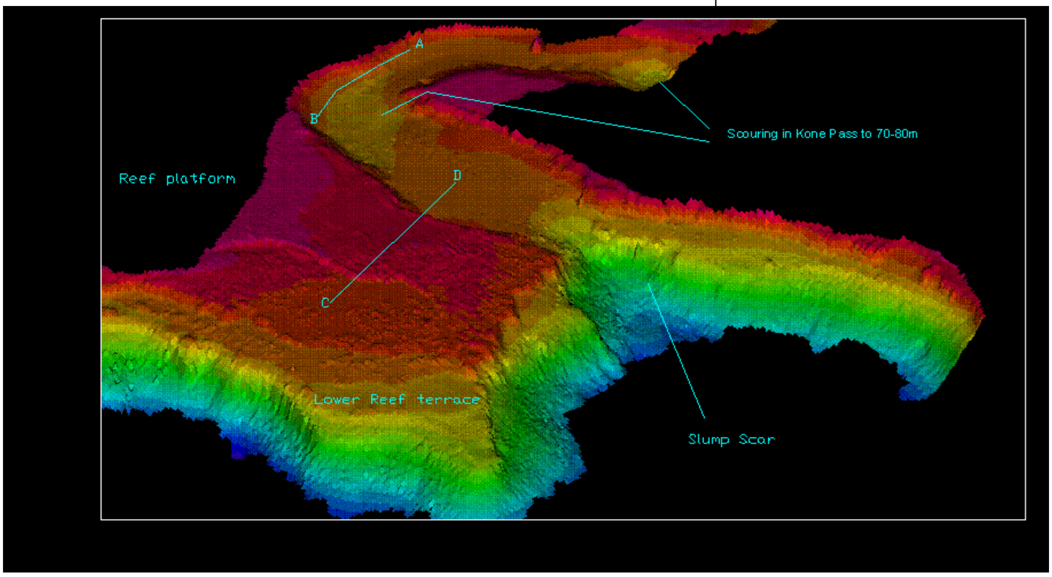
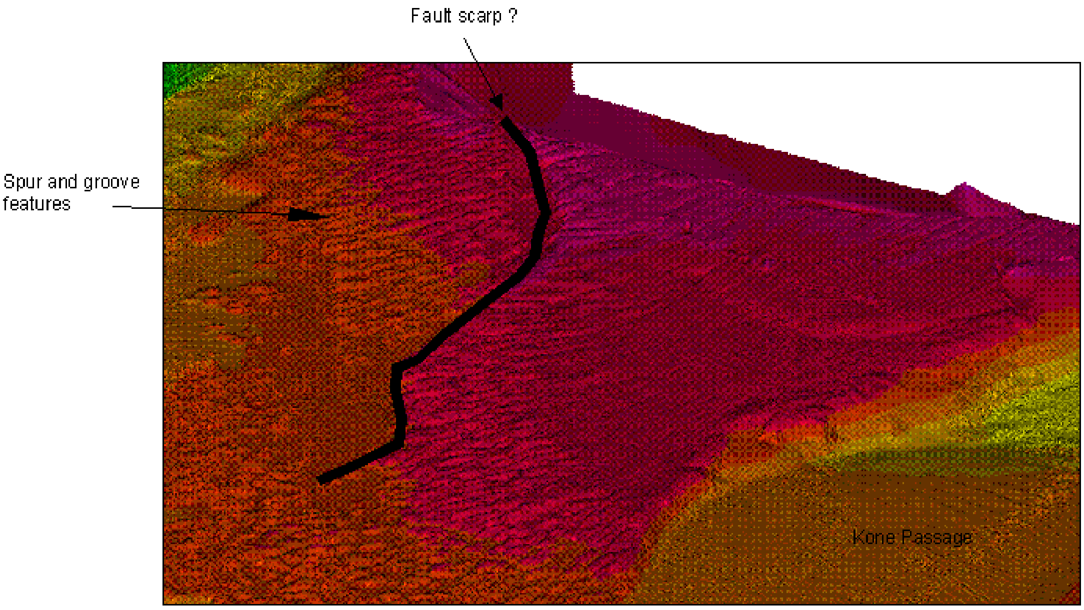


Figure 2: A rendered digital seabed elevation image of a passage in a barrier reef

Features evident in the image include scouring in two places within the confines of the passage. A structual high located between the lower scour and the channel entrance are sediments that have been deposited as a result of lowing current velocities. The top of the platform shown is approximately 10m depth and the base is 250m. Other notable features include a slump

all signal processing of the transducer. A dedicated data collection system then combines the datasets from all onboard sensors, DGPS for navigation control, a motion sensor measuring precisely three periods of vessel motion simultaneously: vessel heave, pitch and roll and a gyro compass for accurate heading information. This data is then stored for later reprocessing, editing and presentation. Data sets generated a large.



A recent fault scarp as evidenced by the apparent discontinuity in the spur and groove morphology of the upper reef terrace in Kone Pass

Figure 3: Spur and groove detail in water depths 5 - 25m

scar at the head of the passage and a faulting across the reef platform.
From the same data set spur and grove detail becomes clearly visible as shown in Figure 3. This data set is based on a 1x1m data cell size.

Figure- 4: *What lies below the waves is now no longer a secret*

Conclusion

High-resolution swath mapping, using multibeam echo sounders, is able to map a complete underwater landscape not possible with a single-beam echosounder. Multibeam swath mapping from which very detailed digital seabed models may be generated coupled with side scan imagery is a very powerful remote sensing tool for revealing the true nature of the seafloor. The benefits of the application of these data sets to coastal engineering, hydrodynamic modelling, habitat mapping, marine monitoring of seafloor pollution, resources evaluation both non living and living, hazard mapping, port and harbour safety navigation are enormous.

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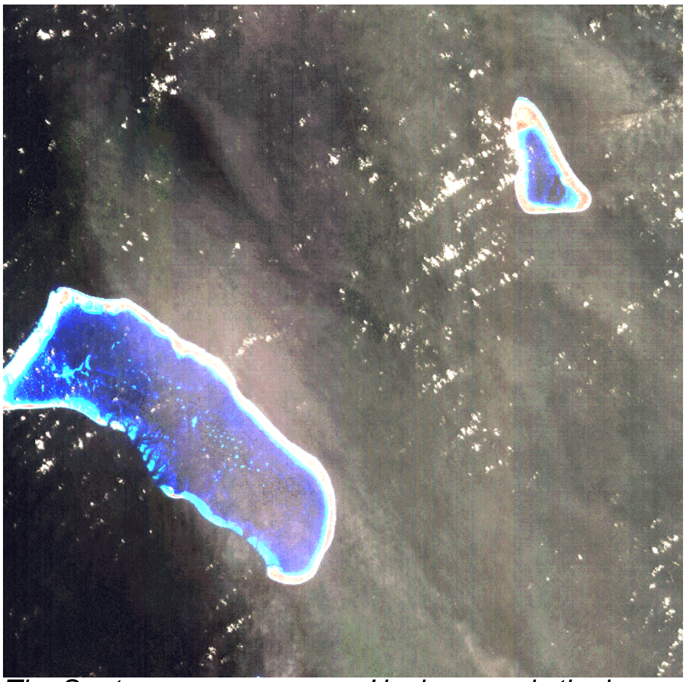
Image Enhancement for Reef Mapping

Wolf Forstreuter, SOPAC

To test the potential of remote sensing data for reef mapping a SPOT scene covering Abaiang in Kiribati was purchased. Landsat 7 images were not available at the beginning of 1999 and SOPAC decided to investigate using a SPOT scene.



The Spot scene was covered by haze, only the lower left part was haze free

When the scene arrived it was noticed that the scene was cloud free, however, haze covered most of the area, see Figure 1. Nevertheless, the image was produced and already a linear contrast stretch seems to remove the haze, see Figure 2. In reality, the influence of water vapour cannot be removed and affects mainly the short wavelengths, blue and green, red and infrared is less affected. SPOT images do not cover the blue part of light, which is most influenced, however, this light frequency penetrates water best and is most suitable for mapping the under-water surface.

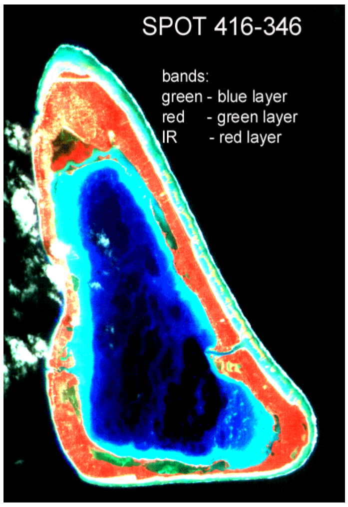
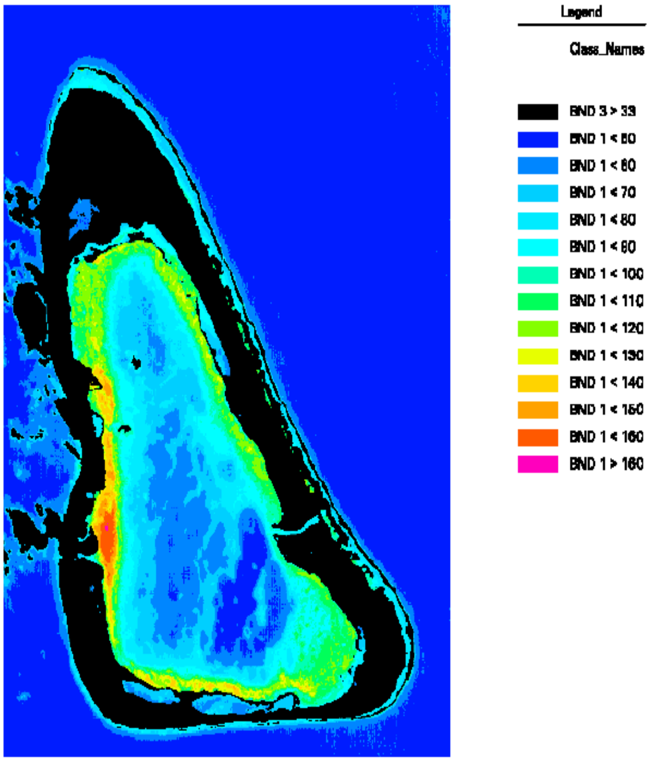
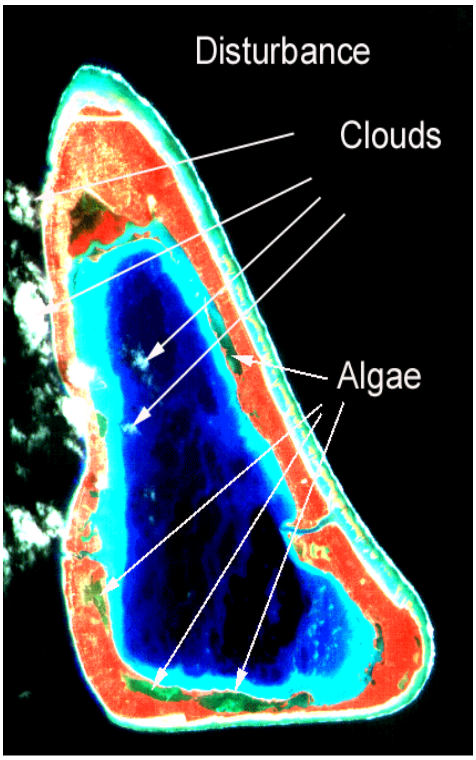


Image enhancement seems to eliminate haze

Luckily the haze was covering the Abaiang lagoon equally and the reflection from the underwater surface in the green channel could be analysed. Figure 3 shows the result of a linear-density slicing, which groups the reflection values into portions of similar reflections. Visual interpretation is essential for such an approach otherwise the area covered by clouds or water bodies with organic material such as algae or cloud shadow would be interpreted as deep-water bodies due to low reflection see Figure 4.



The result of density slicing, the different colours represent reflection intensity of channel 1 (green)



Influence of reflection not related to the depth of the water body

The exercise clearly demonstrates that

a) visual image interpretation is important to eliminate influence not related to the water body

b) haze can influence an image even if images appears cloud free in quicklook

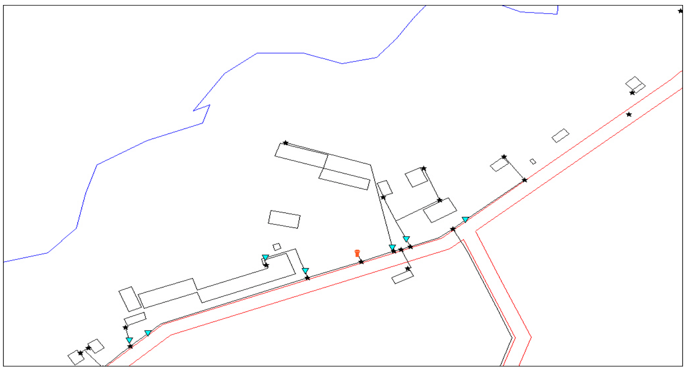
In addition, the blue image channel is essential for water depth analysis. All satellites of the new generation such as IKONOS, QuickBird or OrbView cover this wave length.

GIS for the Water Section of the Public Works Department in Niue

Paula Dawe, SOPAC

In February of this year a member of the SOPAC Water Resources Unit travelled to Niue to help the Water Section of the Public Works Department put together a GIS database of their water distribution system. This work was funded under the New Zealand ODA Water Demand Management and Conservation Project. The work was requested by the acting director of the Water Section, Andre' Siohane.

The in-country work in Niue consisted mostly of pipe detection surveys in the southwestern villages and in the capital, Alofi. By the end of the two-week visit, information on the pipe layout in Avetele, Vaiea, Tamakautoga, Alofi South and North had been collected constituting over half of the population of Niue. Existing plans of the Niue water distribution system were found to be inaccurate in many instances, and the GIS work done will not only provide a correct representation of the pipe network but act as a useful management tool to the Water Section in collecting information on all parts of their distribution system- pipes, tanks, pumps, valves and boreholes. Work on the GIS database at SOPAC is still under way but is nearing completion. The following picture shows a section of the network layout near the Museum, on the main road into Alofi.



Screen display of Niue water GIS layers showing the road network, hydrants, pipes, pipe intersections and buildings

Such simple GIS application shows that GIS is a helpful tool to identify the location of pipes, the loss of pressure, the overview of all asset items. The technology can be transferred to other Pacific Island Countries.

PCGIAP

Bob Irwin

SDI Inter-relationships

The world is moving towards a global model for consistent spatial data. The Global Spatial Data Infrastructure (GSDI) conceptually is a collation of regional spatial data infrastructures (SDIs). Within a framework of technical and administrative support an amalgam of consistent national spatial data infrastructures (NSDIs) in a region of the world enables progression of a regional SDI.

As we approach the final year of the millennium the combining of NSDIs into regional models and regional SDIs into the GSDI model seem a long way off. There are many gaps across the globe. There are many emerging nations not in a position to develop a NSDI past a basic level, and regional coordination mechanisms are in their infancy around much of the world.

Regional Co-ordination

A good example however of regional coordination and SDI development is the Asia-Pacific Spatial Data Infrastructure (APSDI) being managed by the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). The Committee has recognised that without all member countries participating in its activities and developing their own NSDIs, the regional and national benefits accruing from the APSDI will not be fully realised. PCGIAP has an active program to fill in the gaps across the region through its Development Needs Taskforce.

For member countries unable to adequately embrace NSDI development the Taskforce is a potential avenue of support. Through its active program of development assistance the PCGIAP Taskforce is helping to fill in the gaps in the regional spatial data infrastructure, and in turn contributing to the GSDI. The current primary initiative of the Taskforce is with Pacific island PCGIAP members to address their unique needs.

The PCGIAP

The PCGIAP is a regional body established by the United Nations Regional Cartographic Conference for Asia and the Pacific. PCGIAP was formed in 1995 and membership comprises all 55 nations of the Asia and the Pacific region. Its main areas of responsibility are:

- development of a regional spatial data infrastructure and contribution to the global model;
- support for member countries with their national spatial data infrastructures (NSDIs).

PCGIAP currently carries out its activities through three working groups: Geodesy; Fundamental Data; and Development Needs.

The Committee established the Taskforce in 1998 to identify relevant assistance in NSDI activities. The Taskforce is running workshops and gathering information from PCGIAP member countries from which appropriate development projects can be identified in support of these activities.

Cadastre is also seen an issue of regional significance by PCGIAP and it is giving serious attention to the formation of a PCGIAP cadastral working group.

SOPAC and PCGIAP

Australia's role on the Taskforce is primarily to work with Pacific island PCGIAP members in scoping development needs projects that would attract funding support. In March 1999, Pacific island representatives formed a PCGIAP Pacific Group to address their unique GIS and related needs and it was proposed that SOPAC manage the Pacific Group secretariat. SOPAC, at its 1999 Governing Council meeting embraced this challenge and has begun working with the PCGIAP secretariat.

As a first priority of the Pacific Group a draft scoping document for an institutional strengthening project is already being assessed by the Group. In addition the Group expressed interest in regional geodesy involvement and a remote sensing data library for the Pacific.

PCGIAP encourages greater participation of the Pacific island nations in working group and other PCGIAP activities. The Committee and specifically the Development Needs Taskforce look forward to working with the recently formed Pacific Group and SOPAC to help derive maximum benefit to Pacific island member nations.

Benefits

All 55 member nations of PCGIAP have an important role in contributing to the Asia and the Pacific regional model – the Asia-Pacific Spatial Data Infrastructure (APSDI). Their involvement will derive a dual benefit; individual NSDIs will be improved and the APSDI will be enhanced.

The APSDI will provide significant advantage to individual nations and across the region, allowing better informed decision making, particularly in the areas of economic and social development, and for environmental sustainability.

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Drought Effects on Vegetation Mapped with SPOT Image

Wolf Forstreuter, SOPAC

Summary

There are now several satellite systems in place that can provide infra-red images of the Earth's surface. These infra-red images enable analysts to identify areas of vegetation that are suffering from water stress. It is possible to use these infra-red images to identify the impact of a drought. When the satellite images are combined with socio-economic data from population censuses and agricultural production data from agricultural censuses, the data can be used to measure the intensity and distribution of the impact. This information can then be used to more effectively target alleviation efforts.

In this study a SPOT 4 image was tested for its suitability for mapping drought-affected vegetation. A semi-automatic approach of image rationing showed that it is possible to highlight areas where vegetation was affected by water stress and the degree to which it was affected.

Introduction

During the months May, June, July and August 1998, significantly less rain fell in Fiji than in normal years. The impact of the consequent drought varied across Fiji. Some districts were badly affected while others suffered little impact. Even within districts some sites were less affected than others. One of the difficulties faced in measuring the impact of a drought is differentiating between the severity of impact on each site. Without this information it is difficult to accurately target alleviation measures and mitigation efforts.

Remote sensing has the advantage of providing an objective and comprehensive coverage of large areas. The development of infra-red satellite imagery allows analysts to differentiate between the degrees of water stress being suffered by vegetation. For this study SPOT 4 images of Ba and its hinterland were purchased. The images were taken in early August 1998, close to the peak of the drought.

This scene was rectified to Fiji Map Grid and adjusted to the topographic map sheets M26 and M27. The reflection recorded in the infrared portion of the spectrum was used to identify areas without normal vegetation signal of sunlight reflection. After adjusting the images to take account of known forest and urban areas, it was possible to map the impact of the drought at the peak of its intensity.

The Reflection of Vegetation

The method relies on the physics of light reflection. The visible light is reflected by the green pigment in leaves while the blue and red portion of the spectrum is absorbed. Near infrared (NIR) is reflected by the cell walls and the reflection of short wave infrared depends more upon the water content of the leaves, see Figure 1 and Figure 2.

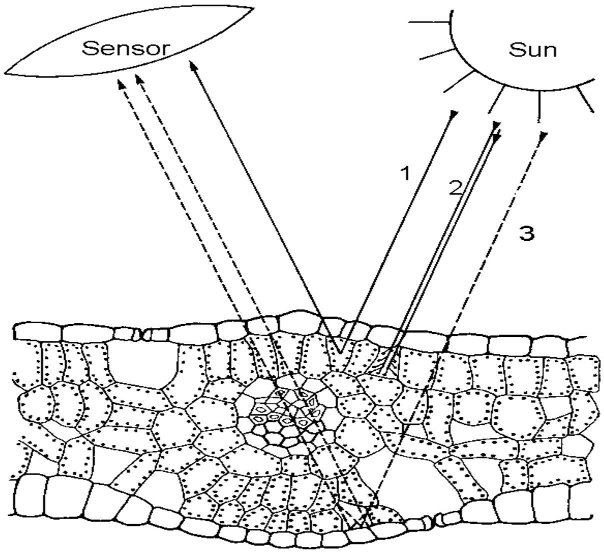

Figure 1: *Reflection and absorption of leaves. Green light (1) is reflected by the leaf pigments, blue and red (2) is absorped by them. Infrared (3) is reflected by the cell walls. (Graph adapted from HARRISON and JUPP*

If plants are suffering water stress the cells of the leaves get smaller and the cell structure changes. This causes less reflection in the near infrared and significantly less in the short-wave infrared when compared with the reflection from healthy vegetation, see Figure 2.

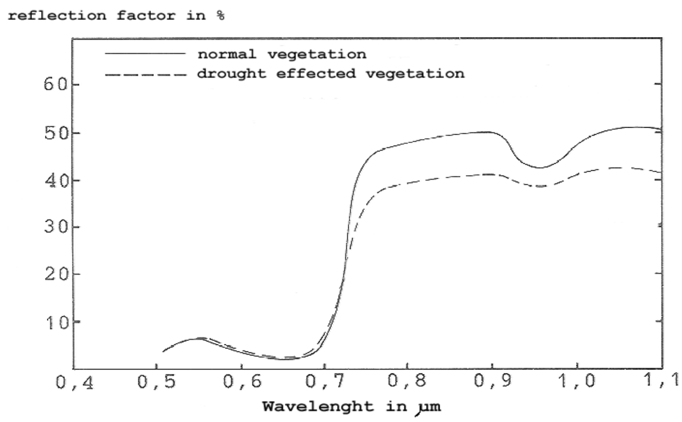

Figure 2: *Reflection of healthy and drought-affected vegetation (Graph adapted from KADRO)*

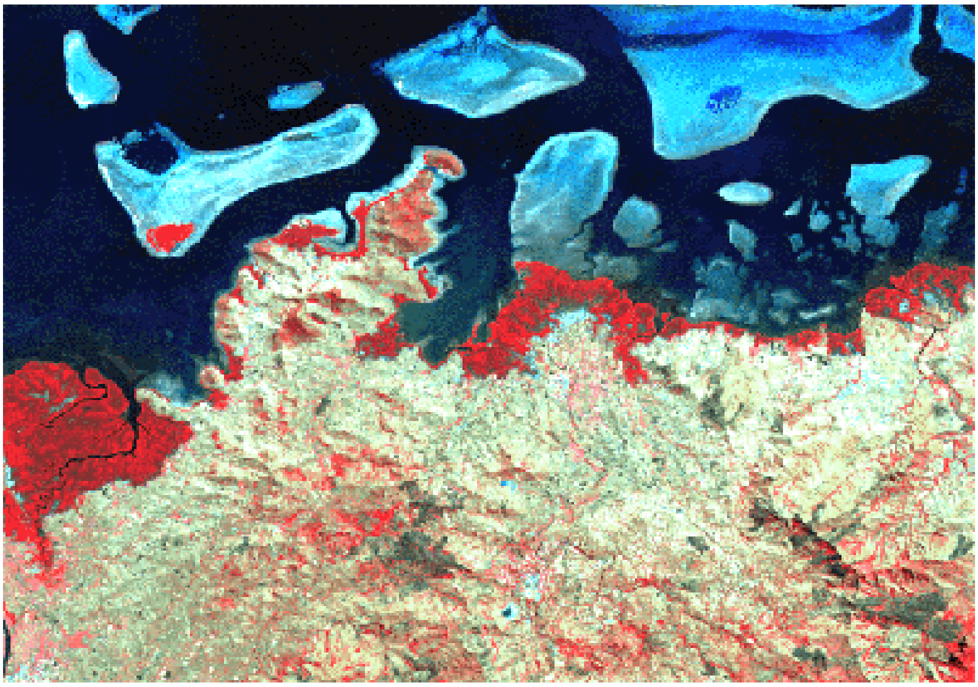

***Figure 3:** Upper part of SPOT -4 scene 435/385, rectified to topographic map sheet M26, bands 2,3 and 4.*

The SPOT Image

The above SPOT image was recorded on 06 August 1998 by the satellite SPOT 4. The satellite's sensor records four spectral bands covering the green, the red, the near infrared and the short-wave infrared portion of the spectrum.

Due to the height and the angle of view of images recorded by satellites, the image data is already in a near orthogonal view. Nevertheless, the image was geometrically corrected to the 1:50,000 map sheets M26 and M27 of the new Fiji Lands Department map sheet series.

The rectified image (Figure 3) shows Ba and its hinterland in northern Viti Levu. The red band is linked to blue, the near infrared to green and the short wave infrared to red colour of monitor or printer. The mangrove cover, which is not suffering water stress, strongly reflects the light in the short-wave infrared and has an intensive red colour in the image. Bare soil shows brownish colour and water is shown in blue.

The Ratio Image

To avoid a time-consuming visual interpretation the semi-automatic image rationing process was used. Given that the three spectral characteristics of vegetation are known the differences can be used to enhance vegetation differences by dividing the value of a pixel of the near infrared by the corresponding pixel value of the red band:

1) In the red part of the spectrum, plants reflect less and in the near-infrared part plants reflect much more than vegetation free areas so the ratio creates a small value. This information can be used to separate areas covered by vegetation from areas without vegetation.

2) The illumination (sunny and shaded hillsides) overlay the reflection from vegetation and non-vegetation. However, the ratio minimises the illumination effect because a low value in the shade is divided by a low value in the other band and a high value of the sunny side is divided by a high value.

3) Drought-affected plants show similar reflection in the red light, however, differs significantly in the infrared as shown in Figure 3. The image rationing enhances the spectral characteristic significantly.

The analysis of the SPOT image used a more complicated arithmetic operation called the Normalised Difference Vegetation Index (NDVI), because this shows an even better separation between the vegetation. Instead of employing the red and the near infrared; the near infrared and the short wave infrared was used, which is less influenced by atmospheric variance.

$$NDVI = \frac{SWIR - NIR}{SWIR + NIR}$$

Where:
NDVI = Normalised Difference Vegetation Index
SWIR = Short Wave Infra-Red
NIR = Near Infra-Red
The result of the rationing process is shown in Figure 5.

The Forest Type Forest Function Map

Due to financial constraints it was not possible to buy the SPOT scene recorded in the same year just after the last rain. However, it is important to have a reference, the fact that parts have no or only low vegetation caused reflection is only significant if there

was vegetation before the drought.
Fiji's forest map was used as the baseline reference. This map is available in digital form and derived from Fiji's natural forest inventory. The inventory classified all forest into three different densities each of, which is shown in figure 6 as different green tones. Non-forest is coloured buff. Plantation lease areas were mapped, but the vegetation was not analysed.
The Arithmetic Combination of Raster Layer
The software used allows a pixel-wise arithmetic or logical combination of different raster layers for the creation of an output layer. Following combination was used as a first step of analysis:

Blue: Forest map = water
Violet: Forest Map = mangrove
Brown: Forest map = plantation lease
White: Forest map = no forest and ratio image low reflection
Green: Forest map = forest and ratio image = high reflection
Yellow: Forest map = non forest and ratio image = high reflection
Red: Forest map = forest and ratio image = low reflection

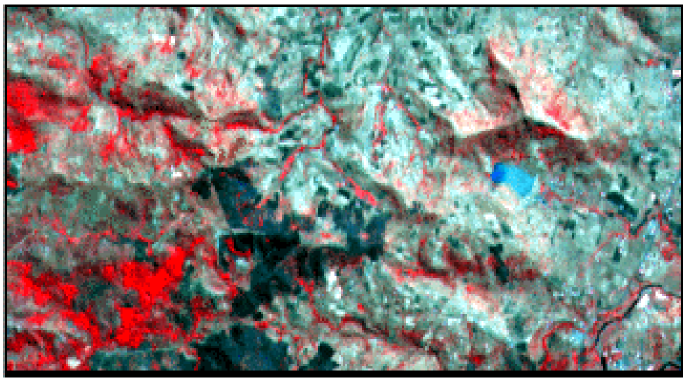

Figure 4: *Sub-image of SPOT map shown in Figure 3*

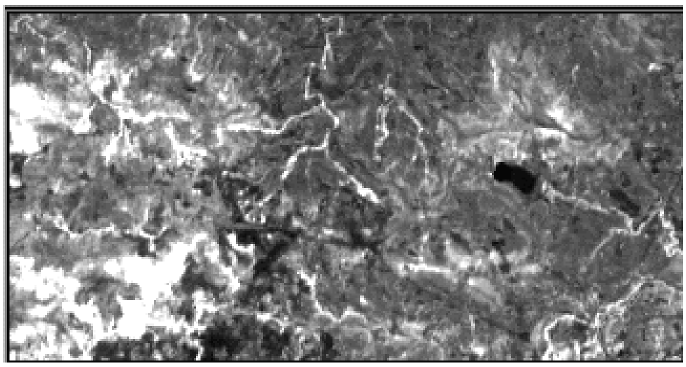

Figure 5: *Sub-image NDVI*

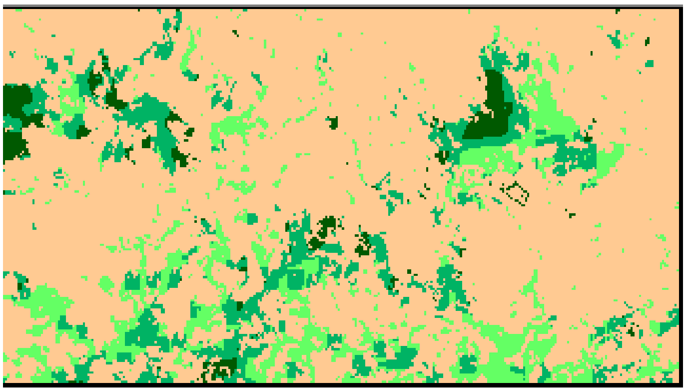

Figure 6: *Sub-set of digital forest map*

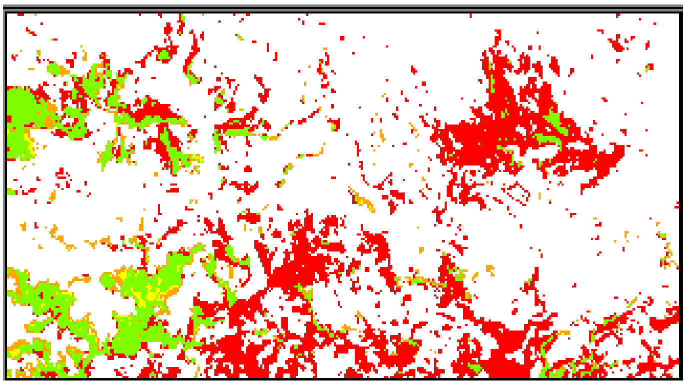

Figure 7: *Sub-set of change detection map*

Results

Due to the fact that it was not possible to purchase another scene, the comparison was made between reflection of vegetation and forest vegetation 1991. Areas in yellow just show healthy vegetation, which was not classified as forest 1991, this includes various types of vegetation. However, a significant area shows low reflection and was classified as forest 1991. Part of this area shows strong absorption, which indicates that these areas may have been burned. It is difficult to identify if the vegetation was only affected or if significant deforestation took place.

This analysis has shown that it is possible to highlight critical drought-affected areas using a semi-automatic remote sensing process. With the incorporation of data from the population and agricultural censuses it would be possible to estimate the impact of the drought down to a very local area. Using the method would help eliminate some of the uncertainty in the response to drought alleviation and the planning of mitigation measures.

Given the wide coverage of satellite images, the method could be used in other South Pacific countries.

Conclusions and Recommendations

A high priority should be given to establishing a baseline map of the entire Fiji Islands based on satellite images. This should be done in close cooperation with Fiji's Forestry Department, which carries out similar activities.

The primary requirement is for a baseline set of satellite images. These images then need to be converted into a comprehensive map of Fiji by cross-referencing data shown in the image against the situation on the ground. Once this baseline map of Fiji has been created it would be fairly straightforward to monitor changes on the ground by comparing new images against the baseline map.

The data would be useful for a wide range of activities. In addition to disaster mitigation it would provide information for agricultural census, forest inventory, geographical systems, cadastral mapping, environmental monitoring, urban spread and other important issues. This satellite images are now readily available and with the recent improvements to the Landsat system, can be obtained fairly cheaply. A further more detailed survey should be carried out involving the Forestry Department to include their field knowledge.

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Raintree Mapping with Landsat-7 TM Images in Fiji

Osea Tuinivanua
Fiji Forestry Department

Introduction

Raintree (*Samanea saman*) was introduced as shade tree from Hawaii over 100 years and has naturalised itself in Fiji. Raintree plays an important role as erosion control, provide habitats for birds and animals and commercially a decorative timber for woodcarving.

Mapping of Raintree Forests

The natural spread of Raintree has increased from 25,300 ha in 1975 to almost double in the recent incomplete survey of 2000 (25 years later). Raintree forests have been growing successfully within the moist/drier areas of the leeward sides of Viti Levu and Vanua Levu. It is characterised by its single storey and dense greenish widespread (domed) type crown formation. This distinctive feature makes Raintree quite different and yet can be easily confused with mango (*Mangifera spp*) at distant visual interpretation growth on the same area.

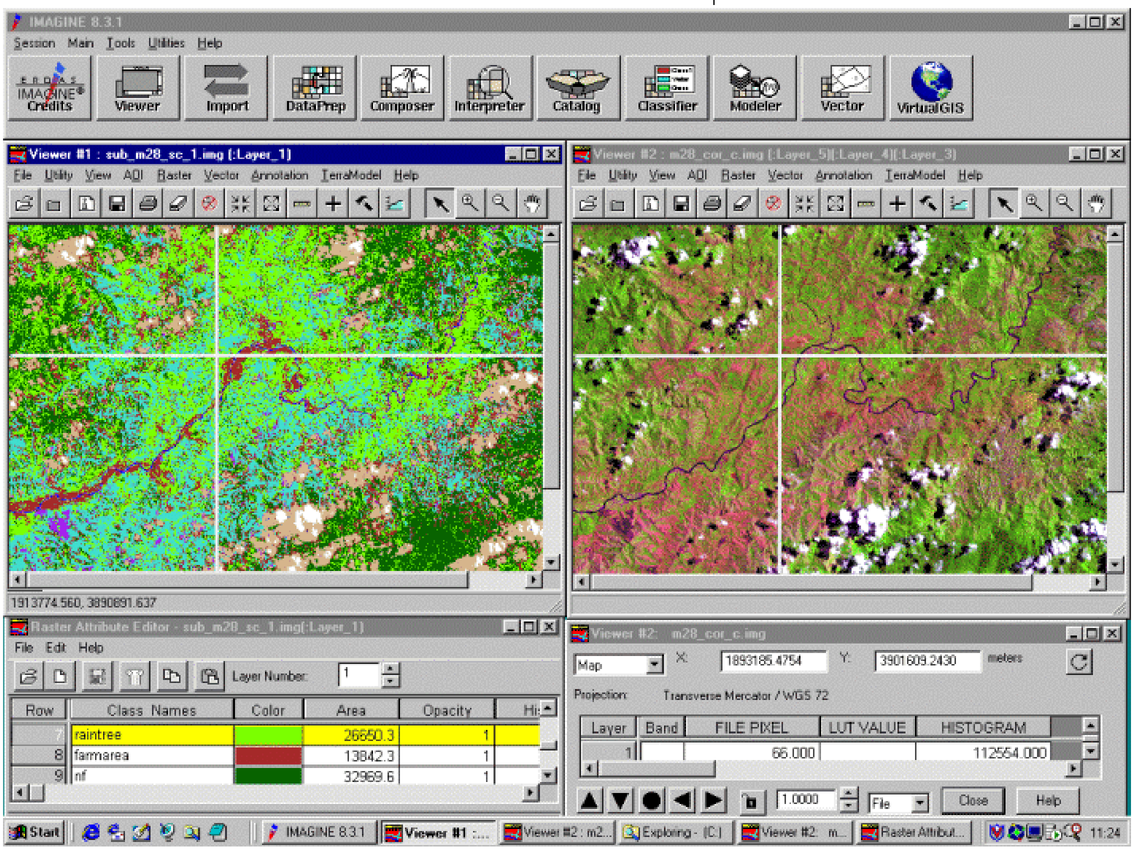

Figure 1: *Geo-link between Acq. Landsat TM and classified image - Sigatoka Valley*

Satellite Images (Landsat-7 TM)

Landsat TM has the advantage of infrared bands to enhance classification of land cover including forest types. Using the Landsat-7 TM acquired in October 4, 1999 the following results were obtained (Figure 1):

With minimal enhancement the best visual interpretation band combination was 5,4,3 for R:G:B respectively. The image analysis showed that near and mid-infrared bands provide the best distinction in the signatures of grassland, farmland, burnt areas and between forest types (pine forests, hardwood plantations, natural forests and Raintree).

Raintree mapping with Landsat TM is enhanced with the presence of infrared bands. Combination of local knowledge, understanding of forest cover and skill from image processing will promote general application for our resource information system.

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Understanding GIS in a Distributed Environment: OpenGIS

Prakash Narayan, MRD

Introduction

Integrating geodata from various sources is increasingly important because of growing environmental concerns, pressures on organisations to perform more efficiently, and simply because of the existence of a rapidly growing body of useful geodata and geoprocessing tools. Data sharing makes sense for the simple reason that there is only one Earth, and we share it. A Distributed GIS can be viewed as, a system of interconnected heterogeneous geographical information systems which form the total geographical information management and processing capabilities.

Geographic data, or "geodata," data describe phenomenas directly or indirectly associated with a location (and time, and orientation) relative to the surface of the Earth, has been collected in digital form over several decades. The overall rate of collection increases rapidly with advances in technologies such as high resolution satellite-borne imaging systems and global positioning systems. There is also the growing number of people and organizations who collect and use geodata. This number will continue to grow with the growing awareness among information technologists that indexing data by location is a fundamental way to organize and use digital data. Geodata formats tend to be complex, more complex than other kinds of digital data formats, because of the range of information that they must be able to represent.

The software that uses and produces geodata is itself varied and complex. Geoprocessing can be any kind of digital computing that uses geodata, including: geographic information systems(GIS), land information systems(LIS), Earth imaging and image processing, storage of geodata in databases of all kinds, digital surveying methods, navigation, meteorology or seismology.

In many areas of human endeavor, people want to acquire specific thematic maps and combine them with other thematic maps in a GIS to accomplish specific tasks. We must share data, but sharing data is a cumbersome, daunting, frustrating, error-prone, sometimes totally an impractical task. To understand the reasons for the complexity of the problem of data sharing, it is useful to consider the close analogy between human language and spatial/temporal computing.

The approach of an Open GIS is to apply the emerging framework of Open Distributed Processing methods in combination with existing distributed object technology in the application domain of Distributed Geographic Information Systems. At the heart of an OpenGIS Architecture(OGA) is a typical client-server scheme. In its simplest form, an OGA server can be used to service requests that come from some outside access point, such as a normal World Wide Web(WWW) Gateway.

OpenGIS is an abstration of geodata and a specification for methods on geographic features and coverages that enables compliant applications to exchange information and processing services. OpenGIS provides an architecture for selecting geodata at its most atomic level, fusing those data into structured information frameworks, analysing information using spatial operators, and viewing the results in informative, decision-supporting ways.
Data transfer standards are a beginning, but data transfer requires off-line, time-consuming batch processing. With distributed computing architectures maturing, and the OpenGIS framework can provide a lingua franca for the geoprocessing interfaces, geoprocessing will be released from its desktop bottle and expanded by the vendors to geo-enable millions of systems on the soon-to-be-ever-present network.

OpenGIS

Open GIS provides a vision of a national and global information infrastructure in which geodata and geoprocessing resources move freely, fully integrated with the latest distributed computing technologies, accessible to everyone. Users of these systems will be able to share a potentially huge networked data space, even though the data may have been produced at different times by unrelated groups using different production systems for different purposes and may in fact still reside under the primary control of the systems used in their production. Open GIS is the incorporation of new technical and commercial approaches to interoperable geoprocessing.

The remote data server will store geodata in a commercial, general purpose relational database management system (RDBMS) configured with an OpenGIS interface. Clients will also be able to request geoprocessing services from remote servers. In many distributed geoprocessing application scenarios, an application or applet will query multiple servers to assemble a response. Open GIS enables users to access and process geographic data from a variety of sources across a generic computing interface within an open information technology foundation.

Much of the stimulus for an OpenGIS comes from a need to share geographic information more effectively between individuals and organizations who not only store and manipulate geographic data in different ways on different computer systems, but who think about, talk about, and visualize geography in very different ways.

Traditional geoprocessing systems have been called “monolithic,” “stovepipe,” or “closed” systems.

Information Technology (IT)

The global Information Technology(IT) society is a rapidly emerging reality. The Internet and other computer networks are providing access to burgeoning sources of data and services for millions of users. The advantages of using such technology are obvious to most users of geodata and geoprocessing resources. Large organisations need to integrate geodata and geoprocessing resources across Wide Area Networks(WAN), and so do small organisations.

Distributed Computing Platform (DCP) enables applications to interact with each other even though they are on different computer network systems. DCPs address issues of networking, communicating between different computer systems from different manufacturers, security, distributed data storage, and other client/server platform issues. DCP also addresses how to provide a service, how to request a service and how to determine whether a request is a request for data, a request for an operation on data or both.

Understanding the results is a framework for interpreting the data - its intended meaning, its accuracy, its level of certification, and so on. Thus the content of these data falls outside the scope of an OpenGIS. However, the OpenGIS provides a framework by which this information can be shared between and among providers and consumers.

Systems integrators seek tools which are platform independent, and which support modeling of complex entities and construction of complex distributed systems. Such systems involve the integration of data and software from many providers, providers with different data formats, different reference systems, and different models of the world. The expectation of an Open GIS is to enable an application developer to use any geodata and any geoprocessing function or process available on “the net” within a single environment and a single work flow.

Each of the leaf-servers translates an incoming query into the native language of the database. The reply is then converted into a standardized format for transmission, upon receipt, the OGA Client converts the information into the format required at its end. This makes the actual process independent of the software/hardware used at either end of the chain.

Object-Orientated

In conventional computer programs, the functions (or procedures) that accomplish a particulair or part of a particulair work are separated from the data they work on. Data files are opened, or “read,” by functions and the data from the files is processed by one or more functions, often creating one or more new data files. On the other hand, Object-Oriented (OO) programs are constructed from building blocks called objects. Each of these self-contained software modules includes all the commands (“methods,” in object lingo) and data needed to do a given set of tasks. An object performs a task when it receives a message requesting that it perform the task. Because it is “encapsulated” in this way, an object can be reused as a unit in any number of programs. By design, object-oriented programming makes it easy to generate new objects that automatically “inherit” the capabilities of existing objects. The programmer can by this means modify methods or add new ones without starting from scratch. A geoprocessing example: a new object whose data have geographic co-ordinates (latitudes and longitudes) might inherit another object’s ability to convert its data from geographic co-ordinates to Fiji

Map Grid(FMG) eastings and northings. This sounds great on paper, but designing the objects in the first place turns out to be a big job.

Components of OpenGIS

Interoperable - The OpenGIS aims to provide standard interfaces to geodata and geoprocessing services. These interfaces support, in stand-alone systems and across networks: geodata access, distributed client-server geoprocessing operations, and distributed peer-to-peer geoprocessing operations.

Supportive of Information Communities - The OpenGIS also optimizes data sharing within a community of users and producers who share a common geographic feature lexicon and between sets of users and producers whose geographic feature lexicons do not coincide.

Ubiquitous - The OpenGIS framework provides the means for all information technology applications to readily take advantage of OpenGIS services through standard interfaces and protocols.

Reliable - Distributed geoprocessing requires a high level of manageability and integrity. The OpenGIS should provide a technology framework that will support OpenGIS branding schemes to give buyers of OpenGIS-based software certain assurances of interoperability.

Easy to use - OpenGIS Specification-based software to employ logical and consistent rules and procedures for the use of geodata and geoprocessing services. Unnecessary geodata and geoprocessing complexity are “hidden” from the application developer.

Portable - The OpenGIS is to be independent of software environment, hardware platform and network.

Cooperative - The OpenGIS supports shared computing and shared data resources. OpenGIS technology can be easily combined with other information technology.

Scalable - OpenGIS based software will often consist of “plug-and-play” geoprocessing software components which are configurable for any geoprocessing application or standard computing environment, regardless of size of database.

Extensible - The OpenGIS to be able to assimilate new geoprocessing software and geodata types, and can accommodate new technologies upon which the OpenGIS is dependent, such as Distributed Computing Platforms, as they become available.

Compatible - The OpenGIS to preserve users’ investments in legacy data and software by providing the means to seamlessly integrate, in a fashion which is transparent to the user, existing geoprocessing software and geodata and related information technology with OpenGIS-conformant geoprocessing applications. Also, the OpenGIS is to be compatible and do not overlap with supporting information technology, particularly Distributed Computing Platforms and database management systems.

Implementable - The most important goal is that the technologies specified in OpenGIS framework must be implementable.

Conclusion

There is an emerging need for Distributed Geographical Information Systems. Geodata and Geographic Information Providers, Government and private sector producers and resellers of geodata and geographic information see that distributed geoprocessing will radically alter their business models. Data collection and integration of new data into existing map databases will become much more efficient. Customers will grow dissatisfied with paper maps because they cannot be sent and used digitally nor kept up-to-date like digital geodata. Demand for geodata will grow as it becomes a pervasive part of the Information Infrastructure. People using desktop systems or mobile digital assistant devices will buy “bites” of geographic information over the Internet much more easily and for more purposes than they currently buy maps or data sets.

The desire of OpenGIS is to develop methods and tools that will decrease the cost of geodata management and distribution for geodata users and further increase the return of investments of geodata collection and establishment. OpenGIS is user-driven by requirements in the area of GIS. The distributed system technology users and developers incrementally transfer their technology to the geographic information system partners, and get requirements and user experiences feed back.

Geoprocessing software vendors, database software vendors, visualisation software vendors, system integrators, computer vendors, telecommunications companies, universities and information providers have a role to play in creating and fostering an understanding for OpenGIS to help solve these problems and fulfil these potentials.

For further information or e.g. getting the list of literature - which was cut because the article was alrady very long - contact: Prakash Narayan, Mineral Resources Department, e-mail: prakash@mrd.gov.fj, prakash@lgs.jussieu.fr

Forest Certification, Fiji's Way to Chain of Custody

Osea Tuinivanua,
Fiji Forestry Department

Introduction

Since the 1950s the Fiji Forestry Department has pursued a national strategy of forest plantation expansion with pine (*Pinus caribea*) and hardwood especially mahogany (*Swietenia macrophylla*) to relieve the demand on natural forests.

More than 50% of Fiji's landmass is still covered by forests (940,000 hectares) with 90% under natural forest and the remainder hardwood plantation (50,000 hectares) and pine plantation (40,000 hectares). The majority of these forests grow on native lands and landowners together with the Forestry Department and the Native Land Trust Board have prevented exploitation by foreign companies. Fiji has been self-sufficient in timber products since mid 1970s with export earnings from its forest products now ranked fifth ($62 million) in 1998.

Selective logging of natural forest has been the only logging practised in compliance to the National Code of Logging Practice, protecting the forest area from extensive damage during logging operation. Indigenous forest annual logging of 10,000 hectares produces an average 140,000 cu m. per year to sustain the timber demands of 20 local sawmills.

The Forestry Department is intensively involved in every aspect of natural forest management from logging, sawmill, and further timber processing to export where this has enabled sustainable development. One of its long-term objectives is the rationalisation of the forest resources and processing to maximise wood utilisation such as value adding in Fiji export markets.

Forest Product Quality Label

Products of high quality need to be readily identifiable by the customers and this is not yet happening for forest products exported from Fiji. Fiji's timber products must be recognised and visible to the consumers as products from sustainable managed forests and certified chain of custody through a quality label.

The International Tropical Timber Organisation (ITTO) has funded a project carried out by Fiji's Forestry Department with the South Pacific Applied Geoscience Commission (SOPAC). This project developed a timber flow monitoring system to clearly identify the flow of sawn timber or other forest products from the point of origin to the point of export. At the same time, Fiji is on the way to apply sustainable forest management under the principles and criteria of the Forest Stewardship Council. This will start for three different areas on the main islands Viti Levu and Vanua Levu. Fiji is confident to:

- reach new markets for their forest products,
- utilise species not exported before
- create value adding of timber products in the country through additional processing levels, which will not only produce more income for Fiji but also employment.

Timber Flow Monitoring System

The Forestry Department has implemented the project through ITTO funding and developed a Timber Flow Monitoring System that uses a wide area network that links computers located at the divisional offices throughout Fiji. The system allows the divisional offices to connect to a central database that contains information necessary for recording and tracking the flow of timber from point of origin, through processing to point of export.

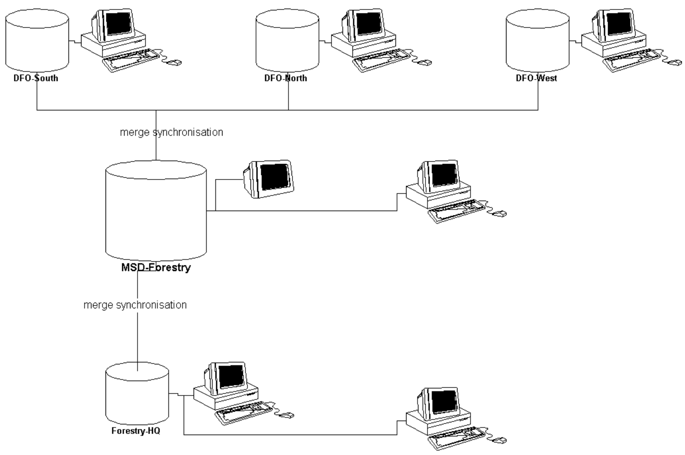

Figure 1: *The wide area network of the log monitoring system*

For such a system to be operational and sustainable in Fiji the following specifications were required:

- PC based hardware that can be maintained by local suppliers
- Recognised standard software that can be developed and maintained by the Forestry Department
- User-friendly interface for data entry by Forestry staff.

- Robust central database system that provides synchronisation with the divisional offices.

Microsoft SQL Server was selected as the database software providing synchronisation between the tables stored at the central server and the tables stored on the PCs at the three divisional offices (Northern, Southern and Western) and Forestry headquarters. Telephone lines provide the link between the PCs and the central server and allow the tables to be synchronised daily.

The user-friendly interface has been developed in Microsoft Access that is a component of the Microsoft Office 97 Professional product. The Microsoft Access interface and tables are linked to SQL Server at each client that allow for synchronisation with the central SQL Server database as shown in Figure 1.

The Chain of Custody

The development of the Timber Flow Monitoring System has enabled the Department to monitor the Chain of Custody from point of origin, where the stem is felled in a sustainable managed forest, through processing to point of export as detailed as follows.

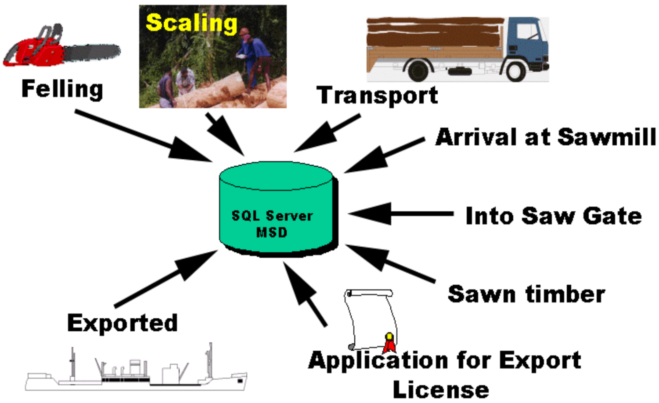

Figure 2: *Information input for tracking the flow of timber*

Point of origin

Prior to this project for the last forty odd years, extracted native sawlogs were traceable to forest owners or landowning units through scaling and log numbering by Forestry staff at the landing sites. The new system, however, employs log and stump identification with plastic barcodes tags fixed directly after felling and during the crosscutting at the landing. This will applied to operational level.

Besides providing information of the exact point of origin, the landowners have a control of the logging operation. For the time being Fiji's Forestry department is paying the labour cost of the labelling not only during the crosscutting but also in the stands during the felling operation. The labelling in the forest will be taken over by the landowners.

Point of processing

There are 22 registered sawmills processing natural forest logs in Fiji. Sawlogs are delivered to the sawmills with the details recorded in the Timber Statements and Removal License. In addition the logs are not only recorded when they enter the saw gate, but also on arrival at the sawmill log yard. The new system enables the data from the Timber Statements and Removal Licence together with the barcode label data to be entered daily at the divisional offices and update the central database. This provides accu-rate and timely information to Forestry headquar-ters on raw materials that have entered the sawmill gate.

Figure 3: *Log tagging*

Figure 4: *Stump barcode tagging*

In addition the sawmill provides the dimension, volume and species of the daily production that enables Forestry headquarters to trace the sawn timber back to the stump.

Point of export

Every timber product exported from Fiji requires a license from the Forestry Department. The licence information is also stored in the central database that again enables the Forestry headquarters to identify the export product to the stump.

Information of Export Markets

The wide area network of the system is also be used to transfer information from the Forestry headquarters to the division forest offices and the sawmills. International timber product market prices are distributed fortnightly to assist the sawmills marketing. In addition a virtual library was installed at the central server keeping all articles related to sustainable forest management certification and chain of custody. All articles including ITTO's timber market information are converted to PDF file format allowing sending this information as a small e-mail attachment. Sawmills and Division Forest Offices are enabled to request information of interest via e-mail, which then will be send to them.

The Spatial Data Front End

At the Forestry Headquarters, reports providing a country wide overview or details of a forest unit, can be viewed or printed from the central database that is continually updated by the remote stations as previously detailed. To provide a rapid overview of quantity and species of logs at various processing points in different locations the information is displayed in GIS environment as shown in Figure 5.

MapInfo can be customised with the MapBasic programming tools to provide an environment or user interface tailored to the specific needs of a sector, a set of users or even a single user. An example is the enhanced toolbar with pull down menus of the user interface of standard MapInfo as shown in Figure 5.

MapInfo is a vector based GIS and allows raster images such as aerial photographs, satellite images or scanned paper maps to be included as an image backdrop or underlay to dramatically enhance visualisation of information. In Figure 5 the scanned topographic map of Viti Levu has been used as an underlay to enhance the visual display.

Tabular back-end databases such as Oracle, Informix and SQL Server can be linked to MapInfo to provide such features as thematic maps where changes in the tabular data are immediately reflected in the thematic maps. The sawmill location symbol in Figure 5 is replaced by a pie chart to provide the information in the form of a thematic map, that shows the raw product logs by the five major species available in the timber yards. In addition, the user can click on the centre of a pie chart and the corresponding record of the table will be displayed in a popup window.

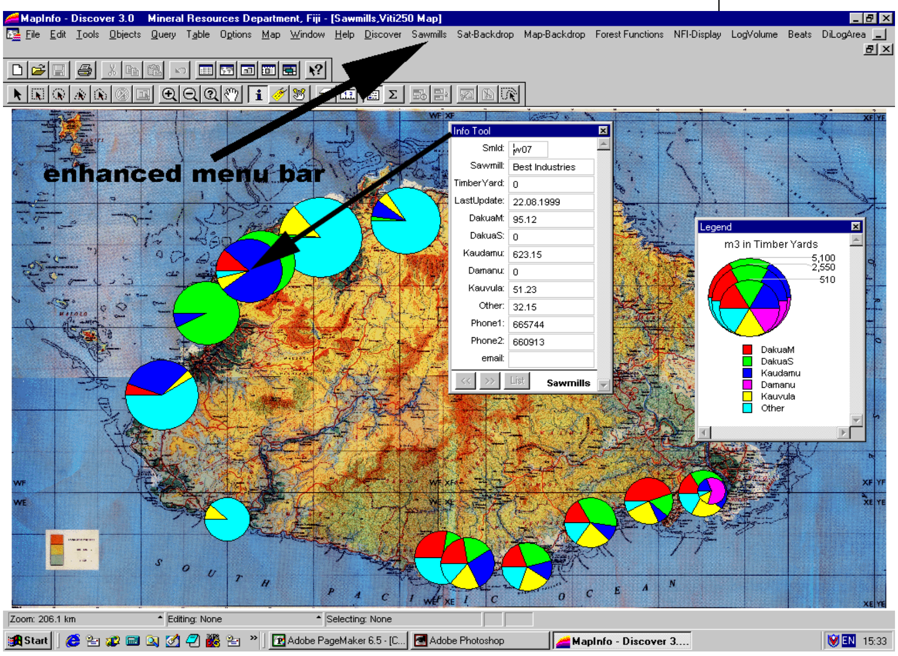

Figure 5: *The picture shows a MapInfo display of sawmills in Viti Levu. The pie charts represent logs of the five main species in the sawmills timber yards. The thematic maps automatically update by sychronising the database. If the operator clicks on a centre of a pie chart representing a sawmill the corresponding record is displayed in a popup window.*

Further Enhancements

Within the current system monitoring the timber flow, the tracking speed can be improved if data input is further decentralised to timber production offices. The remotely based timber production offices would update the databases at the three division forest offices.

Updated information can be readily provided to the Management Services Division of the Forestry Department by equipping the Timber Production Officers with hand held GPS units who can acquire area information of logging sites. This would enable the Forestry Department to monitor the logging progress in even greater detail.

A further improvement of logging control would be a country wide forest cover monitoring at 1:50,000 scale and monitoring of selected areas, where logging actually takes place, at 1:10,000 scale. The new generation of satellite data would allow mapping in regular intervals at these two levels and customers could be provided with verifiable information about Fiji's forest situation.

Besides export products local consumption of timber products such as sawn timber, veneer, plywood and blockboard will be fully included in the system. The will provide even better picture of the wood flow.

Summary
Fiji's forest situation is stable because the forests are managed in a sustainable manner. Three forest areas have been identified for certification by an internationally accepted organisation.

Following certification, timber quality labelling can be implemented that will result in timber products from Fiji being recognised by customers worldwide. Reaching this stage, more value adding of timber products in Fiji would be the consequence, which would create employment in addition to financial benefits for Fiji. This is not limited to timber, bamboo and other renewable forest resources could be added, if a market and production line is established.

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Linux: a GIS/Remote Sensing Tool?

Franck Martin, SOPAC

Linux is an operating system that was developed in the 90's by Linus Torwarld, a student in a Finland University. Linus built this new operating system to learn how Unix Commercial operating systems work. He quickly requested the help of the Internet community to bring input to the development. Now Linux is developed cooperatively by several hundreds of developers all around the world. Linus still calls the shots for the kernel, the most important part of the operating system.

Linux, Unix and GNU

Linux is compatible with professional grade Unix systems such as Sun Solaris, IBM AIX, HP UX, SGI IRIX… It means that most application developed for one platform can be ported to another. Unlike Unix, Linux is a free open source software licensed under the GNU General Public Licence (GPL). This licence stipulates that anybody can use the software freely for any purpose, but also that anybody can modify the software in any manner as long as the list of copyright of previous developers is retained. GNU GPL software and its enhancements or modifications remains free. Most of the software developed under Linux follows the same GNU GPL.

From a learning exercise, Linux has evolved into professional grade software. The Linux kernel is known for its robustness, and comparison with Microsoft stable operating System Windows NT or Windows 2000 is in favour of Linux for the stability of the system. However, Linux does not run on all hardware and one must choose carefully its hardware before running or installing Linux. Manufacturers are working towards Linux compatibility and the big names, IBM, Compaq, HP, Dell have all their computers able to run Linux. Moreover Linux runs on a variety of platforms: Intel, AMD, Alpha , PowerPC, SUN Sparc,..

Linux Flavours

Linux exists in several flavours. All flavours are compatible at the source code level, and binaries exist for all flavours if you don't fancy re compiling the code into binary. The difference between all the flavour is how the default setting are configured and which tools are defaults. The major Linux distributions are: RedHat (US www.redhat.com), Mandrake (France www.mandrake.com), Suse (Germany), Corel (Canada), Turbo Linux (US), Caldera (US), Slackware (US). Redhat brought easy installation to Linux with the RPM tool (RedHat Package Manager). It is a tool that allows easy installation or upgrade of any software distributed in a rpm package form. The advantage is that it is easy to install a newer version and all dependent software, and there is no needs to reboot the machine unless a new kernel is installed (very rare).

For the desktop environment, there is a choice between several interfaces, mainly KDE (www.kde.org) and GNOME (www.gnome.org). Both have similarities and it is just a question of look and feel, but both are comparable to MS Windows, if not better.

Linux a Corporate Server

Linux is the perfect operating system for server tasks, and especially for Internet server tasks. Linux as a compatible Unix comes with all the server tools for Internet operation: Apache Web server (www.apache.org), Mail server (www.sendmail.org or www.postfix.org), Database (www.postgresql.org), MS Network File Server (www.samba.org),... All these services are free. In comparison with MS products the savings are huge despite the fact that Linux is somehow more difficult to learn. However new tools are built that make Linux a breeze to administer.

Linux a Corporate Desktop?

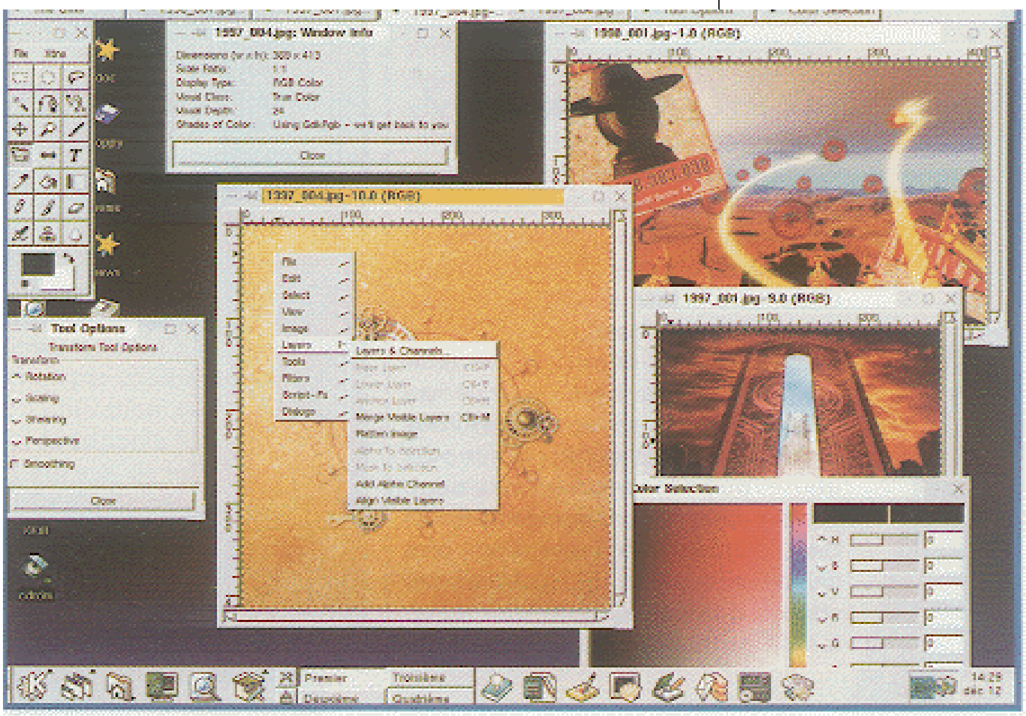
In terms of desktop computer, Linux is just entering the market with the offering of the free SUN StarOffice: a complete Office suite for Linux, Windows, OS/2 and Solaris. KDE, Gnome, and Corel are also developing an office suite. StarOffice is the most finalised product today in the office suite. It compares equally with Microsoft Office 2000, and fully understands MS file formats. The only drawback IMHO (In My Humble Opinion), is that it runs in its own window.

It is now possible to deploy and entire office running Linux desktop and Linux Server for the cost of the Hardware.

But how do people make money to live? Well there are several answers to this question. Some developers are paid by universities to develop software to help in their research subject. The distributors of Linux flavours, which earn money on manual printing, packaging, and support, pay some people to develop Linux. Hardware manufacturers pay developers to port Linux to their hardware. This last category is interesting. People like IBM, SGI, HP and others have to pay a whole development team to build an operating system that will run on their specialised processors and hardware. They are finding out that with a smaller development team they could simply port Linux source code to their specific hardware, and just enhance it if there are some capabilities that are missing. IBM and SGI, are developing a new file system for Linux to allow them to sell Linux on their hardware.

GIS/RS

In terms of GIS and Remote Sensing, there are two sites to visit: www.freegis.org and www.remotesensing.org.



The picture shows a screen display of GIMP an image manipulation program on LINUX compatible with Corel Photo Paint or Adobe Photoshop

The list of free GIS/RS software includes GMT, GRASS, SPRING, MapServer, MBSystems and cwp.

GMT

GMT is a modular software developed by the University of Hawaii. It allows the printing of accurate maps through the processing via the command line of data file. The results are great but the user must be proficient in the command line utilities to manipulate the files.

GRASS

The University of Hannover in Germany developed GRASS. It is based on the same modularity of GMT, but includes a Graphical User Interface (GUI) to facilitate the use of the command line untilities. This software is a real GIS/RS software.

SPRING

SPRING is a free software developed by a Brazil institute. It has a much more easy interface than GRASS, however the source code is not available.

MapServer

MapServer is a tool that allows generating and displaying maps in a browser via a web server such as Apache. SOPAC is using this tool to present a Pacific Regional map on its home page www.sopac.org.fj.

MBSystems

MBSystems is a software that allows the interpretation and display of bathymetric swath data.

Cwp

Cwp is a software that allows the display and interpretation of seismic profiles saved in the SEG-Y format.

Future Direction in Linux GIS/RS

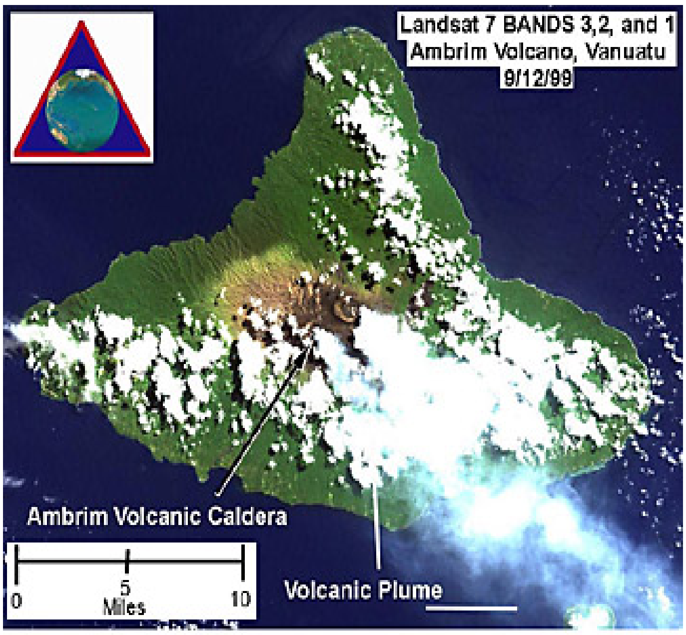
As seen previously, none of these tools are user oriented and have ease of use in their concepts. Therefore a new project is getting developed to provide a easy to use GIS/RS tool for Linux. The project information is located at http://fmaps.sourceforge.net/ and as any Linux project any person can participate in writing the software, the documentation, or just testing or giving advice or directions.

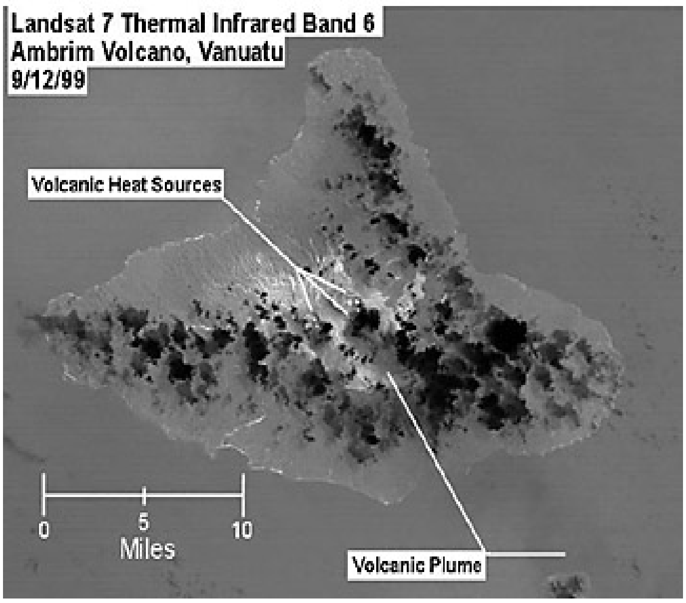
For further information contact: Franck Martin, SOPAC, Fax: +679-370040,
e-mail: Franck@sopac.org.fj

The Pacific Disaster Center Begins Collaboration with SOPAC

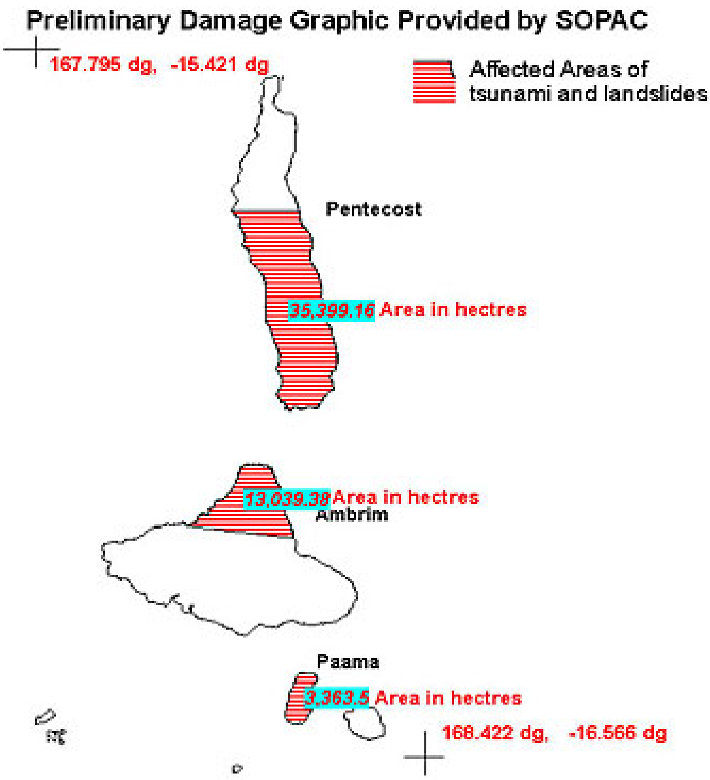
Rhett Rebold, PDC

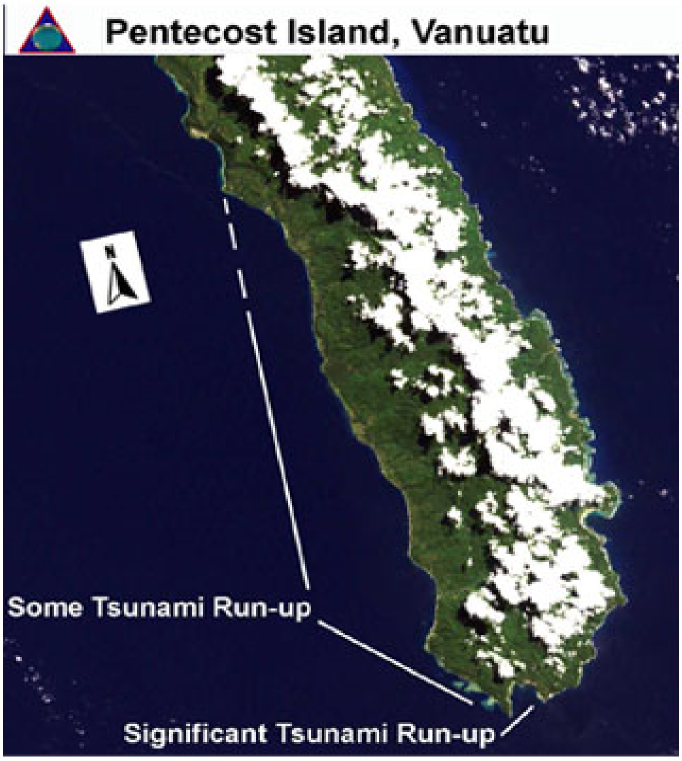
The 7.5 strength earthquake that struck Vanuatu on November 27, 1999 and its related disaster phenomena provided the impetus for the Pacific Disaster Center (PDC) and SOPAC to begin active collaboration in data and information sharing. The PDC is a regional U.S. Federal Disaster Center that creates information products and develops capabilities for emergency managers in the Pacific and Indian Ocean areas. In October 1999, PDC's Modeling and Simulation Analyst Stan Goosby attended the ENSO Regional Workshop on Response and Mitigation in





The Pacific Disaster Center Begins Collaboration with SOPAC





Nadi, Fiji and met Russell Howorth, Wolf Forstreuter, and Joseph Chung among others at SOPAC. That meeting laid the groundwork for collaboration on Vanuatu.

The initial information needs following the Vanuatu earthquake included the locations and amount of wave run-up from the locally-generated tsunami, the locations and severity of landslides, and the activity level of Ambrim Volcano. PDC Imagery Analyst Rhett Rebold worked with SOPAC's GIS and remote sensing person Wolf Forstreuter to obtain pre- and post-event imagery of affected areas in order to map and assess the damage. Mr Forstreuter was able to provide a digital map of general areas to target for PDC/SOPAC cost-shared IKONOS imagery collection, initial ground reports from the damage survey team, and later with 1:50,000 maps and ground photography of the tsunami run-up area.

PDC provided SOPAC with pre-event Landsat 7 imagery that covered the affected areas and obtained priority IKONOS tasking of Pentecost, Vanuatu from Space Imaging. Although clouds interfered with the IKONOS imagery's multiple collection attempts, there was value in establishing this sharing mechanism and an education provided in the region's weather patterns. USGS/National Geodetic Data Center (NGDC) also provided vector data allowing the PDC to map the area's major historical earthquakes and tsunami run-ups. This and further background on the Vanuatu region's seismicity provided by University of Hawaii scientist Dr Mike Bevis and further survey reports provided by SOPAC's Forstreuter and Howorth allowed the PDC to present an integrated situation report (text, images, and maps) to USPACOM's Virtual Information Center, SOPAC, and other interested emergency managers.

The collaborative work on Vanuatu among PDC, SOPAC, and others has opened an important door to what is hoped to be even greater collaborations in the future. PDC's mission as a coordination and fusion center of information derived from federal, regional, international, scientific, and private vendor sources makes it anxious to grow a Pacific regional information network. This network would be created through relationship building, collaboration on data/information sharing, information synthesis including risk and consequence assessments, and finally communication and dissemination to all collaborative partners. PDC looks forward to an even stronger relationship with SOPAC and others in the Pacific in the future.

For additional information on the PDC, contact
PDC Director Joe Lees
For additional technical information contact:
Rhett Rebold, rrebold@pdc.org

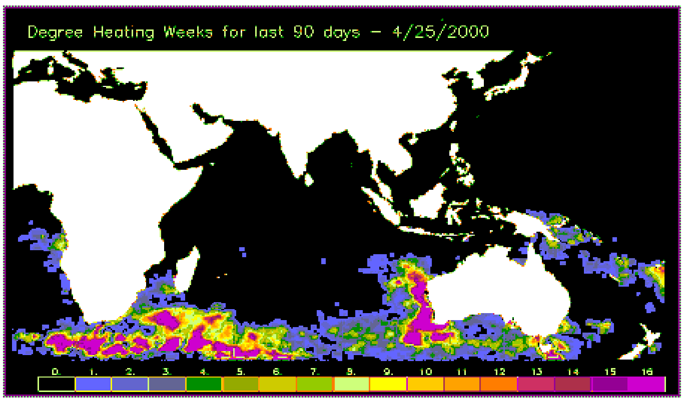
Spaceborne Image Data News

Wolf Forstreuter, SOPAC

Articles in this newsletter is normally limited to Remote Sensing information applicable for mapping scale between 1:5,000 and 1:100,000. Due to the importance of coral bleaching explained in the first article, the newsletter wants to also inform about a web site of NOAA (National Oceanic and Atmospheric Administration, U.S. Department of Defense).

Degree Heating Weeks (DHWs) are an experimental product designed to indicate the length of time that coral reefs experience thermal stress. One DHW is equivalent to one week of sea-surface temperatures one degree Celsius warmer than the expected summer-time maximum. Two DHWs are equivalent to two weeks at one degree above the expected summertime maximum OR one week of two degrees above the expected summertime maximum. These charts (produced biweekly at a 50km resolution) are being used to determine the amount of accumulated thermal stress that results in bleaching. More about DHWs can be found under:

http://psbsgi1.nesdis.noaa.gov:8080/PSB/EPS/icg/dhw/dhw_new.html



Hot spots on the sea surface, web display

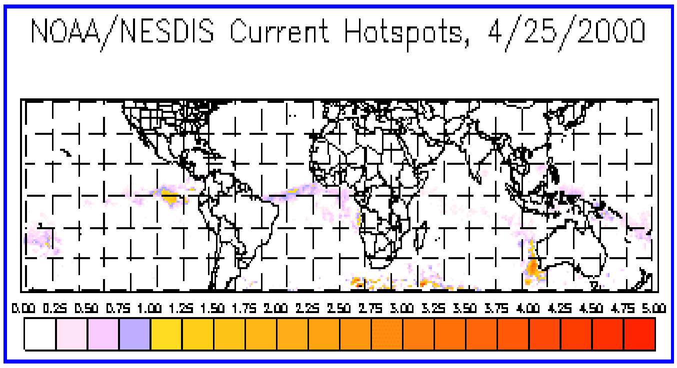
NOAA gets data from several satellites using visible and infrared spectrum. NOAA also receives data from a network of buoys, which send water temperature data up to satellites.

Further information can be obtained by users from maps providing anomalies between the experimental 50 km nighttime temperature and the average monthly temperature.

To see the updated hot spots, link into:

http://psbsgi1.nesdis.noaa.gov:8080/PSB/EPS/SST/climohot.html

Coral Bleaching Hotspots



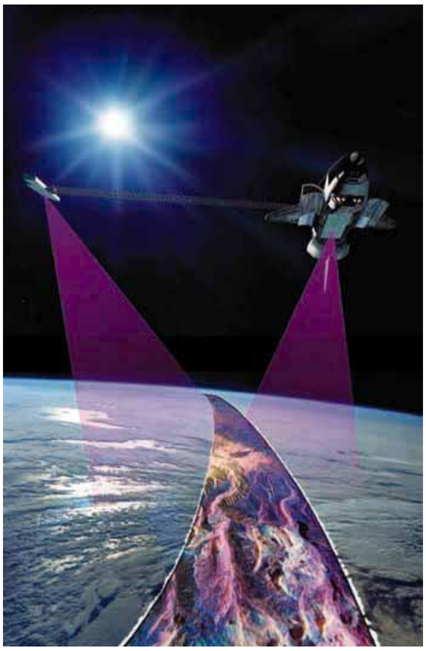
Click on your region of interest.

Hot spots on the sea surface, web display

and then click onto the region and get the display (see figure in the first article about coral bleaching).

SRTM

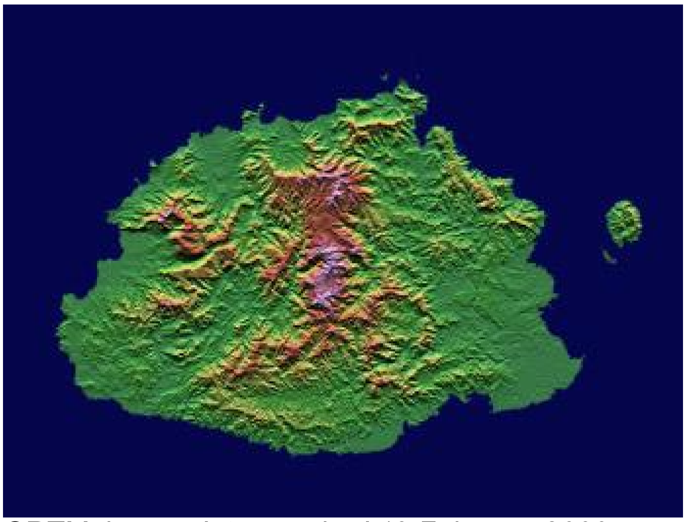
The Shuttle Radar Topography Mission (SRTM), launched on February 11, this year, for a 11-day flight using the a Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR) that flew twice on the Space Shuttle Endeavour in 1994. The mission was designed to collect three-dimensional measurements of the Earth's surface. To collect the 3-D data, engineers added a 60-meter-long mast, an additional C-band imaging antenna and improved tracking and navigation devices.



The SRTM viewing the earth

This shaded relief image was generated using topographic data from the SRTM. A computer-generated artificial light source illuminates the elevation data to produce a pattern of light and shadows. Slopes facing the light appear bright, while those facing away are shaded. On flatter surfaces, the pattern of light and shadows can reveal subtle features in the terrain. Colours show the elevation as measured by SRTM. Colours range from green at the lowest elevations to pink at the highest elevations.

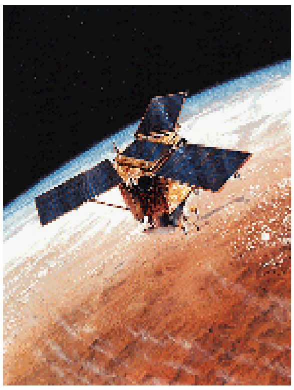
The SRTM mapped all Pacific Island Countries with an absolute horizontal and vertical accuracy of 20 meters and 16 meters, respectively. The data is sufficient to produce a rectified, terrain-corrected radar image mosaic of at 30-meter resolution.



SRTM image date acquired 19 February 2000

The image displayed is made from preliminary digital elevation maps created from a quicklook processor designed for engineering evaluation of the SRTM data set. They have not been calibrated or verified and utilise data from a single mapping pass. The final DTMs will incorporate data from multiple passes that will fill in the shadows and improve the height accuracy. It will take about two years until the final products will be finished in USA and Germany, currently just the copying process of the mission data (7 terra byte or 20,000 Cds of raw data) should be finished.

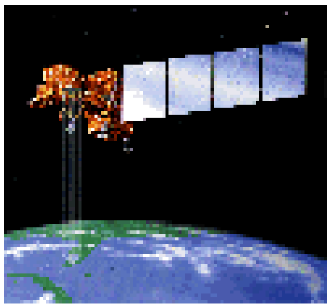
IKONOS



For some months IKONOS 2 provided images with 1m resolution in panchromatic and 4m resolution in multispectral scale. The Pacific Disaster Center tried to purchase IKONOS image data for the Island Pentecost in Vanuatu after the Tsunami to map the landslides at 1:10,000 scale. However, it was impossible to record cloud-free images during this period. SOPAC is currently purchasing IKONOS images for Kosrae in the Federal States of Micronesia to update maps at 1:10,000 scale. It will be the first Pacific Island Country utilising this remote sensing data.

IKONOS panchromatic image data (1m resolution) produced within 24 hours of the tornado striking Fort Worth, Texas on 28 March 2000. The image provides an exact picture of the damage.

Landsat 7

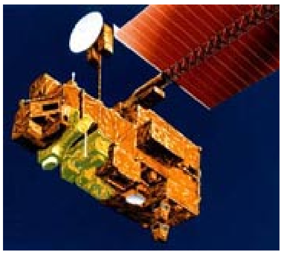


Since Landsat 7 image data is available for $US 600 per scene (about 20 times less than SPOT data) the application in the Pacific increased. Fiji's Forestry Department purchased images for Viti Levu. The Pacific Disaster Center for Vanuatu and SOPAC analysed a Landsat-& TM scene for Christmas Islands and is currently purchasing for Pohnpei in the Federal States of Micronesia. Landsat 7 is the only satellite which has a sensor providing thermal data for medium mapping scale (1:50,000 to 1:100,000). The article from the Pacific Disaster Center describes the application.

SPOT

SPOT Image has a cooperation with ORBIMAGE and will use its infrastructure for data distribution. ORBIMAGE's OrbView first high resolution satellite will provide low-cost, real-time imagery. The satellite's sensor will produce 1m panchromatic and 4m multispectral images with a standard size of 8 kilometers. The scheduled launch date for OrbView-3 is the year 2000, however, we have not heard of a launch so far.

Terra

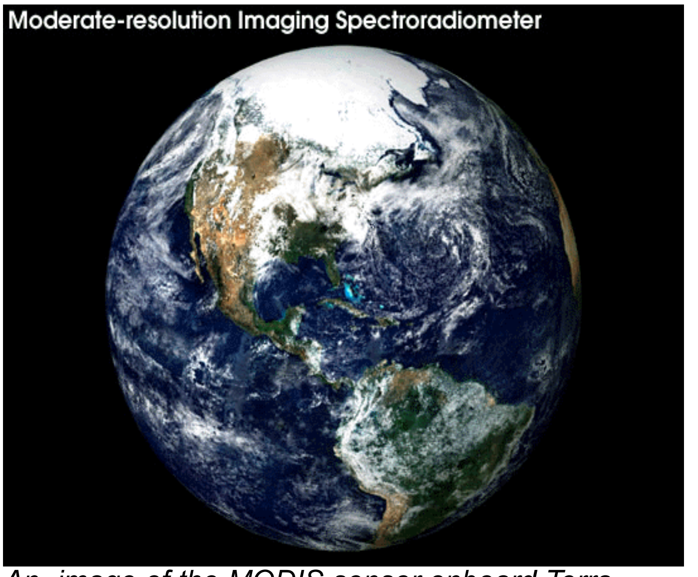


NASA's Terra satellite was launched from Vandenberg in December 1999. The two sensors of high interest on board of the satellite are ASTER and MODIS.

ASTER: (Advanced Spaceborne Thermal Emission and Reflection Radiometer). The sensor provides images of the Earth in 14 spectral bands. Visible and Near-Infrared Radiometer 3 bands (VNIR), Short Wave Infrared Radiometer 6 bands (SWIR), Thermal Infrared Radiometer 5 bands (TIR).

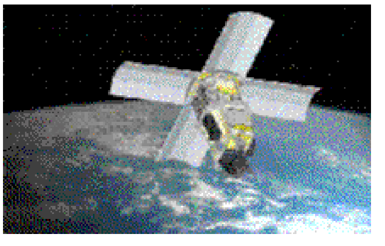
One of the first images provided by the ASTER sensor onboard the Terra satellite. The image shows San Francisco area recorded by the visible and near infrared bands which have a spatial resolution of 15m

MODIS: (Moderate Resolution Imaging Spectroradiometer) is an instrument aboard the Terra satellite which views the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands. The spatial resolution of this data ranges between 500m to 1000m. Application for mapping the landmass of Pacific Island Countries is limited.



An image of the MODIS sensor onboard Terra

MTI



The Multispectral Thermal Imager is a satellite sponsored by the U.S. Department of Energy. MTI's primary objective is to demonstrate advanced multispectral and thermal imaging, image processing, and associated technologies that could be used in future systems for detecting and characterising facilities producing weapons of mass destruction. The satellite's sensor has 15 bands and onboard recording facility by using onboard memory to store the images. It is the first hyperspectral sensor recording data from the Pacific in spectral resolution usable for mapping at 1:50,000. The first four channels covering blue, green, red and near infrared allow, with 5m resolution, a mapping at 1:10,000 scale. SOPAC is currently trying to identify a joint project with the Space and Remote Sensing Sciences Group of the Los Alamos National Laboratory. The problem is the restriction in data usage to USA only.

Praise for GIS & Remote Sensing Work at the SOPAC 28th Session

Lala Bukarau

During the SOPAC Governing Council's 28th Session held at the Tanoa Hotel in Nadi, Fiji Islands, there was nothing but praise recorded for the quality of GIS and Remote Sensing work, back-up service and training that is being carried out by the various units of the SOPAC Secretariat. Several island countries that had readily embraced GIS tools as the most efficient way to go forward in environmental management, clamored for in-country training workshops on how to properly set up and maintain GISs in their countries. Countries that received basic training workshops during the year requested follow-up workshops of a more advanced type to bring their technicians and professionals up to speed on the use of this versatile tool.

SOPAC is the regional organisation that has been given the mandate by the Pacific island nations for GIS and Remote Sensing because of its extensive experience in applying these tools in their ongoing work program tasks. The policy paper endorsed by the SOPAC's Governing Council and its Technical Advisory Group recognised the Secretariat "as the most appropriate institution to provide the link between remote sensing data suppliers, hardware and software suppliers, research institutions and the end users of the systems and data where the cycle of design, deployment and training is essential."

SOPAC's acquisition of the SeaBat multibeam mapper enhances the array of equipment available for SOPAC's remote sensing data collection in its member countries. The SOPAC Governing Council approved all the GIS & Remote Sensing activities proposed for the year 2000, and the establishment of new positions that would further strengthen the service but cautioned against liaisons with other institutions involved in the same area of technical work that would prove to be a financial liability to SOPAC.

Nine out of the twelve SOPAC Work Program Units use GIS and remote sensing in carrying out various components of the SOPAC Work Program, and the IT Unit under Les Allinson's stewardship is charged with overall coordination in this field.

Solomon Islands GIS User Group

Bryan Pitakia

The User Group

The Solomon Islands GIS User group started in 1995 between Solomon Islands Water Authority and Solomon Telekom has now got a number of members (users). The user group now consists of:

1) Solomon Islands Water Authority (SIWA)
2) Solomon Islands Electricity Authority (SIEA)
3) Solomon Telekom
4) Lands Department
5) Forestry Department
6) National Census
7) Rural Water Supply and Sanitation (RWSS)
8) Solomon Islands College of Higher Education (SICHE)
9) National Malaria Control Unit, Ministry of Health

There are other ministries who have indicated their interest but are yet to join. They will probably join when they actually set-up a GIS in their organisation. However, the user group welcomes all potential GIS users in the group. The user group mentioned above includes current GIS users and those who have the software and information but are,as yet to, set up a GIS.

Monthly Meetings

The user group has monthly meetings and in three meetings held this year (2000) a number of interested users attended the meeting. New ideas are introduced at every meeting. In 1999, the users observed the world GIS day and has set up an awareness at the Solomon Islands College of Higher Education and through the media (local news paper/FM radio). Although it was small, a number of people came to the show and were amazed at the importance of GIS in the country and how others countries used GIS.

Excutives

This year the user group has elected a committee to look after its interests and monthly meetings of the user group. The committee consists of:

Chairperson: Gilmor Pio (SICHE)
Secretary: Bryan Pitakia (SIWA)
Members: Telekom, Lands, SIEA, Forestry

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