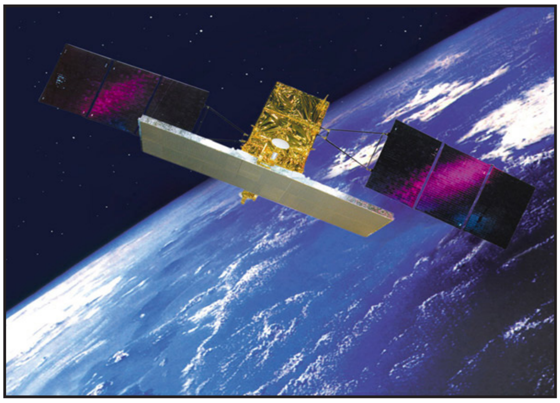
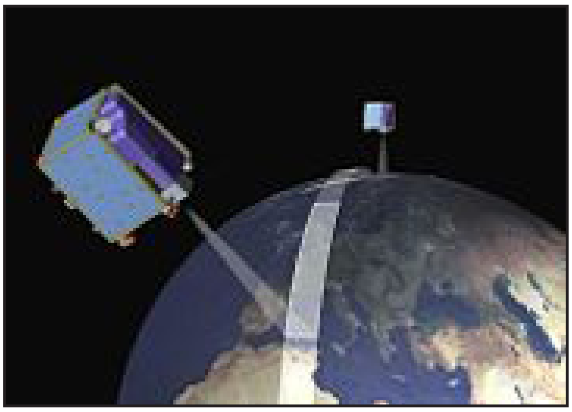
Pacific Islands
GIS&RS NEWS

The Newsletter of the GIS & Remote Sensing Users in the Pacific
Newsletter - 02
November, 2008

New Satellites Provide Images for Pacific Island Countries

There are two new satellites having onboard storage devices to capture images from Pacific Island Countries. GeoEye operated by a company by the same name records with 40 cm spatial resolution in panchromatic mode and 1.6 m in multi-spectral mode. This is an increase of one third compared with QuickBird, which was the satellite with the highest resolution so far. Whether the user can access this data is another question, as US military laws do not allow the sale of data with resolution better than half a metre to other countries. Nevertheless, this is additional high-resolution image data, which is important as the QuickBird satellite is often booked out. The spectral coverage is like IKONOS or QuickBird, blue, green red and near infrared.





Another satellite constellation is RapidEye, which will deliver data with 5 m resolution (resampled from 6.5 m) but on a daily basis. The satellite system consists of 5 independent satellites, which were launched together and will ensure a frequent coverage (for more details see page 2). The satellites record five bands: blue, green, near infrared and red edge, further information see on page 2.

Besides Radarsat 2 and TerraSAR-X there will be another high-resolution radar satellite called COSMO. Like RapidEye it is a constellation of several satellites (4), which will be launched during the next months and years one after another and will ensure a daily coverage. The data will be uploaded through 20 ground receiving stations and will be distributed by Telespazio through a known company, EGEOS, at the end of 2008.

The Pacific Islands GIS&RS User Conference will provide a complete update of satellite image data available for Pacific Island Countries. We expect a complete overview of all image data and reselling companies providing space-borne information for the Pacific. Please visit the website of the conference www.picisoc.org

Wolf

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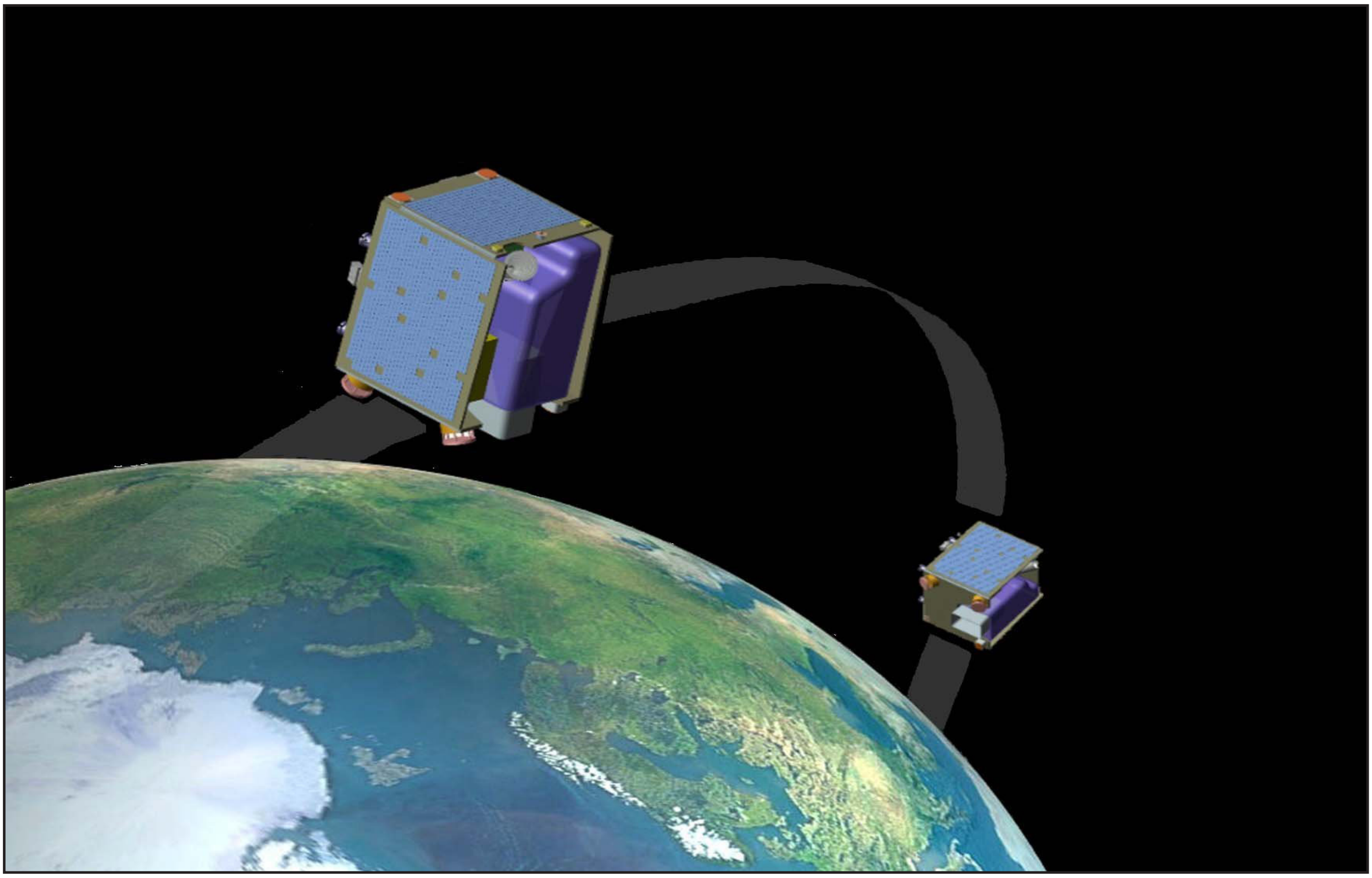

The 5-satellite RapidEye constellation was successfully launched from Baikonur on August 29, 2008. All five satellites have been integrated in a one-only launch vehicle. MDA's subcontractor Jena-Optronik GmbH of Jena, Germany, designed and built the imaging payloads. MDA is the prime contractor of the RapidEye mission that is delivered turnkey and in-orbit to RapidEye AG. MDA has direct responsibility for the mission design, the spacecraft design and the ground planning and image processing system.

RapidEye is a commercial small satellite mission that will enable global monitoring of the Earth's surface. The constellation is designed to provide insurance, food companies, farmers, government and other agencies and institutions throughout the world with valuable, up-to-date, customised information products and services of the highest quality. The RapidEye system will image any area in the world at all latitudes between +/- 75 degrees within one day and cover the entire agricultural areas of North America and Europe within an average of five days. The multi-spectral pushbroom style imager onboard each spacecraft will image the Earth in five spectral bands, scanning a 78 km swath at 6.5 m resolution resampled to 5 m.

Source : http://www.spacemart.com/

Haze Removal and Atmospheric Correction of Satellite Images

Etuate Cocker, SOPAC

Haze interference is a frequent problem when interpreting satellite images especially in Pacific Island Countries where local haze appears in most images due to marine environment influence. Image pre-processing is part of a SOPAC service which will now include both haze removal and atmospheric correction. Haze is removed semi automatically masked out by the software and as a further step the contrast in these areas is enhanced by adjusting the image features to the contrast outside haze affected areas. The image after the process shows more details enabling better image interpretation. Haze removal does not work over water.

Figure01: *Multi-spectral QuickBird image before (left) and after haze reduction. The software only can remove haze not clouds.*

High-resolution images are not recorded at one time from the nadir view like the old generation of satellite image data such as Landsat. The new generation finally provide image data usable for 1:10,000 scale mapping a requirement for most Pacific island Countries where Landsat was restricted to 1:50,000, however, these images are stitched out of different image tiles recorded at different times. To create homogeneous images these influences have to be eliminated as far as possible and atmospheric correction does it. All parameters are taken into account such as view angle, main land cover type, spectral coverage of the sensor, atmospheric conditions of the region, location together with day and time of recording leading to sun angle calculation and regional calibration of the sensor (offset). Then the software calculates the influence of these parameters and subtracts it from the image data. When the corrected image tiles are stitched together the image contrast between the tiles minimises and the image has better overall contrast. Atmospheric correction works also over water bodies. However, both procedures atmospheric correction and haze removal require multi-spectral images they do not work with panchromatic or pan-sharpened image data.

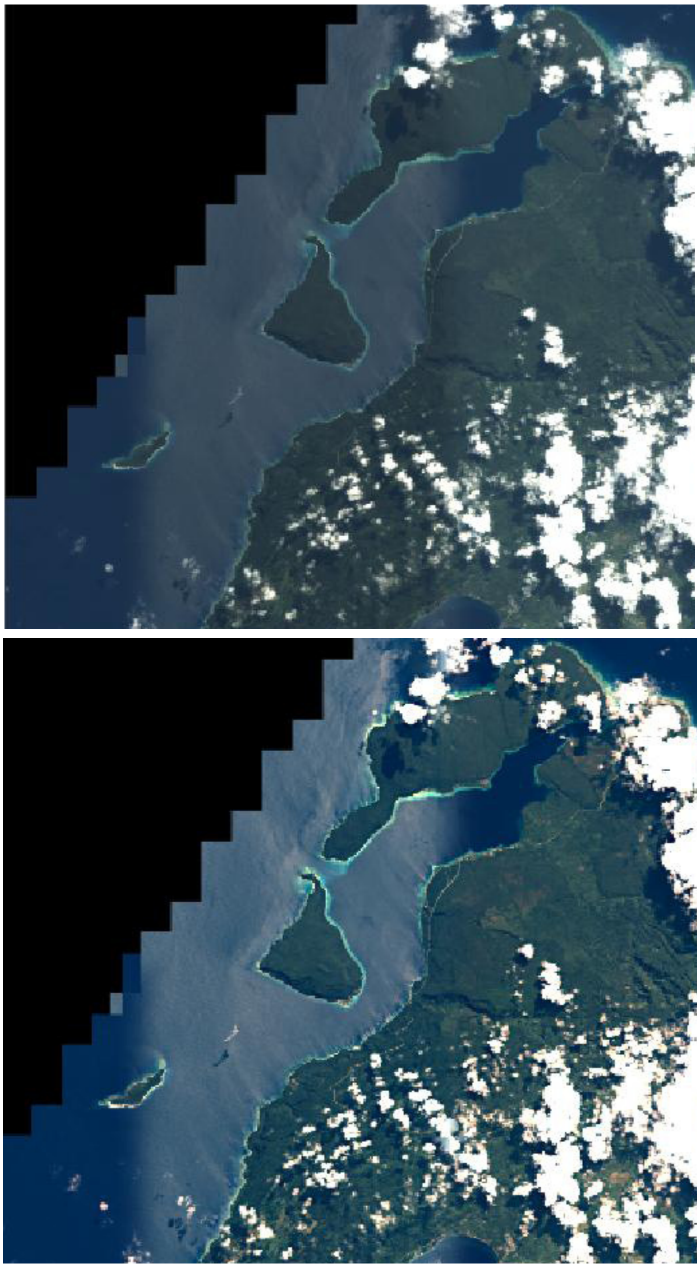

Figure 02: *Three QuickBird image tiles mosaiced together. Left: the uncorrected mosaic where the difference in the vegetation area is clearly visible. Right: the same mosaic but atmospheric correction was applied for the tiles before they were stitched together. The difference on land between the tiles is not visible, however, the difference on water areas increases. This will be eliminated through applying the correction for water bodies and land separately.*

Both haze removal and atmospheric correction were tested at SOPAC and work well. It is now up to the user in SOPAC's member countries to request the service. The presentation explains how haze removal and atmospheric correction works and shows the results.

Utilisation of TerraSAR-X Image Data for Coastal Mapping

Wolf Forstreuter, SOPAC

Introduction

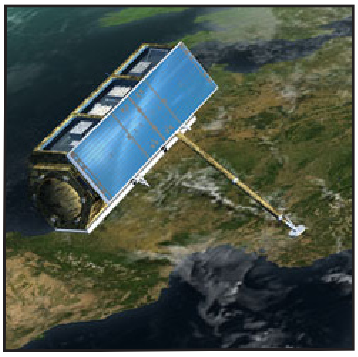

Figure 01: *TerraSAR-X.*

TerraSAR-X (see Figure 01) is the first satellite equipped with a high-resolution radar system capable of recording with a spatial resolution down to 1m enabling mapping at 1:10,000 scale. SOPAC ordered data for the Nadi area in Viti Levu to map water bodies after cyclone Gene. There is a general interest to also map coastlines applying new type of radar data because the data is cost effective and can be recorded shortly after coastal erosion has taken place, as radar beams penetrate even thick cloud cover, which normally disables optical recording of images during or shortly after cyclones.

The TerraSAR-X Image

The Nadi image was recorded on Valentines Day (14.02.08) at 17:48 GMT, which is 05:48 on 15.02.08 Fiji time. The data cost € 1,375 (USD 2,186) and covers an area of 30 x 60 = 1,800 square km (see Figure 02) with 3 m resolution (StripMap), which is equivalent to € 0.8 (USD 1.2) per square km. SOPAC could download the image data 12 hours after recording. In comparison: IKONOS or QuickBird image data would take an average of more than a month to receive the images after the satellite takes the pictures and cost USD 15 to 20 per square km.

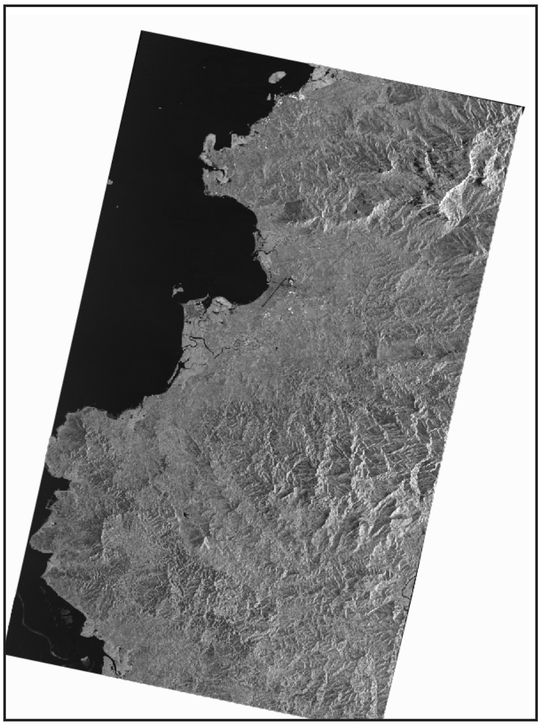

Figure 02: *Coverage of the TerraSAR-X radar scene (30 x 60 km).*

The TerraSAR-X image data arrived rectified to UTM WGS84. Compared with pan-sharpened QuickBird data, which arrived rectified to the same coordinate system an average difference of 183 m was recorded. Both types of image data has to be re-rectified in the Pacific.

Coastline Mapping

Interpreters normally utilise the colour difference when delineating on QuickBird or IKONOS images between a) vegetation indicating land or b) sand and water indicating the area covered by the sea. The radar sensor is not sensitive to colours; the sensor records the intensity of the beam reflected from the target back into the sensor which is influenced by the angle of the objects surface towards the sensor, the texture and even the type of the material. Water normally has a very low reflection as the beam is reflected away from the sensor and water bodies appear black. The mapping of the coastline is therefore theoretically very clear and mapping with pan-sharpened QuickBird data providing 5 times higher resolution (60 cm) resulted in the same waterline (see Figure 03). However, there are some anomalies in other areas where the radar data based mapping creates a different line between land and sea compared with QuickBird image data based mapping (see Figure 04). The reason is not related to coastal change between 2006 when the QuickBird images were recorded and Valentines Day 2008, it is the difference in tide. On 15 February 2008 at 05:48 it was just one hour before a very low tide (0.7 m below normal low tide). Sand was dry and created a high reflection.

Conclusions

Radar images of the new generation such as TerraSAR-X and also RadarSat-2 provide a space-born image data source enabling coastline mapping at 1:10,000 scale.

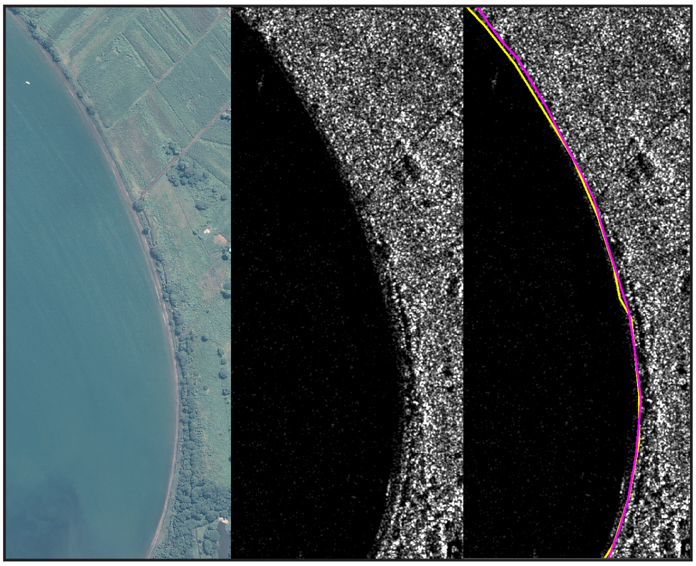

Figure 03: *Comparison of coastline mapping using TerraSAR-X data 3 m (black and white) and pan-sharpened QuickBird data 60 cm. If there are no parts which are not covered by water the mapping is accurate within 1:10,000 scale limits.*

Radar data can be recorded shortly after erosion takes place when the area is normally still under thick cloud cover.

For coastal mapping, data has to be recorded during high tide and not during low tide.

Radar data 10 times more cost effective.

Some reasons that TerraSAR-X data can be delivered much faster than image data of optical sensors, are as follows:

- The radar satellite can record also during night time and therefore has more over flights.
- The radar sensor can penetrate clouds and every programming to record a target area creates images, whereas optical sensors might record clouds and the customer has to wait until a next free onboard storage capacity allows to records the area again.
- The radar data can be received via internet, whereas currently the data of optical sensors are subject to complicated purchase and delivery procedures, which result in several weeks or months between request and receiving the image data.

To be able to geometrically rectify high-resolution radar images, rectified high-resolution image data with

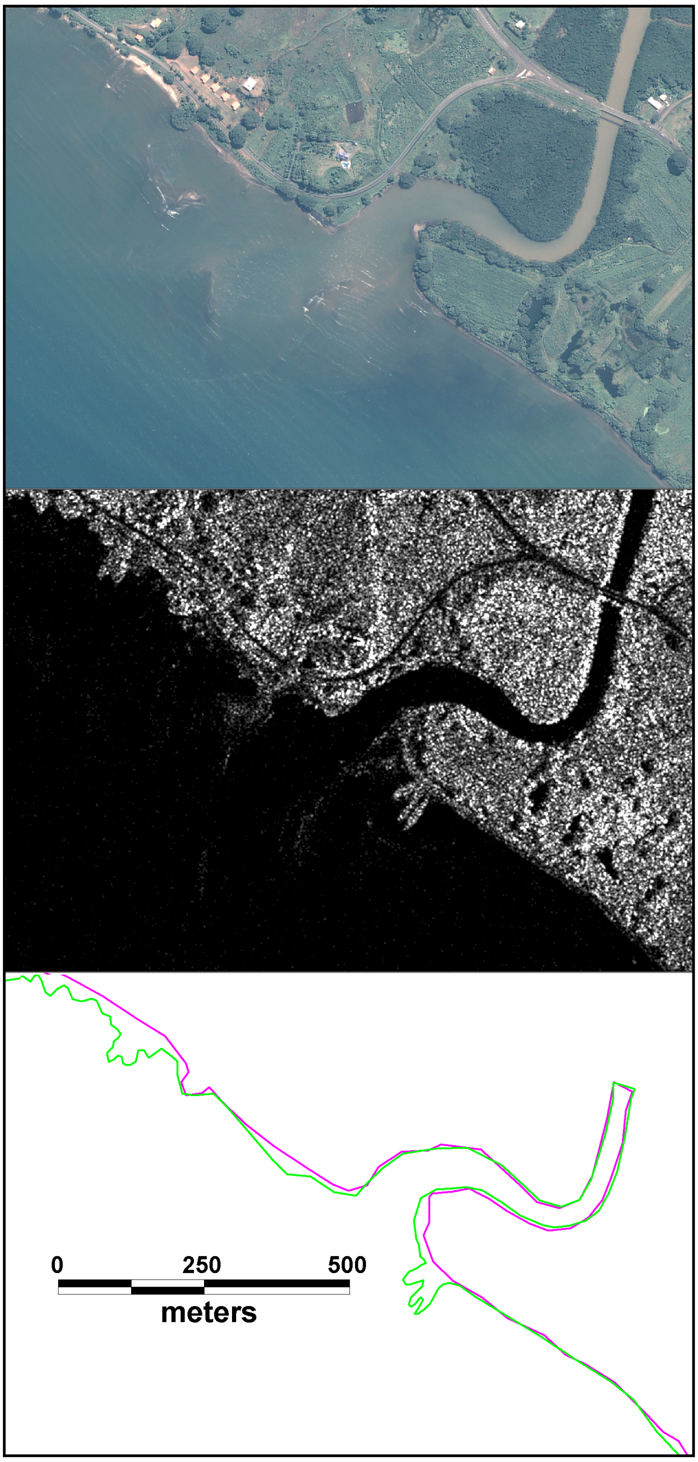

Figure 04: *During low tide areas not covered by water have a reflection like real land areas and an interpreter is not capable to see that these parts are sand-banks normally covered by water, which is possible with optical image data.*

sub 5 m resolution has to be available or a network of corner reflectors has to be established. This has to be integrated in the Reference Image Point database, which is currently in the design phase.

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Reference Image Points

Wolf Forstreuter (SOPAC) & Malcolm Archbold (BECA)

Introduction

Experience shows that geo-referenced satellite image data received for Pacific Island Countries are often not correct (see Figure 01) and have to be checked and mostly geometrically corrected. During the discussion on day four of the Regional GIS&RS User Conference the outline of a Reference Image Points (RIP) network was discussed and the need was addressed by several Pacific Island Countries. RIPs are points of known coordinates (X, Y and Z), which are also visible in the image. The setup of existing ground control point networks of several Pacific Land Departments are not usable as these points are not necessarily visible in the image data. It was therefore decided not to speak about Ground Control Points but speak of Reference Image Points.

Characteristics of RIPs

To ensure that RIPs are visible in the image data features have to be selected, which have contrast against the background. At the same time the RIPs must have the required accuracy for the corresponding image scale. For example pan-sharpened QuickBird images have a resolution of 60cm and the RIPs therefore must be located with decimetre accuracy.

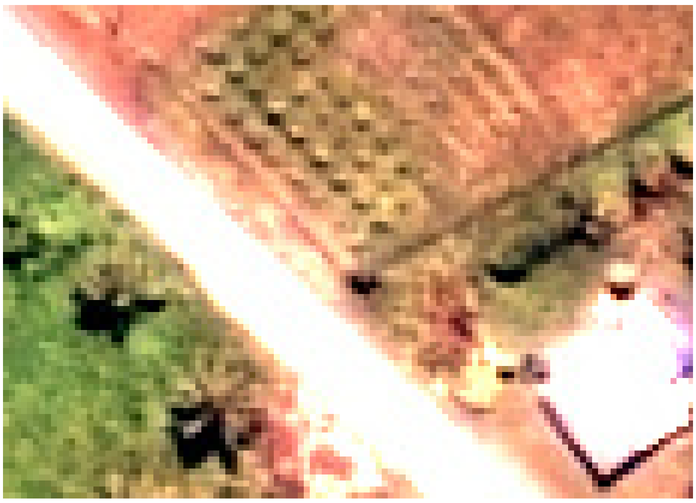


Figure 01: *A fence corner as reference image point. 60cm width is clearly visible in the pan-sharpened QuickBird image. Red the location of position recording, green the corresponding position in the geo-referencved image data.*

In semi urban areas corners of fences provide good references, as linear elements such as fences are mostly visible far below the image resolution. The 20 cm concrete foundation of the fence in Figure 01 is clearly visible and the corner point can be exactly located on the image. Sometimes point features provide a strong contrast against the background such as the base of the flagpole in Figure 02. In urban areas roof corners can be utilised if a GPS survey is possible in such areas. So far, the situation in rural areas and especially in forested areas has to be explored, as there are no experience in the Pacific yet. Possibly permanent marker have to be established.

Survey of RIPs

Like the features of RIPs the survey has to also follow the requirements of the image scale; this refers to the

Figure 02: *Through the high contrast to the grass around the flag pole foundation of 60cm diametre is clearly visible in the image data (pan-sharpened QuickBird). The centre of the foundation can be recorded as reference image point.*

field data collection and the post survey treatment.

Field Survey

1:10,000 scale (multi-spectral IKONOS image data) requires 2 to 3 m accurate RIPs and a GPS enabling differential correction is sufficient for the work.

1:5,000 scale (pan-sharpened QuickBird image data) requires a totally different GPS setup, survey grade necessary which can analyse the carrier phase and provide position data in centimetre accuracy. For the survey the base station has to have a locations in cm accuracy. This can be achieved by either selecting and existing ground control point and getting the coordinates (X, Y, Z) from the corresponding Land and Survey Department or by establishing a dedicated Absolute Reference Point (ARP) as shown in Figure 03.

To establish a ARP the receiver has to record for 24 hours in static mode. Next the Base Station Points (BSP)

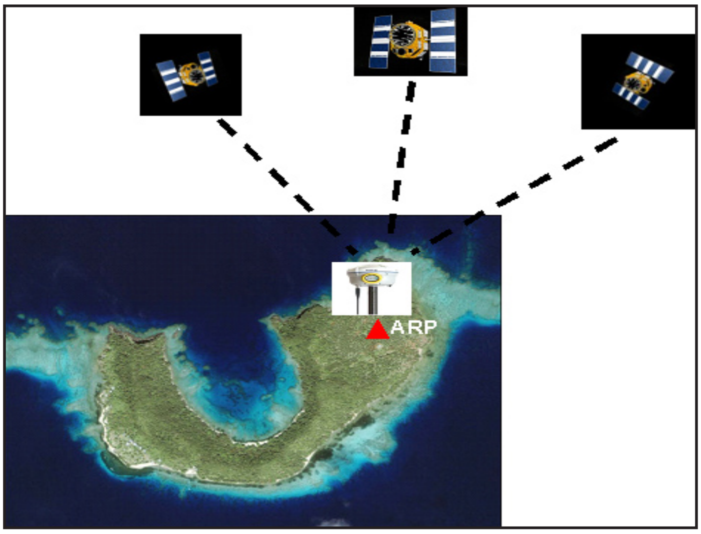


Figure 03: *Survey grade receivers and 24 hour recording in static mode is necessary to record Absolute Reference Points.*

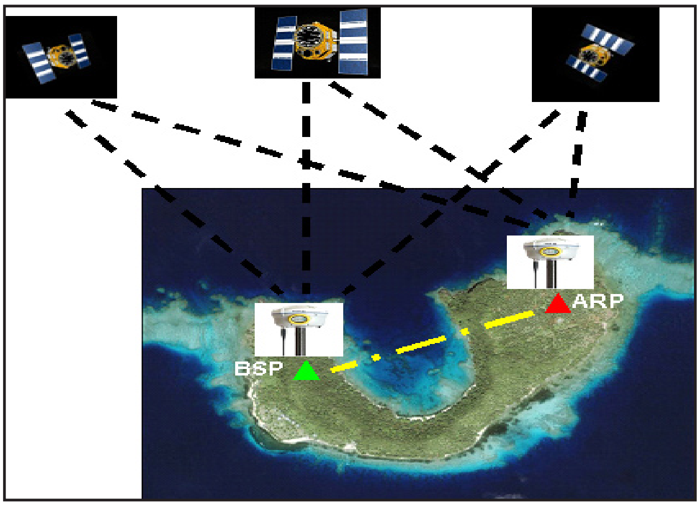


Figure 04: *To establish Base Station Points (BSP) one GPS receiver has to be positioned at the BSP and one at the ARP and both receivers have to record for one hour in static mode. This allows the base line calculation by the GPS software.*

have to be established where both a) the base station receiver; and b) the rover unit record simultaneously for 1 hour in static mode (see Figure 04). Having done this, the base station can be established at the BSP and the RIPs can be surveyed in a circle around the base station of maximum 15 km. On each RIP the GPS receiver has to record for 0.5 hour (see Figure 05).

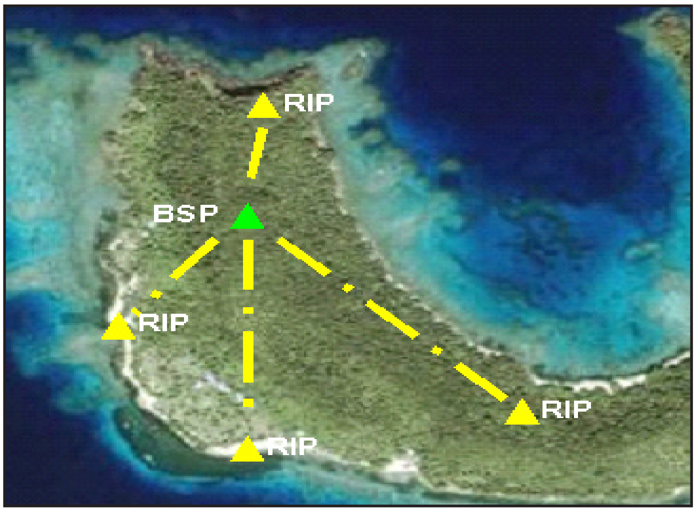


Figure 05: *After the BSP is established the Reference Image Points can be surveyed in an radius of maximal 15km around the base station.*

Post Field Survey Correction

After finishing the survey of RIPs the user has to download data from the two closest South Pacific regional GPS base stations. The data is available on Australia's GeoScience website: <www.ga.gov.au/geodesy/slm/spslcmp/network.jsp> Having the data the position of the ARP has to be adjusted using for example Trimble Geomatics Office software. The BSPs and RIPs have to be ajusted as well.

Database

During the discussion at the Regional GIS&RS User Conference it was also stated that there should be a RIP database, which can be accessed by everybody including the satellite data distributing companies. This is currently on the way, Franck Magron at SPC Noumea is establishing it. This database will keep for every RIP:

1. A small subset of the image data, where the RIP is visible,
2. The position data and survey details of e.g. the base station was utilised, the correction by AUSLIG, etc.
3. A photo of the feature in the field
4. A description of the feature and the features location.

The database will be online at www.picisoc.org.

Summary and Recommendations

To utilise image data as backdrops with correct image geo-reference a RIP database is essential. If all users who produce image backdrops work together funds and effort can be saved. Solutions have to be found to establish RIPs in areas covered by vegetation or on reefs. New solutions might also be necessary to include RIPs for radar data.

Digital Elevation Model of Beaches Using RTK GPS

Wolf Forstreuter & Joy Papao, SOPAC

Introduction

SOPAC purchased RTK GPS equipment worth FJD160,000, which allows position data collection providing an accuracy sufficient to produce 20 cm contour lines ideal for mapping low lying areas.

Purpose of Beach DEM

Sand or beach movements on atoll islands have the potential to cause significant problems for housing and infrastructure. It is important to monitor where the sand drifts away and where beach is building up. The reasons for these shoreline movements are still not fully known; however, understanding it would allow one to to take certain procautions to reduce negative impact.

Contour lines of sub-metre accuracy are required to map the shape of the beach and the DEM will then provide the basis for any monitoring. A re-survey after one or two years or directly after the visible impact of a storm can be used to compare both DEMs in a quantitative way and the volume of sand washed away or accreted can be provided using available software.

The purpose of this particular DEM in Laura at the end of the Majuro lagoon was to test equipment and software under real conditions. Therefore the situation was simulated where slands and atolls often have no survey points. This requires a base station to be established as an absolute reference point.

Technical Steps of Survey and DEM Establishment

Setup of Base Station (Absolute Reference Point)

A base station provides a fixed point to which all other points of a survey are referenced. To setupa new reference point a base station has to run 24 hours without interruption to average the position calculated. This set of position data is then referenced to other base stations in the Pacific region to further increase the accuracy of the position. This is handled by AUSPOS Online GPS Processing.

In the beginning the team tried to establish such an absolute reference point of the roof on the EPA office; however, the system did not work properly. Then a location of the roof of the high-school in Laura proven safe enough to keep the base station running 24 hours without interruption.

Survey and Data Correction

For the DEM a grid of 4m intervals was surveyed where the surveyor is guided by a little map to the next survey point. There he initialises the data receiving and gets an acoustical signal after sufficient position receiving and moves to the next survey point. After the end of survey the data has to be downloaded from the rover or control unit and imported into Trimble Business Centre. During the import antenna height and other survey details can be corrected. From the Trimble software the file can be exported as ASCII format. during a RTK survey the rover positions are corrected each time it receives a signal from the base station.

The DEM Establishment

The ASCII files were then imported to Access for data editing, which will be explained in the next chapter. From Access the data sets were exported again to ASCII (txt). The files required a renaming with dat extension before ERDAS allowed an import. The ERDAS import was handled by the surfer module, which at the same time converts the X, Y and Z values into a DEM.

Problems Faced and Solutions Developed

Base Station Recording

The base station was equipped with an internal battery and a car battery which was supposed to take over after the internal battery runs out. This did not work as the base station simply switched off after the

Figure 01: *Local base station established on a engine block at the beach. The GPS antenna is mounted on a pole to increase the height and subsequently the field of view.*

internal battery was exhausted; however, it worked when the internal battery was removed and the base station was connected to the car battery right from the beginning.

Vegetation and Radio Signal

Under ideal conditions a rover is able to receive base station corrections up to 40 km; however, where vegetation is obstructing the line of sight even with a distance of 3.5 km the rover could not receive the base station signal. This is the case when surveying close to the vegetation line.

The solution was to setup a second base station a suitable distance to the vegetation line providing the line of sight to the rover units. Every day this local base station was established at the exact same position. The averaged local base station height was used to adjust the surveyed beach position data.

To decrease the influence of obstructions the local base station was mounted on a pole, see Figure 01.

Survey of Reef Flat

The reef flat was included in the survey, which did not produce expected results related to:

a) the point distance: At a level of 20 cm contour line interval the grid distance of 4 – 5 m is too big. An approximately 1m grid would improve the result. With a 4 – 5 m grid and a pixel size of 1 x 1 m, local unevenness is overrepresented.

b) Bigger size holes in the reef flat cannot be surveyed without risking expensive equipment. These important parts of the reef flat are underrepresented in the DEM.

c) The low water mark, where the waves are breaking on the reef could not be surveyed correctly as it was too dangerous for the equipment even at low tide. GPS equipment is not suitable for surveying the low water mark line. The horizontal position can be extracted from satellite images and the vertical position is known.

The Erosion Line

The erosion line is a break line created during highest water and strong wind. It indicates the frontline of the beach erosion see Figure 02. It was possible to survey most of the line due to adjustment of the equipment, see next section on 'Vegetation Cover'; however, creating the DEM with ERDAS software eliminates the break line as the ERDAS module surface levels it out.

Figure 02: *The erosion line. During extreme tides the water washes the sand away and the tree roots are free. This line moves inland and is an impoertant indicator of the ersion status. At this location it forms a step of about 1 m height.*

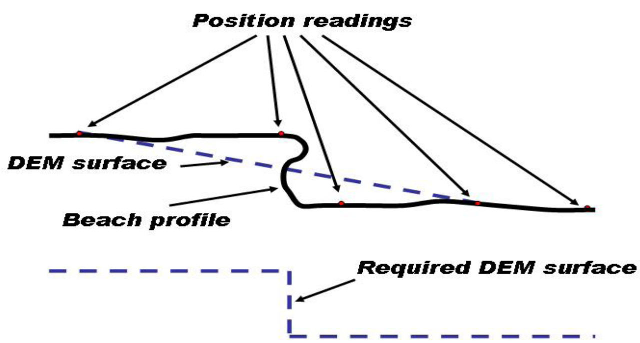


Figure 03: *The DEM was established with ERDAS and this software with does not provide a module creating breake lines. The DEM surface is equalising th erosion line as position readings of the second line are acting with each other.*

Here software is required, which has an inbuilt break line function. ERDAS is providing this now as an add-on module to ArcGIS but not within its ERDAS Imagine modules. The Trimble Business Centre has a break line function; however, the product is far too expensive to be distributed in addition to ERDAS.

Vegetation Cover

RTK GPS is sensitive to vegetation cover making it difficult to survey the erosion line. It helped to mount the rover on two joined poles increasing the height above ground from 2 m to 4 m. It was possible to map most of the erosion line without losing the satellite signals. In cases with very thick vegetation cover (see Figure 04) the increase did not help. In this case the

Figure 04: *At this beach location the erosion line was under thick tree cover. GPS reading was impossible.*

DEM was edited as follows: a) In MapInfo environment points were created along the position of the erosion line, which provides the X and Y values; b) In Access the Z value of these points was added from points with recorded height nearby; and c) These points were added to the GPS readings and the DEM was re-created showing a more realistic situation (see Figure 08).

Multi Path in Vegetation

While surveying the erosion on one location (see Figure 7 arrow A) the GPS received positions with Z values 3m higher than the surrounding values. The real reason is still unknown and assumed as an effect of multi path. These obviously wrong values were manually edited in Access and the DEM re-created without these anomalies.

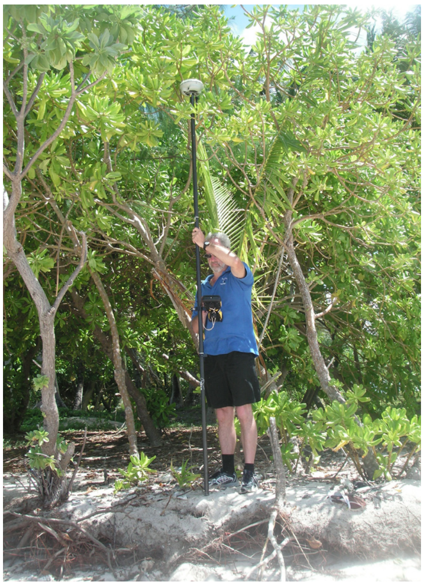


Figure 05: *Mounting the rover on a 4m pole allowed GPS receiving under thin vegetation cover.*

Outline of DEM

In cases where the DEM does not have a round shape the Surfer module of ERDAS fills these gaps with height values interpolated between the outline height values. This is visible in figure 7, where the arrows (C) indicate the recorded posiitions and the surfer module creates a slope towards the outline. There are two ways to avoid this:

1) The DEM can be clipped along the outline of recorded positon data using ERDAS modules; and

2) position points (indicated with arrow C in Figure 7) can be shifted to the outside line and the slope disappears (see Figure 8).

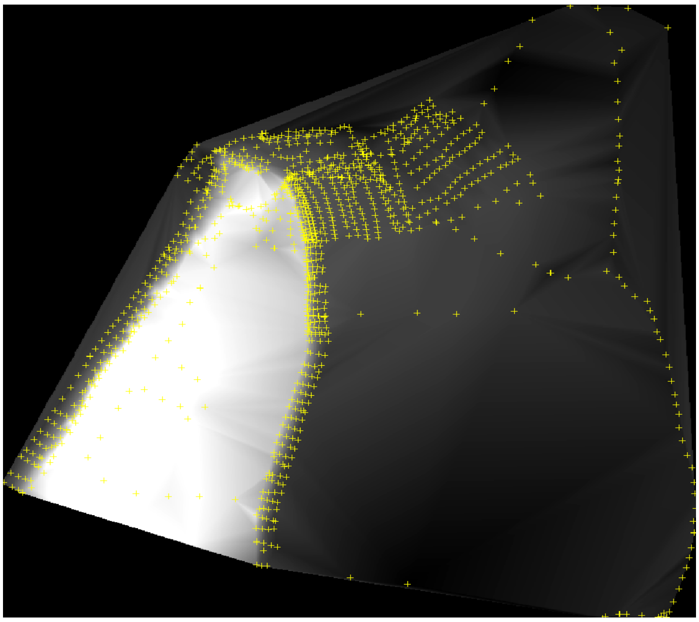


Figure 06: *The DEM display in ERDAS Imagine software imported to MapInfo and overlaid with position data.*

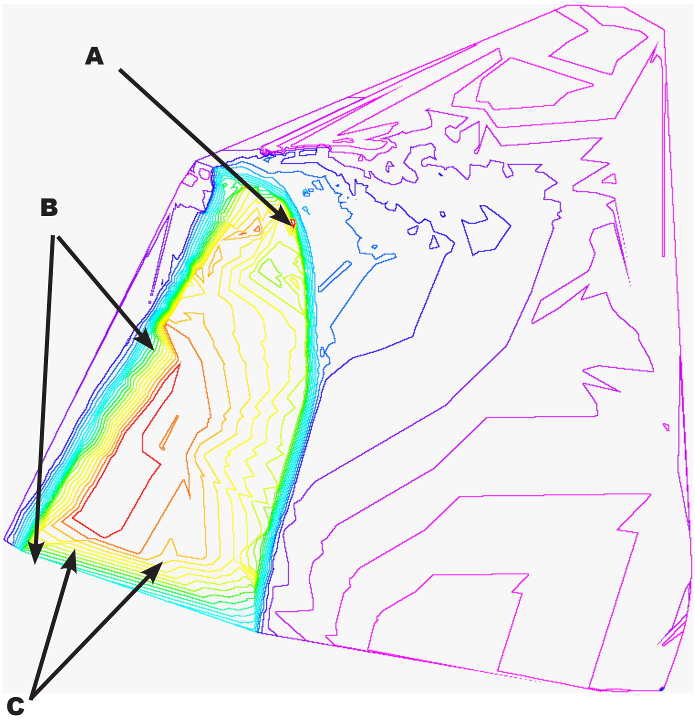


Figure 07: *20cm contour lines created from the DEM. A = wrong height receivings, B = missing points due to thick vegetation cover, C = position points which should be recorded on the outside line.*

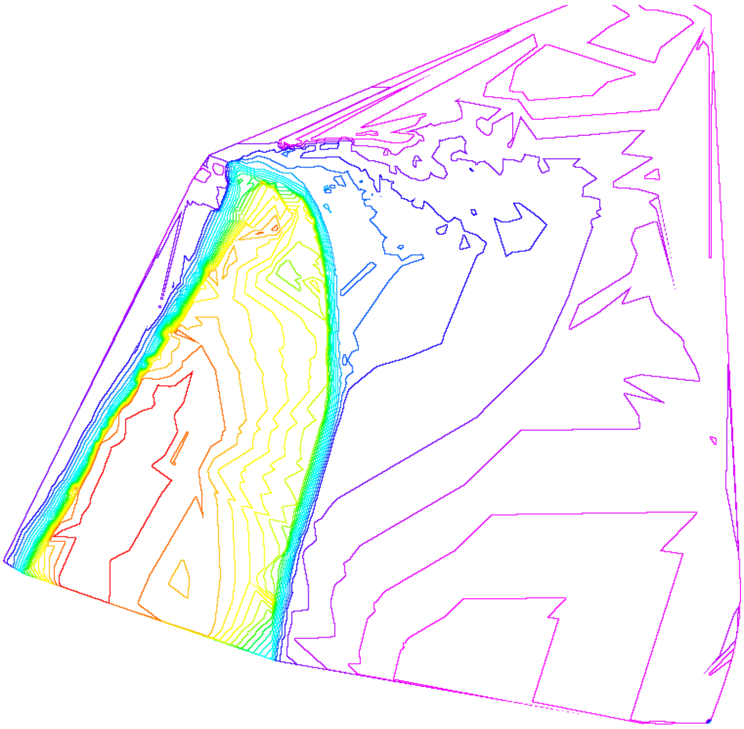


Figure 08: *20 cm contour lines created from the DEM after height and position correction.*

Summary and Recommendations

The RTK GPS equipment was purchased to have a tool for creating beach DEMs. The system fulfils the requirements: "a DEM with 20 cm contour line can be created".

The idea was to establish successively DEMs for all low lying islands and do re-survey wherever erosion or accretion is visible. This is only feasible if responsible staff from the countries carry out the data collection. The test survey showed that:

- the setup and method still needs development;
- the DEM creation should be carried out directly after the survey in country allowing a re-survey for areas where data is not properly captured;
- survey and DEM establishment including data cleaning and DEM editing require detailed knowledge about system and data handling;
- DEM creation and editing is limited in ERDAS, which is currently the most distributed image analysis software in the Pacific Island Countries. Break lines and other features are not implemented and there is apparently no plan to include this in the ERDAS Spatial Modeller. Other software such as the Trimble Business Centre or ArcGIS with special additions would be expensive to purchase for all Island states.
- The GPS system itself did not perform as well as was expected after the test survey (sandbank in the Suve reef).

Currently the system is used for other duties than beach DEM establishment. SOPAC staff should further develop the method allowing it to be used by others. A team of technical SOPAC staff should staff should be set up to do the surveys together with staff from the Pacific Island Countries.

Shallow Water Bathymetry Utilizing Satellite Images

Etuate Cocker, SOPAC

Many Pacific Island countries are fringed by reefs enclosing shallow water lagoons which are integral parts of their ecosystems. The mapping of these areas can be difficult, time consuming and costly in particular if changes in these areas are to be monitored. Hence the application of Shallow Water Bathymetry Utilizing Satellite Images has provided an alternate option for addressing this issue.

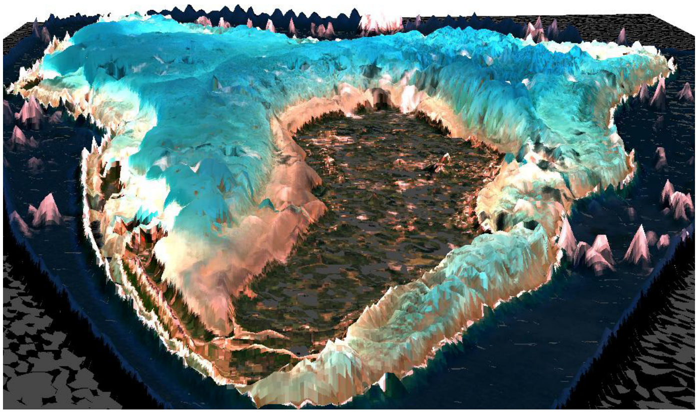


Figure 01: *The 3-Dimensional QuickBird Satellite Image of Aitutaki Lagoon, after applying the correlation function of reflectance and depth.*

As an example, the ability to determine the sea bottom with digital elevation model (DEM), can be useful in order to reduce future tsunami impacts. This can be achieved through modeling to identify areas that are more susceptible to the impact from such events. Government Fisheries and Agricultural Departments can also benefit from sea-bottom modeling for marine species habitat mapping, sediment deposition and transportation impacts as a result of erosion from the land, and other applications that contribute to developing projects for the management of coastal and marine resources.

Satellite sensors measure different levels of energy that penetrate through and are reflected from the earth's surface back into space. The penetration of light through sea and its reflectance into space can be roughly estimated with the function ¨Log of blue divide by Log of green¨ (Figures 01 & 02). In developing the methodology the sample data comprised of water depths measured using single beam sensor. These were then compared with reflectance data to determine a correlation function between both data sets (Figure 03). A skeleton of the function was developed in "ERDAS Spatial Modeler" that applied the derived function to each estimated depth from Log of blue over green to compute a more accurate depth. A second sample was extracted from measured depths for comparison with the result so as to further establish levels of confidence and the effectiveness of the methodology.

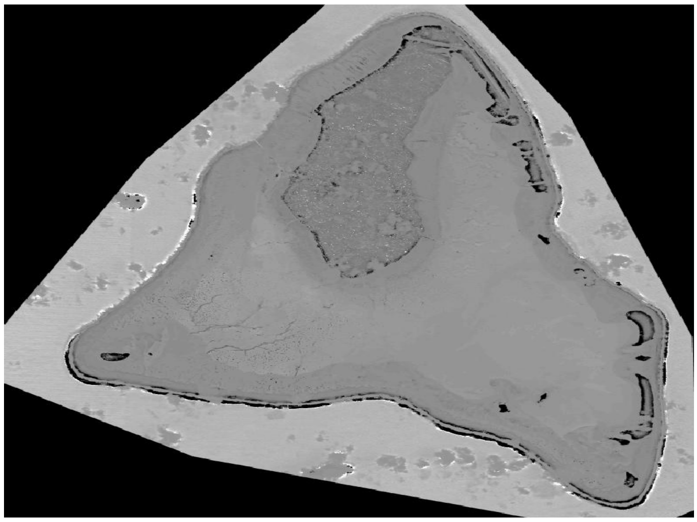


Figure 02: *The result of dividing log of blue over log of green that extract estimated depth according to attenuation of light.*

Results show that for up to 8 metres of water depth there is a strong correlation between reflectance and water depth. For depths over 8 metres, the levels of confidence and accuracy deteriorate significantly (Figure 04). As for accuracy of the method, the results from comparing measured and derived depth shows more than 70% of derived depths are closer or equal to measured depths.

This method is deemed applicable for use in the Pacific where there are extensive shallow water or

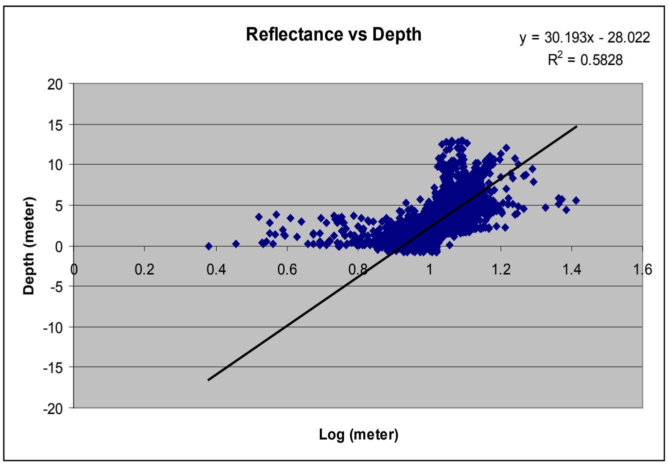


Figure 03: *The graph shows the correlation between log and depth and the corresponding function.*

lagoon areas although the methodology requires simplification through automation of methods if it is to be utilized extensively in Pacific Island countries.

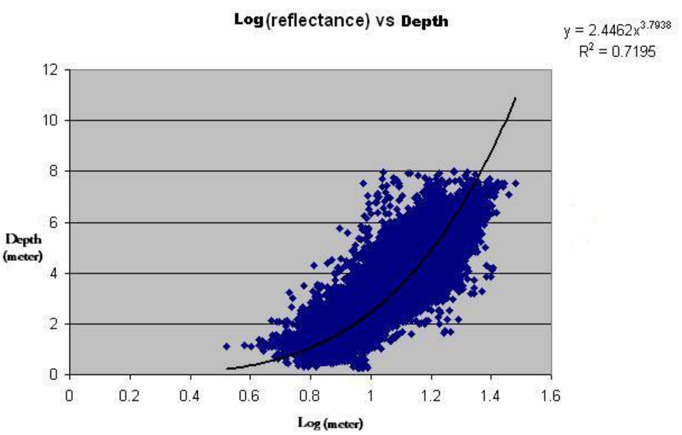
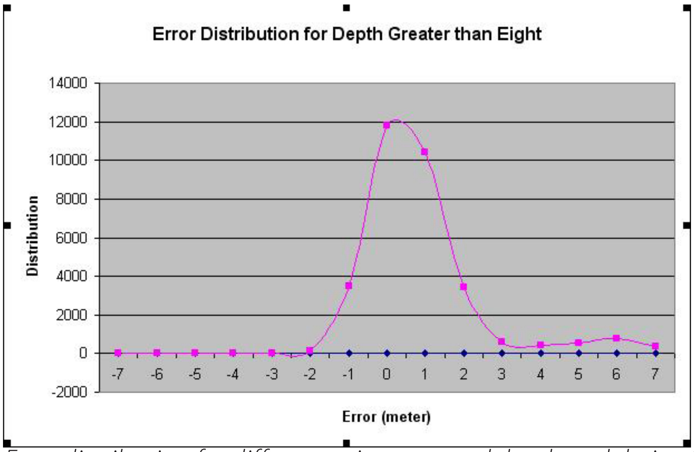
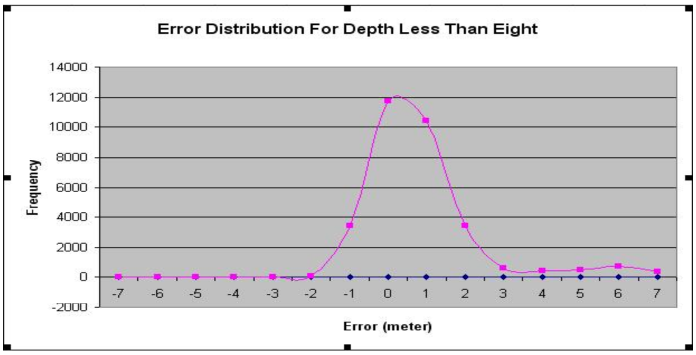


Figure 04: *The graph shows correlation power function for depths greater than 0 and less than 8 m.*



Error distribution for differences in measured depth and derived bathymetry data on all second sample data.

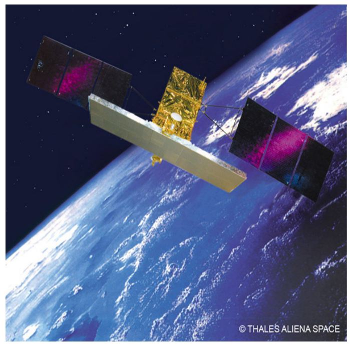


Error distribution graph for differences in measured depth and derived bathymetry depth for depths less than eight metres.

This is a proof that the method is applicable for depths less than eight metres which is of interest to pearl farmers on finding suitable farming locations.

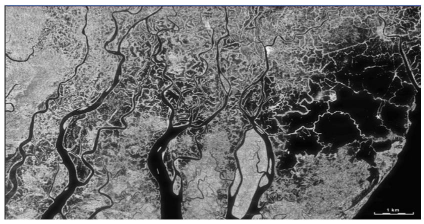
Italian COSMO Satellite

Wolf Forstreuter, SOPAC



COSMO-SkyMed (COnstellation of small Satellites for the Mediterranean basin Observation) is funded by the Italian Ministry of Research and Ministry of Defence and conducted by the Italian Space Agency (ASI).

The system is a constellation of four satellites using high-resolution radar to observe the Earth day or night, regardless of weather conditions, for civil and military use. Its purpose is to monitor the globe for the sake of emergency prevention (management of environmental risks), strategy (defence and national security), and scientific and commercial purposes. Two satellites were launched in 2007, the third in October 2008 and the fourth satellite needed to complete the constellation will be launched by the end of 2009.



Imagery of flooding in Burma (Myanmar)

Special features:

- Revisit Time of few hours;
- Fast Response Time
- High volume of daily High Resolution Image acquisitions
- Image Quality and Geo-location accuracy with different sizes, polarizations and points of view;
- Compatibility with Interferometric operations

The system can record with different options:

1. Stripmap
3 x 3m resolution and 40 x 40km scenes
15 x 15m resolution and 30 x 30km scenes

2. Scansar
30 x 30m resolution and 100 x 100km scene
100 x 100m resolution and 200 x 200km scenes

3. Spotlight
1 x 1m resolution and 10 x 10km scenes

There will be 20 stations around the world to download the data.

There is great potential for this service to reduce the response time, especially following a tropical cyclone.

Creating Digital Terrain Models from Fiji Topographic Digital Data Layers

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The Fiji Department of Lands and Survey has created a digital archive of the 1:50,000 scale Fiji topographic map sheets. Each sheet in this map series has been digitized and stored under the following layers: hydrology, terrain, vegetation, survey, structures and transport. The native format for this data is the MicroStation design file (DGN) file format. This article reviews a process of creating a digital terrain model (DTM) from a single map sheet from this data set, using ArcGIS.

ArcGIS has a variety of tools for creating DTM, and the tool that is used in this example is the Topo to Raster tool. Topo to Raster is an interpolation method specifically designed for the creation of hydrologically correct DTMs. It is based on the ANUDEM program developed by Michael Hutchinson at the Australian National University. Topo to Raster uses input from common terrain data sources such as contours lines and spot heights, and combines these with hydrological data such as stream lines, lake boundaries and sinkholes, to create a hydrologically correct surface model. The process uses a specialized interpolation algorithm that has been specifically developed for terrain modeling.

For this example, the M28 map sheet was used, which covers a coastal area in southwest Viti Levu known as Momi. The layers used were the terrain layer (containing contour lines and spot heights) and the hydrology layer (containing streams, lake boundaries and coastline boundaries). The datasets require error checking and editing before they can be used in this process. This pre-processing is required because the source data (the DGN files) contain errors from the digitizing process. For the purpose of this example, these errors are of two main types. The first is the consistency of the z-coordinate for the contour lines in the terrain layer (Figure 01). The DGN file has the ability to store features with x, y and z coordinates (similar to a 3D shapefile). In the terrain layer, all the contour lines are 3D lines, with the contour height represented by the z coordinates of the contour line vertices. All the z coordinates for a single contour line should be the same (since a contour represents a line of equal height), but errors in the digitizing process mean that this is not always the case. These errors are first identified using a geometry query and then eliminated through manual editing.

Figure 01: *The first error is the consistency of the z-coordinate for the contour lines in the terrain layer.*

The second main type of error is in the line direction of stream features in the hydrology layer. In order for the surface creation algorithm to function correctly, the streams need to be digitized in a downstream flowing direction. A number of stream features in the hydrology layer were digitized in the wrong direction (Figure 02). These errors were identified and manually corrected.

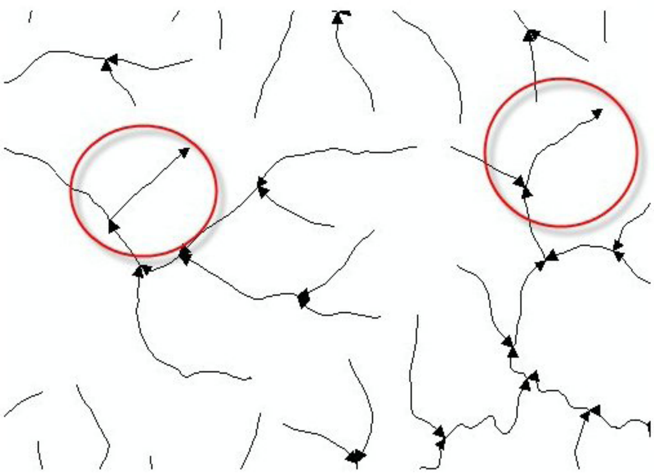


Figure 02: *The second error is due to a number of stream features digitized in the wrong direction.*

Another issue with the hydrology layer was the use of two lines to represent the banks of wider streams and rivers. The surface creation algorithm requires a single stream centre line for the entire area. In order to convert the double lines to single lines, the lines were first converted to polygons, and then converted to raster grids with a 1-m resolution. A thinning operation was then carried out on the raster grids to reduce them to a single line of cells (Figure 06), which were then converted back to vector lines. The final step was to extend the existing stream centre lines to snap to the newly created centre lines (Figure 07).

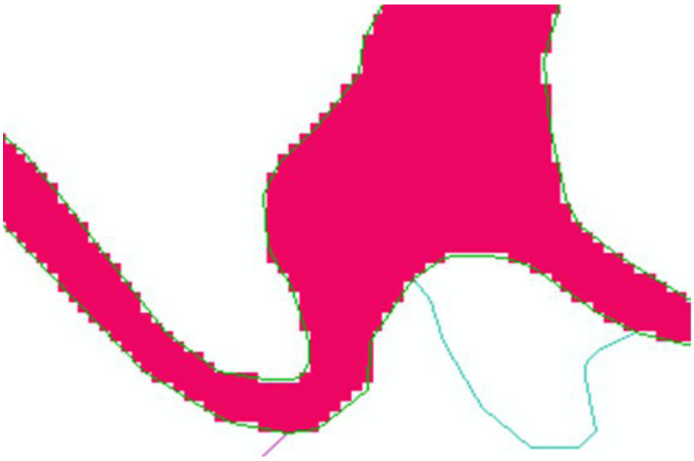


Figure 05: *The double lines are converted to polygons.*

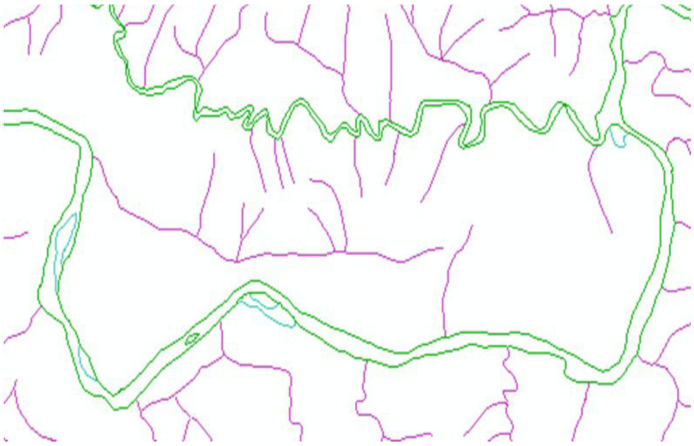


Figure 03: *Two lines were used to represent the banks of wider streams and rivers.*

The wider streams and rivers are drawn with double lines to represent stream and river banks (see Figure 03).

The double lines are converted to polygons (see Figures 04 and 05).

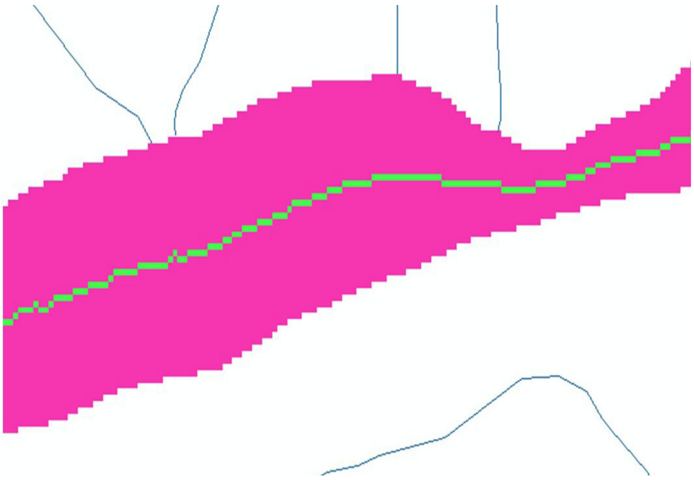


Figure 06: *The raster grids are thinned down to a single line of cells.*

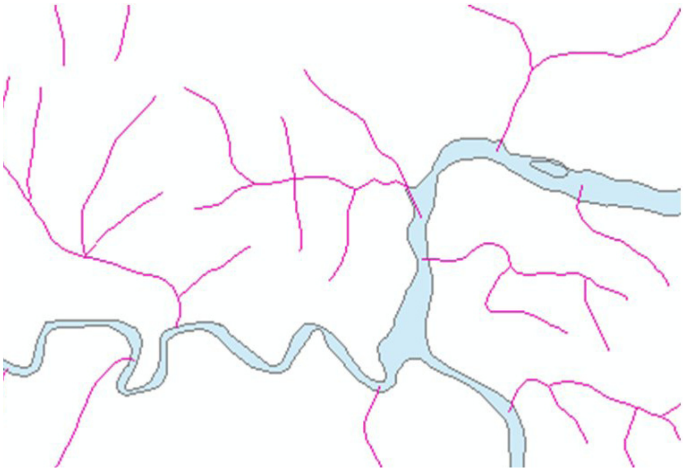


Figure 04: *The wider streams and rivers are drawn with double lines to represent stream and river banks.*

Figure 07: *The existing stream lines are then extended and snapped to the new stream centre lines.*

Once this pre-processing was complete, the Topo to Raster tool was run, with input layers for the boundary (coastline and map sheet edge), contours and stream centre lines (Figure 08).

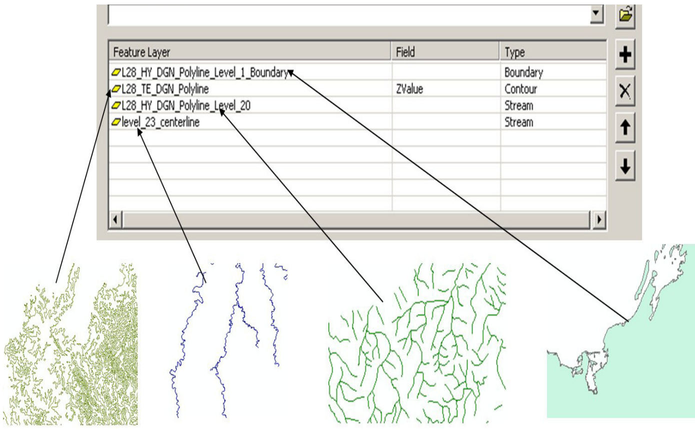


Figure 08: *Running the Topo to Raster tool.*

The resulting DTM was then compared with the topographic spot heights from the map sheet. It was found that over 53% of the spot heights were within 0 m to +10 m of the height from the interpolated DTM and 92% were in the -10 m to +25 m range.

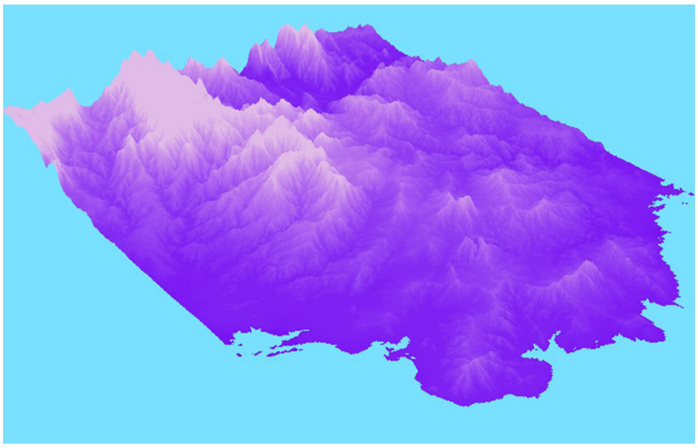
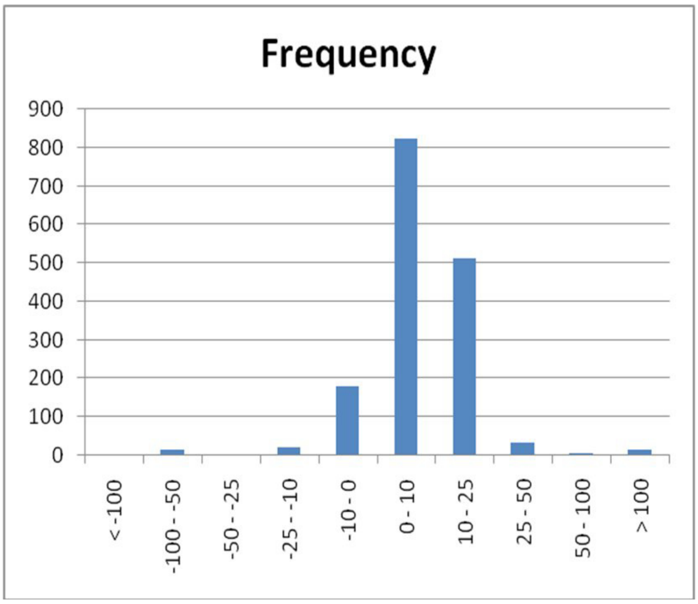


Figure 09: *The resulting DTM.*

Conclusions

In conclusion, the process of creating DTM from Fiji topographic digital data is relatively straight forward to carry out using the Raster to Topo tool in ArcGIS. The main considerations for wider use of this process are the inconsistencies and errors in the original DGN files. These errors need to be identified and removed before the tool can be properly used.

For more information and details on the queries and scripts used in the data pre-processing, please contact the author.



2008 Pacific Island Countries GIS & RS Conference

The 2008 Pacific Islands GIS User Conference preparation is well underway. The event is anticipated to be a better and bigger event.

The participation of Pacific Islanders and specialists from different areas will ensure another interesting discussion on method development suitable for the Pacific environment.

Social events are planned for each evening for a chance to catch up with colleagues around the region .

The conference will be held at the Unversity of the South Pacific from 2 to 5 December 2008

Applications to present at the conference is open until the 2nd of November

Registration is free and forms can be accessed through the PICISOC website: www.picisoc.org

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