

NEWS

NOVEMBER MEETING

Management Services Division,
Forestry, 14 November 1995

News Updates

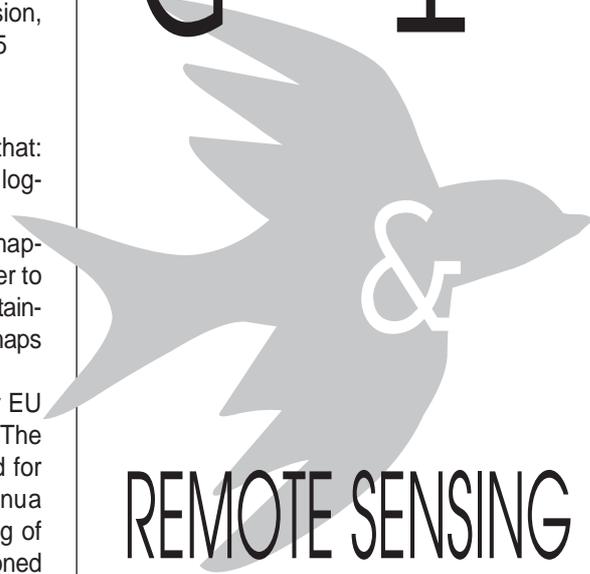
MSD Forestry announced that:

- Data capture of proposed logging areas is completed.
- FFI may request further mapping in Vanua Levu in order to be able to operate with sustainable yield which requires maps of 1:10,000 scale.
- Plantation mapping under EU funded project continues. The GPS survey is completed for most plantations of Vanua Levu. The stereo mapping of these plantations is postponed because of difficulties producing copies of the 1:25,000 aerial dia-positives.
- Forest change detection using new satellite data continues.
- ERDAS-Imagine is running under version 8.2, however, the system is not fully operational yet.
- The new addition of the forest type / forest function map was checked in the field and minimal errors were noted. These maps will be printed soon.
- Logged areas are still mapped on old LRD maps (1:50,000) by sketching.
- MSD-Forestry were faced with many hardware problems during the last weeks. Thanks to SOPAC and also to USP who helped.

SOPAC announced that:

- Production of mapping material during past month for review of the European Union funded Regional Marine Resources Program which included SOPAC-MAPS seabed mapping project.
- PEACESAT site is continuing operation and will be officially opened 1st December, 1995. Daily testing for one hour of full Internet connection. Other organisations encouraged to use this facility for regional communications.
- SOPAC, in joint partnership with

GIS



FIJI USER GROUP, Number 13 (9504), December 1995

the British Geological Survey (BGS), will be implementing a Mineral Resources Database in Vanuatu using Microsoft Access for organising the data and MapInfo for display.

- Ordered several datasets on CD from the National Geophysical Data Centre (NGDC), USA. The titles are: Geological Hazards Photos, Global

Relief Data, Global View Project, Gravity, Terrain Base, Southern Oceans Geophysical Data.

- Evaluating two Geology software applications for storage and display of borehole data. One is GDM, a French package while the other is Discover, an Australian product, which is a MapInfo add-on. An article

with the results of the evaluation will be published in the next Fiji GIS & Remote Sensing Newsletter.

MRD advised:

- Vanua Levu geological map is now available.
- A data base is available for underground water. This data mainly concentrating on Namosi.
- The network is now complete.

Lukemine Enterprise announced that:

- A private consultant is working with GPS for Fiji Sugar.
- Drainage location is being undertaken for PWD.

FLIS advised that:

- First draft of 1996 training program is available.
- A Hazard mapping pilot project has started with involvement of FLIS.
- The data capture of existing cadastral maps of Fiji will be completed by next week.
- The census boundary data capture continuous.
- One consultant is upgrading the FLIS GIS system and two other consultants are enhancing the other components including the information technology strategy.
- Two examples of the digital topographical map of Fiji at

This is the fourth and final newsletter for 1995 and the end of the year is a time to reflect on the successes and failures of the past twelve months. The best thing about 1995 was the increased awareness in the benefits from improved communications and the first footsteps by many into the world of the Internet. What were the things we could have done better? Well, besides producing more releases of this newsletter we could have made a more united front and obtained a more cost effective Internet service for Fiji. But we have 1996 to put both of these issues to rights.

Of course the end of the year is a time of food and drink and while on the subject of the former there was food for thought when Mike Poidevin made his final presentation in summarising his work in Fiji over the past two years. He reminded us of the importance of the GIS and Remote Sensing User Group Newsletter and the User Group itself in keeping government departments, regional organisations, commercial sector and interested parties informed of who is doing what and who is holding what data. He also encouraged the different groups within Fiji to work closely together and provide assistance and support to each other. This is especially true in relatively small countries where it is not practical to have specialist services in each group.

So if there is one message for 1996 it's to keep the user group committed to providing relevant information to the widest possible audience and to share data and services in the most cost effective manner.

All the best for 1996.☺

1:25,000 scale will be brought in two weeks to FLIS. This data will include contours and drainage.

- The last two missing map sheets of Fiji's topographical map 1:50,000 are available, now.

NLTB advised that:

- FLIS is assisting NLTB acquiring cadastral data to be used in NLTB ALTA Task Force.
- Since September NLTB is using InfoCAD GIS software running under Windows NT. NLTB moved from mainframe to PCs. First experiences are positive.

UNHDA advised that:

- A server for windows NT is installed
- They have no GIS at the moment.

Presentations

Mike Poidevin's presentation focused on the mapping project he was involved with during his two year contract with The Fiji Forest Resource Tactical Planning Project. The main points from Mike's talk were:

- His contract was to introduce a mapping capability into Management Services Division in the Forestry Dept. This involved the purchase of suitable mapping equipment and the training of counterpart staff.
- The equipment purchased included a Zeiss Visopret stereoplotter, computers, digitising tablet, ink-jet plotter and a GPS mapping system.
- Microstation is used for the digital mapping in Forestry.
- The mapping focus is on the production of 1:10,000 scale topographic maps of logging areas.
- GPS is used for control of the aerial photography, and for adding detail to the maps, and eventually the update of logging operations onto the maps.
- Forestry has worked well with other Government Departments in Fiji and regional organisations.
- Fiji is a small country and resources, both human and

equipment are scarce. It is important that the different groups within Fiji work closely together and provide assistance and support to each other. An example of this is where, Forestry uses the Lands Dept. PUG-IV for aerotriangulation marking, and Lands uses the Dept. of Forestry's PAT-M aerotriangulation software. The Lands Dept. has made use of the Dept. of Forestry's GPS system to acquire ground control points for their 1:50,000 scale mapping project.

Atu Laqeretabu explained the Village Profile Project which consist of a data base containing statistical data grouped for village, district, province and division. This survey stored in a data bank gives a picture of the rural Fiji. It reflects the status and can be used for planning the development. An important feature of this data base is the ability to analyse population water and sanitation relationship.

Discussion

It was agreed that the value of the Village Profile Project data would be more fully realised by integration with a GIS in order that the interaction between population pressure and the environment may be displayed and better understood.

Further to Mike Poidevin's presentation, considerable time was spend highlighting the limited technical resources and the large areas to be covered and how these problem can be addressed by through sharing of technical services, sharing of baseline data and expertise. The value of the user group was agreed as it serves as a forum for discussion and regular exchange of ideas and developments at technical level well as preventing duplication of effort and repetition of data capture.

The establishment of the GPS base station at MSD for differential correction was discussed

and several examples noted where this valuable services can be utilised by a wide audience of GPS users throughout the entire country. MSD and SOPAC explored the possibility of storing the necessary reference data in a suitable format for subsequent downloading via dial up telephone lines. For example, a surveyor in the Lau Group Islands could arrange for the reference data for differential correction of his GPS survey, to be stored in Suva and downloaded via telephone lines the next day to enable him to produce survey results with sub-meter accuracy.

DECEMBER MEETING

Fiji Land Information Service, 12 December 1995.

News Updates

Department of Lands reported from:

- the ISSIR conference which highlighted future use of satel-

✦ by J. Bhusan, V. Latilevu, E. Tupua, A. Wata, MSD, Forestry

FOREST TYPE MAPPING OF TAVEUNI

Introduction

Taveuni is an island east of Vanua Levu on which the eastern side was mostly covered with clouds. However, it has dense tropical rain forest containing rich flora and fauna. It was not possible to map it during the forest inventory carried out 1969. During the recent inventory of Fiji's natural forests no cloud free satellite data was available. Towards the end of 1994, it was possible to take cloud free aerial photographs at a scale of 1:50,000. Where other parts of Fiji's rainforest was mapped by satellite data analysis, for Taveuni aerial photo analysis was applied. A ZEISS Visopret was used to map the land cover types, road network, villages and drainage system. The map editing of this vector data was carried out by MicroStation. ARC/INFO was necessary to convert the MicroStation data set into an ERDAS readable format and finally ERDAS software integrated the forest cover into other raster data, necessary to calculate forest functions. The forest functions and forest cover was sent as TIF file and all vector data was sent as DXF file to a German printing company.

Stereo Modelling

The forest type mapping of Taveuni was undertaken using the 1994 AAM¹ photographs and field controls (GPS) established by Mike Poidevin (MSD-Forestry) for the Lands & Survey Department.

Altogether a total of 19 stereo models were set up which had been pugged and controlled by the air survey section of the Lands Department. Initially the aero-triangulation control

¹ AAM = Australian Aerial Mapping

- lite data
- the AURISA conference which concentrated on user applications on GIS and Remote Sensing

FLIS advised that:

- Systems are updated for topographic mapping.
- 1986 boundaries from Bureau of Statistics are digitised.
- Data transfer from NLTB is ongoing.

MRD advised.

- Further sections have been equipped with computer facilities.

MSD Forestry announced that:

- Forest cover mapping for Taveuni is complete. Aerial photographs were mapped by stereo plotter and transferred

to raster GIS via Microstation and Arc/Info.

- Data capture for Nadarivatu plantation at 1:10,000 completed and shifted to FMG
- Forest change detection continued for map sheets Suva and Nausori. An alarming decrease of mangrove and decrease of natural forest was noted. However, this will require field verification.

NLTB announced that:

- Data translation is an ongoing activity
- The first district has been translated from Infomap to Infocadd

SOPAC announced that.

- Phase one of the Vanuatu Mineral Resources Database will be completed this week which

will provide the Department of Geology, Mines and Water Resources with access to tabular and spatial information from mineral surveys which have conducted in Vanuatu over the past 40 years. The system is written in MapInfo and Access.

- SOPAC will be providing the technical expertise for implementing the Department of Environment GIS commencing January 1996.

Town Planning stated:

- The need to acquire computer equipment has been identified to assist in access to data from other departments.

UNDHA advised that:

- A GIS is needed and a system will be implemented early next year

World Wildlife Foundation reported that:

- There is considerable interest in applying GIS within their organisation to assist fulfilling their mandate.

Presentations

Ilaitia Navunisaravi, FLIS, presented the digitising of census boundaries. The Bureau of Statistics defines the census

boundaries on cadastral maps and FLIS is digitising these boundaries. The title for this project is CCMS (Computerised Cadastral Mapping System). There are several boundaries: one from 1976, one from 1986, and the new one for 1996. The latter will be completed in March 1996. The purpose of this project is to provide spatial data for elections, medical health centres and education centres.

Wolf Forstreuter presented on behalf of **Rupeni Anise** (MSD, Forestry) the new forest-type/forest-function maps which have been verified in the field and are now being printed in Germany. It was explained that the information contained in these maps will enable Fiji to undertake improved land use planning. These maps contain three types of information:

1. the forest types stratified into three densities of natural forest, hardwood and pine plantations, coconut dominated areas, mangrove areas, and non-forest;
2. forest functions classified into multiple use forest, preserve forest, protection forest, timber production plantation, and

extensions was done using PAT-M² software and the stereo-plotter (Visopret) by the Lands Department staff at the MSD. These photo controls were downloaded when mapping proper started. Some problems were encountered when the models were set up for absolute orientations. Quick liaison with the air survey unit resolved this problem. In fact they had done a new set of adjustments.

Since two flight runs covered the island all the stereopairs set up for observations were incomplete models. But this did not hinder accuracy of mapping. The tolerances were set up at 5 metres for x and y values and 3 metres for z. The actual mapping is more precise where tolerances were far below the accepted level.

The Photointerpretation and Mapping

On the black and white contact prints (aerial photo-

graphs) the following land cover types and other linear features were interpreted and delineated. Diapositives were used to do the actual mapping on the Visopret. The contact prints were used as a guide. All the classes of forest typing done was based on crown closure.

Non-Forests: Any zone with: no trees, shrubs, bushes and grassland were all identified as non forest. The texture allows a clear separation from forest.

Villages: Most of the villages are situated along the flat coastal plains, very few inland. Villages are easily identifiable by the houses, roads and other man made features in the surrounding.

Rivers and Creeks: Interpretation and mapping of these features was easy of the western side of the island due to less vegetation and deep gorges. Where dense vegetation and overgrowth was found mapping was less precise.

Scattered forests: Scattered forest was mostly found along river banks and gorges and along cultivated sides. Other such areas fell in logged over forest locations. The criteria was the crown closure of less than 50% including trees and tree ferns.

Medium dense forests : Medium dense forest was also based on the crown closure concept. Forest areas where 30 - 70 % crown closure was seen got classified as this type.

Dense forest: Dense forest typing was interpreted in regions where 70 to 100% crown closure was found. Most of these regions fall in-

land, on and around the main ridge running down in the middle of the island. A dense concentration is seen in the middle western fringes of the island.

Coconuts: The coconut plantations fringe on the coastal line extended up the main rivers. Most of the coconut plantations are seen in the north, south and the west of the island the east is covered mainly by forests (see Figure 1). The fine pattern of the coconut leaves gives a typical texture on the image which is easily identifiable.

Evaluation of crown closure is more subjective than the determination of other forest typing e.g. species

² PAT-M = aerial triangulation software of MicroStation Visopret

amenity plantation;
3. infrastructure which shows the river system, road network, and village locations and other annotations.

It was noted that access to new satellite data is critical for land use planners to have up-to-date thematic maps. The forest type information is currently being updated by MSD through the use of new satellite images.

An article by Rupeni Anise will be published in Fiji GIS & Remote Sensing News 9504.

Tevita Wara, NLTB presented the translation of NLC maps to standard format which can be integrated into other Fiji departments. The conversion of the NLTB data which was held in the now redundant Informap system

has been achieved through assistance from FLIS. NLTB had carried out capture of a variety of land use data through a comprehensive digitising program but the project was hampered by different grid systems and non standard software. These problems have now been overcome though by translating the old data into DXF format files which has been adopted as the agreed interchange format in Fiji. The project will be completed by mid 1996 and the data, which includes ALTA information.

Discussion

The problems of data exchange was discussed and FLIS noted that, following attendance at conferences, there are severe problems in Australia through the lack of common formats. These problems have been identified by the

identification. A number of factors enter into this estimation of crown closure:

- scale of the photographs
- quality of the images
- quality of the optics
- pattern and texture of the Taveuni vegetation

Because of the scale (1:50,000) small gaps may have been overlooked. However the quality of the aerial photographs and diapositives is excellent because of good illumination, good film material and professional developing. The optics of the Visopret allow good enlargement and provide a very clear view of the images. Taveuni's forest mostly falls into nature and forest reserves which are mainly untouched. Dense forest and scattered forests are more different than in other parts of Fiji. The interpreter have forest knowledge which proved to be essential for this job.

There was no field checks necessary because both interpreters have a good local knowledge about the island.

In a few doubtful cases advise was sought from other MSD foresters. It proved to be unnecessary to undertake further field checks.

Map Editing and Data Conversion

The mapped data went from the Visopret to MicroStation map editing. From there to ARC-INFO and finally to ERDAS.

MicroStation

All the features shown on the map were on different levels for ease of reference. Feature names i.e. text were placed along elements (creeks, miners, villages etc.) during map editing and the labelling of land cover was done during observation with some corrections during map editing.

Finally the whole of Taveuni Island were cut into 3 different sheets as per 1:50,000 mapping series namely S23 Rabi, S24 Taveuni, S25 Vatuvu Point. All the mar-

user group as early as 1992 and addressed by participants so that Fiji is able to easily exchange data among different organisations.

In remote sensing applications, the Pacific Island Countries, lag behind their neighbours, in particular Australia. If immediate steps are not taken to address this gap, then severe problems

will arise as this gap may widen sufficiently and it may prove impossible to overcome. It was suggested that a regional organisation, with suitable specialist skills be requested to take steps to reduce this problem.

There will be a Regional Remote Sensing meeting in Fiji during 1996. There should be thorough preparation before the meeting

SOFTWARE WARNINGS

Forestry have encountered a problem with Version 2.54 and Version 3.00 of Trimble Navigation Pfinder software. The problem relates to conversion to FMG (Fiji Map Grid). Heights computed are in error to approximately 20 metres. The problem has been logged with Trimble Navigation. For further information contact Epi Rakita at MSD-Forestry phone 320814.

Another problem was encountered with Image Alchemy software Version 1.7.7 during plotting raster data files. The plotter is not able to produce the output in the right size. The difficulty was discussed with Handmade Software Inc, USA and the company has found a solution. If you have problems to plotting with this Version of Image Alchemy please contact Wolf Forstreuter MSD-Forestry phone 322635.

Mike Poidevin, MSD-Forestry

ginal information normally shown on the 1:50,000 series were omitted.

Co-ordinate shifting was done using MicroStation were mapping on full FMG co-ordinates is not possible. The software controlling the Visopret only accepts truncated co-ordinates. There are two possibilities, one is to shift the global origin and the other a MSD written software which adds the missing digits to the truncated co-ordinates. Lastly, the files containing the planimetry data were converted to a DXF file by MicroStation software.

ARC-INFO

ARC-INFO software package is equipped with the module DATA CONVERSION which converts different file formats to ARC-INFO coverages. The program used called DXFARC. This module allows to display (DXFINFO) all layers created by MicroStation and to select only the forest cover.

MicroStation do not have the facility to relate a defined GIS value to every polygon. A GIS value is a numeric code indicating the land use type. MicroStation does this by displaying the annotation.

to ensure that the needs of the region are heard and adequate steps taken to meet those needs. It was noted that considerable effort had been put into the ESCAP funded meeting in 1995 but no actions or benefits have resulted from this meeting which was generally agreed to have been ineffectual.

Osea Tuinivanua, briefly outlined the research undertaken in Europe. He investigated the relationship between forest cover and water catchment using remote sensing data and GIS applications. He will be applying these techniques for monitoring forests within the region to forecast problem areas arising from deforestation within water catchments. The need for a portable satellite receiving ground station was highlighted due to the current as well as future lack of data for the region. It was agreed that Pacific Island politicians must be informed of this urgent need for satellite data in order that they will lobby at the appropriate level. The inclusion of a portable ground station in a "shopping list"

of an UN organisation is entirely inadequate.

Next Meeting

To be held first Tuesday February 1996 at FLIS.

SATELLITE NEWS

Because it is only six weeks since the last newsletter was published, there have not been many new developments.

EOSAT informed the newsletter that the 11 years old space vehicle **LandsatV** is still working well. The spacecraft's orbit inclination decreased and its equator crossing became earlier. This effects the illumination of the scenes because the sun angle is lower as Landsat's orbit is sun-synchronous. During 27 October and 29 November 1995 three orbit inclination adjustment manoeuvres were carried out and the scenes

will now have the same illumination as before the orbit inclination decrease.

EOSAT also advised that the Indian satellite **IRS-1C**, which data EOSAT is distributing, will be launched end of December 1995. As mentioned in earlier newsletter, the satellite has a on-board tape recorder and is able to collect data from Fiji. We expect the price list and further details and will publish it in the next newsletter.

RADARSAT International advised that its satellite has been launched successfully and the first images acquired 14 December 1995 are excellent. RADARSAT images are available for public in February 1996.

RADARSAT is equipped with Synthetic Aperture Radar (SAR) which penetrates clouds, smoke and haze. This sensor can record day and night and is able to download to stations in Canada, UK, Norway and Singapore. The satellite has also onboard tape facilities so data recording from Fiji is possible! RADARSAT announced that they will send a Videotape to SOPAC about the satellite launch and product information.

RADARSAT satellite **portable ground stations** are being developed as well as the IOSAT one described in the last newsletter. RADARvision from MacDonal Dettwiler provides a portable station capable to receive and process data from this satellite. ☺

The operator has to relate the GIS values in ARC-INFO environment. Table 1 shows the GIS values used for 1:50,000 forest type mapping.

Table 1. GIS values of forest type mapping. Agriculture and villages are classified as non forest, the land use type coconut with scattered forest was reclassified to coconut.

Water	1
Mangrove	2
Non Forest	3
Coconut	6
Scattered Forest	9
Medium Dense Forest	10
Dense Forest	11

Finally, the BUILD program of ARCEDIT correlates the GIS values with the PAT file.

ERDAS

The program ERDARC of the ERDAS data conversion module converts ARC/INFO coverages to ERDAS DIG³ files. The

³ ERDAS DIG file = file format of the ERDAS digitising program which contains vector data in ASCII form.

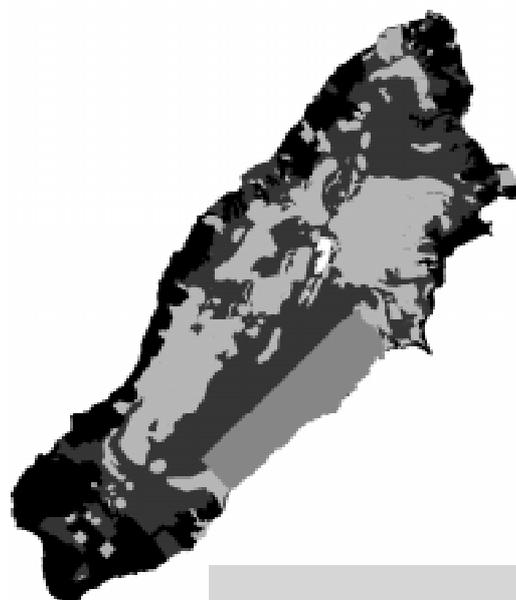
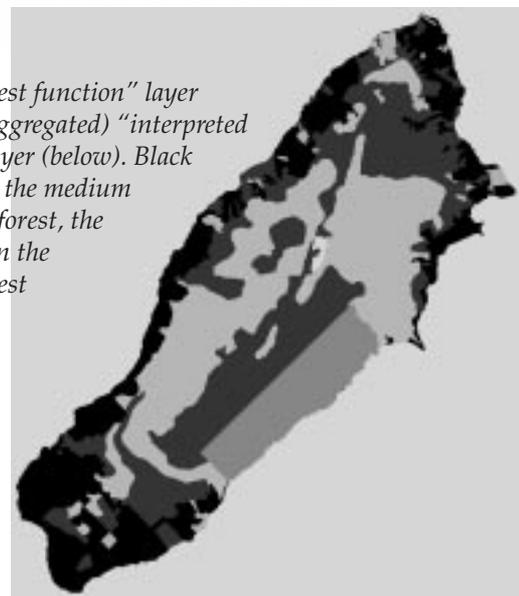


Figure 1. The "forest function" layer (above) and the (aggregated) "interpreted forest function" layer (below). Black indicates coconut, the medium grey multiple use forest, the lighter grey part in the west preserved forest and the very light grey protection forest. Non forest and water is indicated in very light grey and white.



FMG related data is treated as UTM during this conversion because there is no FMG option in the program. However, there is no distortion at 1:50,000 scale if this process is carried out separately for every map sheet.

Then, the ERDAS program GRDPOL converts the vector data of the DIG file to raster data by importing it into a raster background map-file. The data conversion of the forest cover layer is necessary to be able to carry out overlay analysis for determination of forest functions.

Calculation of Forest Function

The forest functions derive from GIS overlay analysis. Several sources of spatial information have to be combined to create this layer. The forest functions indicate which parts of the forest should be protected, preserved or can be managed for timber production.

- 1) In Taveuni there is a large forest reserve, a nature reserve and some areas of endangered species. These areas are shown by the layer "declared areas".
- 2) The slope layer was not created from the DTM⁴ because the DTM of Taveuni did not reflect the actual field situation. The slope classes were manually delineated on a topographical map and digitised.
- 3) Soil erodability classes derived from the digital soil map is available at MSD.
- 4) Mean annual rainfall and seasonality rainfall layers were already available for the island.

The forest function layer is calculated separately for every pixel. This creates a so called salt and pepper effect. For map production and management of these different forest categories the areas were aggregated into clusters (see Figure 1).

A further GIS overlay process combined the forest function layer with the forest type to produce a layer showing the forest types and forest functions in different colour.

Sending Files to Germany

The forest type / forest function was converted to TIF file by ERDAS software. This is a more common format compared to the normal ERDAS GIS file and can be used by a German printing company to download the data directly for offset printing. The linear features were send in DXF file format.

Because even airmail needs much time to reach Germany and because of outdated mentality of German customs, the files were send by telephone line. In order to reduce the cost all files have been compressed by ARJ⁵ software to approximately 10% of their originally size. Then the telephone link was established by modem and QuickLink software for uploading the data to the GOPA headquarters computer in Germany.

Summary and Recommendations

If recent aerial photographs at a scale of 1:50,000 are available, they can have more potential than satellite images:

- texture information was used for forest stratification which

is impossible with available satellite data.⁶

- all linear features such as creeks and small roads can be mapped which is impossible with satellite data

Vector data is difficult to be used for overlay analysis and for the calculation of forest function, overlay analysis is absolutely essential. The work carried out demonstrates that the integration of vector and raster data is possible.

Forest stratification requires a field experienced forester who is trained in aerial photo analysis. If an operator of such qualification does the aerial photo analysis less field work is necessary.

If there will be a regional remote sensing and GIS centre for forest monitoring it should have the potential to analyse aerial photographs and combine the analysis with raster data.☺

⁶ The aerial photographs and the optic of the Visopret have a very good quality.

✉ by Neil Nimoho, Department of Geology, Mines & Water Resources, Vanuatu

ESTABLISHMENT OF VANUATU MINERAL RESOURCES DATABASE

The British Geological Survey (BGS) and the South Pacific Applied Geoscience Commission (SOPAC) have been awarded a contract to establish a Mineral Resources Database. The project, funded by the British Government under its bilateral assistance to Vanuatu aims to establish an integrated geoscience information system with the primary objective of compiling all data sets relating to mineral exploration in Vanuatu.

The project which began in November 1995 and will be completed in 1996 is implemented by Gaynor Collins of BGS and Frank Martin of SOPAC. Initially the project will establish the database format and provide training to the national counterparts in the input of data and the maintenance of the data base. The national counterparts will be responsible for the input of data and the project personnel will return to complete the project in 1996.

The database written in Microsoft Access and MapInfo will capture and adapt key spatial data sets (geochemistry and mineral occurrence etc.) land access information and prospecting licences in digital form and will utilise a GIS to create integrated data packages for islands and regions of high exploration potential. Technical data that once took weeks to locate and collate will be available in an instant in GIS form, and the data can be regularly updated as new information becomes available on open-file. Other geo-technical data including magnetics and radiometric data will be compiled in future which will create a "one-stop-shop" computerised information system by linking spatial, text, attribute and image data through the GIS.

This project forms part of the Vanuatu Mineral Exploration Initiative, implemented in 1995 to assist the mining industry in the exploration for and development nation's mineral resources, and the associated to Government and consequently the community.

We acknowledge the support received from SOPAC in the maintenance and upgrading of our computing facilities and both SOPAC and BGS for the training of our nationals in GIS and database operations.☺

⁴ DTM = Digital Terrain Model, created in Germany from 1:50,000 topographic maps.

⁵ ARJ = data compression software which is used by MSD mainly for compression of raster data.

Evaluation of IDRISI for Windows



Version 1.0 – A raster GIS

Raster GIS

A raster GIS has most of the functionality of any GIS but it includes image processing facilities. It is therefore a natural link between Remote Sensing, which produces images, and a GIS that analyses and integrates them.

The choice of a raster GIS

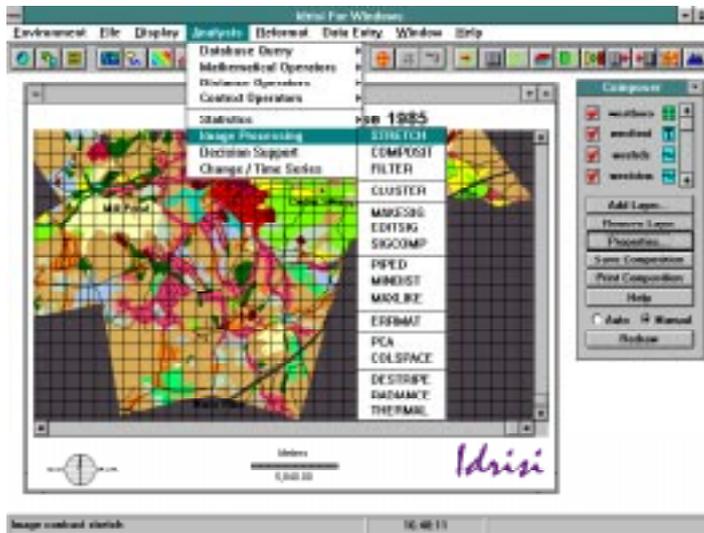
One of the tasks of SOPAC is to provide recommendations to its members countries about software. The use of a consistent set of computer tools within an organisation or region is a way to make easier training, support and exchange of data. Thus, in this way, a software suite has been defined by SOPAC for its secretariat as well as for the member countries.

This suite includes core office software and the more specialised application such as GIS, mapping and remote sensing. Some vector mapping applications are already included in the software platform and it is now time to evaluate a solution to address the need of the countries in terms of Remote Sensing, Image processing and Raster GIS. IDRISI for Windows could be a good candidate.

IDRISI for Windows

IDRISI for Windows is a raster based geographic analysis and image processing system developed by the Graduate School of Geography at Clark University. It is designed to provide professional level geographic research tools on a low cost, non-profit basis.

IDRISI for Windows is composed of a main interface and a collection of over 100 program modules. These modules provide capabilities for the input, display and analysis of geographic data. See Figure 1. The geographic data is stored in



map layers, each one being an elementary map component that describes a single theme. Furthermore, IDRISI for Windows is able to store in different map layers, geographic data of different types:

- Image layers;
- Vectors layers.

The structure of raster or vector layers is composed by one header and one data file. The data file of raster image is only a matrix of numbers. (in ASCII or binary format) Therefore, IDRISI files are very easy to manipulate. See Figure 2.

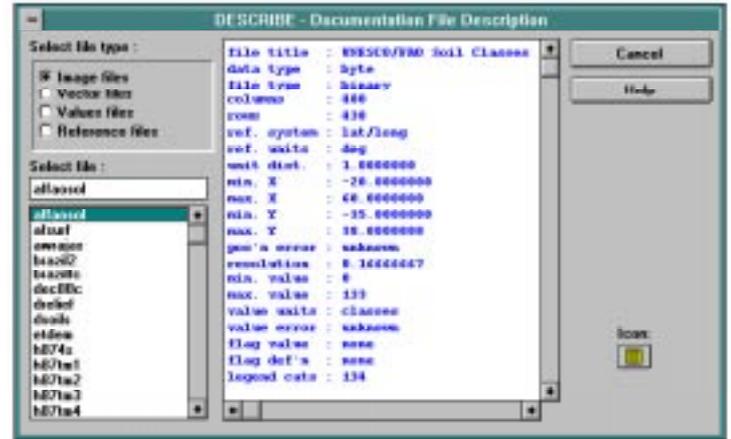


Figure 2. IDRISI for Windows provides a utility to see the headers or documentation files description.

IDRISI for Windows associates each vector or raster file to an attributes file, which describes all the non geographical data. A database Workshop provides the ability to manage these attributes.

Requirement

IDRISI for Windows requires an AT or PC/2 compatible computer with 512k of free RAM, a hard disk, and an EGA, VGA,

MapInfo NEWS

MapInfo Debuts MapInfo Professional (version 4.0)

MapInfo Corp., Troy, N.Y., introduced MapInfo Professional, the latest version of its flagship software, in October 1995. Available in Windows 95 format and 32-bit and 16-bit executables, the new version is the fourth release for

graphic user interface platforms and the ninth since the product first shipped in DOS in 1987. A Power Macintosh version will be released during the first quarter of 1996, according to Randy Drawas, MapInfo vice president of communications.

Release highlights include a new interface, designed around Windows 95 standards' intelligent client/server functionality, which allows users to access, change, manipulate and replace data from and between software programs in a server environment; Object Linking and Em-

Figure 1. IDRISI for Windows provides some interesting image processing capabilities.

Super VGA or 8514/A graphics adapter. A math co-processor is highly recommended but not required.

Evaluation of IDRISI for Windows

Advantages

- Image processing facilities: image restoration, image transformation, image enhancement, image transformation. IDRISI for Windows provides a lot of modules in those four topics : filters, stretch contrast, overlay, etc. See Figure 3.



Figure 3. This module allows to overlay 2 images and creates an output image of the result.

- An efficient Database Workshop (internal DBMS): ability to read, create and modify database files in its own format, or in Access format (.mdb), or in Xbase format (.dbf). See Figure 4.

bedding (OLE) technology which allows data visualisation and geographic analysis in mainstream business applications via drag-and-drop and integrated mapping functionality; bundled Global Positioning System (GPS) software from Blue Marble Geographics, Gardiner, Maine, which provides connectivity to commercially available GPS receivers and allows users to collect, display and track field data; and Version 4.0 of the MapBasic Development Environment, a MapInfo programming language for building custom vertical mapping applications.

According to Drawas, the release follows MapInfo's evolving strategy of segmenting its product line by releasing high and low-end products. "MapInfo Professional's release, users no longer will be bound by the desktop. And through (our low-end

products), we are trying to bring mapping into mainstream applications by map-enabling them or adding mapping elements and functionality".

MapInfo Professional, priced at \$1,295 upgrades and replaces MapInfo as the company's flagship software package. Its release follows the release of Data Map with Microsoft Corp, Redmond Wash. (see MapInfo, Microsoft Ready Data Map Feature for Release, "GIS WORLD, September 1995), and MapMarker as well as the initiation of its MapOpen program. According to Drawas, MapMarker 2.0, an address matching product that can be embedded in applications, will be released in December 1995 with enhanced algorithm functionality. In addition, a series of Data Map data applets, add-on products produced by MapInfo and its

id	name	population	cattle	sheep	goats
101	Arbaquga	202019	291570	126724	61002
103	Ticha	327960	394661	178198	26738
107	Dalaba	894880	948836	403335	185001
204	Mesakepa	232206	272100	48365	48067
207	Elbano	60630	65834	12467	114299
201	Daba	71770	96272	394	5985
206	Maba	190100	187881	49124	29701
200	Gawala	162940	208100	73726	7529
400	Galab &	142525	135846	75558	185223
400	Gardaba	240860	108249	55920	33718
401	Gama	267471	156712	38314	20747
404	Gafa	281762	118261	27642	22464
500	Ebaha Da	471531	469726	25306	5807
506	Kodalega	500444	373394	100990	44000
508	Meskel	140111	107701	6367	37744
504	Dababba	484020	448156	128106	43756
500	Elbano	280777	245247	58905	34694
501	Agara Med	440594	138302	145219	36364
507	Maba	326767	218901	105074	61700

Figure 4. The Database Workshop loads and save files directly in Access format.

- Import / export capabilities: .tif, .bmp, .dxf, .wmf, and Erdas, Grass, ArcInfo file formats, and more ...
- Easy to learn,
- Low price.

Drawbacks

- Version 1.000000 ! So, there is a lot of little bugs !
- lack of homogeneity of the Man Machine Interface,
- printing facilities: you print what you have on your screen. (No page setup, no layout)
- no Cancel command,
- no efficient macro language.

Conclusion

IDRISI for Windows has the most important capabilities of image processing with the ability to import and export image and data format commonly used in the region.

It appears to be a good application to complement MapInfo and promises to become a very powerful software with an extension of data management capabilities, new modules for image processing and a macro language.

It is a version 1.0 which says it all. There are a lot of details which need to be cleaned up for version 1.1 or 2.0.⊕

value-added resellers, will be released during the next several months. *GIS World - December 1995*

It is not known whether the GPS feature will be bundled with all software as it was announced in September by MapInfo that the bundle only applied to the first 10,000 units shipped. Price quoted is in US Dollars and the "international version" which will be distributed in the region by MapInfo, Australia, will cost con-

siderably more. This reflects MapInfo's national and international pricing strategy as well as the cost of doing business in the region.

There have been rumours circulating on the MapInfo Internet mailing list (MAPINFO-L) that a hardware key will be included in the "international version". SOPAC has ordered both MapInfo and MapBasic 4.0 as upgrades with an anticipated delivery of early January. A "first impressions" article will be in-

The New Forest Cover / Forest Function Map of Fiji

Introduction

From 1991 to 1993 a forest inventory was carried out for Fiji's natural forests. A forest inventory normally provides two products: statistical data about timber volume, species composition etc. and a map showing the forest cover and different forest types within the forest function. The map for Fiji's forests was also supposed to show forest functions such as production and

protection forest. The map production was delayed and the forest type mapping of the first edition of maps was not accepted. The second edition was checked in the field during November 1995 and the final print will start in Germany early 1996.

The map shows forest types, forest functions and necessary infrastructure for orientation in the field. The forest types are derived from

cluded in the next newsletter and the hardware key question will be answered.

There have been criticisms of MapInfo 4.0 on MAPINFO-L where users have questioned whether 4.0 is a full point upgrade from 3.0 or whether it should have been a revision number such as 3.1. These users are invariably running on Windows 3.1 or 3.11. MapInfo replies:

As for the question of whether 4.0 is a worthy "full point" upgrade, someone on the list mentioned that a major upgrade should include fundamental technological changes. Here they are:

Support for 32 bit Windows means that you get a faster, more robust product than would ever have been possible with Windows 3.1. We took the time and care to get certified as a Windows 95 compatible application. This means that we won't destroy your registry, you can uninstall the software completely, and that our NT version is fully functional.

The Database Connectivity feature is a fundamental change to the product that many users requested. If you use data stored in a server database, this new

feature allows you to work with that data directly without having to move your changes back and forth between MapInfo and your main database. We used to charge extra for a feature that didn't come close to doing what this feature provides.

Integrated Mapping is based on the ability to launch MapInfo as an OLE server. We have provided a robust OLE automation interface, and many extensions to MapBasic that will allow developers to create mapping applications that were simply not possible before. Because MapInfo can act as an OLE server, developers can now use Visual Basic, Visual C++, or Powerbuilder to create the front ends to their applications.

There are also major enhancements to our Raster support, digitising, DXF import, Metafile export, True Type and custom symbol support. We revamped labelling and added seamless map sheets, transparent fills and raster, an animation layer, and a dozen other features. You also get GPS receiver support, a vastly improved bundled data set, and a slew of new utilities and applications to further improve the product. We tried to pick the features and changes that would remove roadblocks, and that would ben-

efit the most users. I think we've provided the best MapInfo upgrade ever. Jim Coloprisco, MapInfo Corporation.

Forest Cover

- **dense forest**
Crown density by trees and/or ferns 75 - 100 % and ground coverage by grass, palm and/or bamboo 0 - 25 %.
- **medium dense forest**
Crown density by trees and/or ferns 45 - 80 % and ground coverage by grass, palm and/or bamboo 20 - 55 %.
- **scattered forest**
Shrub forest (including scattered coconut stands), dense bushland (thickets) with single trees. Crown density by trees and/or ferns 15 - 50 % and ground coverage by grass, palm and/or bamboo 50 - 85 %.
- **mangrove**
Mangrove forests are forest types with high occurrence of mangrove species.
- **hardwood plantation**
Areas declared as hardwood plantation on

sketch maps available at the forestry department.

- **pine plantation**
Areas declared as pine plantation on maps provided by Fiji Pine.
- **coconut plantation**
Areas mapped as coconut plantation on MPI maps.
- **non forest**
Areas covered by settlements, urban areas, grass and shrub vegetation visible as such in the satellite images

The forest cover types *dense forest, medium dense forest, scattered forest* and *non forest* derived from satellite data analysis. Satellite data has been used instead of aerial photographs because there were no recent aerial photographs of the forest and it was too expensive to do a photo-flight at 1:25,000 scale. This is the scale required for forest stratification. In the planning phase of the inventory it was decided to contract a company in Germany specialising in satellite data interpretation. This company took much time to deliver the first maps because the company faced several unexpected difficulties.

In order to speed up the mapping process the plantation areas were digitised in Fiji. All *pine plantations* were digitised from 1:50,000

organisations to offer a road centreline database. *GIS User, December 1995.*

A list of all MapInfo sites can be found at <http://www.gisnet.com/gis/mapinfo> This is particularly useful if you are trying to find MapInfo data conversion utilities such as DXF to MIF, Arc to MIF and other helpful programs and related information. *GIS User, December 1995.*

MapInfo Corp of the US has acquired Peripheral Systems Pty Ltd to create MapInfo Australia Pty Ltd. Peripheral has long been one of the most significant companies in the Australian desktop mapping scene and was one of the first commercial

9

scale maps delivered by Fiji Pine. The *hardwood plantations* were digitised from sketch maps. The maps used for the digitising of areas stocked with *coconut plantations* have a scale of 1:126,720. The scale of 1:126,700 or even sketch maps create inaccuracies. However, it was the best information available. The hardwood plantations are now re-mapped under European Union funding.

The company in Germany had many problems to separate *mangrove* areas from some forest cover. Finally the company digitised the new Lands Department maps. The mangrove mapping of these maps derived from aerial photographs taken in 1986.

Forest Functions

• *preserved forest*

Preserved Natural Forest are areas of natural forest to be maintained in an undisturbed natural condition and for the preservation of specific biological values. It includes the Forestry Department Nature Reserves, other legally established reserves and other areas of known unique, rare, or consideration for formal preservation. This includes formal propos-

als or recommendations for World Heritage, Nature Reserves or National Park status.

• *protection forest*

Protection forest are areas of highly sensitive native forest by virtue of their topography, climate, soil type or combinations their of timber harvesting or other forestry operations would be restricted to minor forest products or to manual or non mechanised timber extraction. Such operations should have negligible effect on forest cover, stand composition or hydrological conditions.

• *multiple use forest*

Multiple Use Natural Forest are areas carrying indigenous forest vegetation to be maintained under forest cover and to be used for timber production, catchment protection, wildlife habitat, forest recreation and amenity uses and for minor forest products.

• *amenity plantation*

Amenity plantation are sites of or intended areas for plantations primarily for some amenity purposes such as reforestation, catchment rehabilitation, landscape improvement. Timber production would be permissible to

the extent compatible with the retention of the amenity value, but is not the primary purpose.

• *timber production plantation* Timber production plantation are areas of existing or intended plantation established primarily for timber production.

The determination of forest functions is an output of a GIS overlay analysis. In order to combine spatial information shown on different maps all maps have been digitised and imported to the GIS. The GIS then is able to combine these maps and analyse for every picture element (25 x 25 m) if it is suitable to do logging or if it is more advisable to protect or preserve the forest. The parameters in the system were set by Dr. Dick Watling. See Figure 1 for the different information layers.

The information layer "*declared areas*" includes areas which are declared as catchment or reserve or which are proposed reserves or catchments. Reserves can be either declared Forest Reserve or Nature Reserve and also those that were still under proposal. The Forest Reserves are areas generally planted under forests to and

being managed as plantations of native or exotic tree species or allocated for future plantation.

Nature Reserves are areas of natural forest maintained in an undisturbed natural condition and for the preservation of biological values. These include Forestry Department Nature Reserves and other legally established reserves (e.g., Garrick Memorial Reserve) and other areas of known unique, rare, or very uncommon biological values which are worthy of consideration for formal preservation. Development is generally excluded from this category.

Areas of existing *Parks and Reserves* are also values of miscellaneous amenity which includes: a) Recreation b) Education c) Landscape. In these areas, management for other use is constraint to a level designed to maintain the value of these amenities.

Protected catchments are areas of particularly sensitive water supplies or aquatic ecosystem where comprehensive prescriptions or constraints in catchment use for maintenance of water quality or soil stability are required.

Proposed Nature Reserve, catchment and national park etc., are areas that have similar natural values as previously described but differs only in terms of their legal references.

Special Emphasis refers to special features that deserve to be considered in views of their legal status. It is the combination of declared areas and the existing forest cover. This information was obtained after combining declared areas and forest cover. It seemed to be necessary because dense forest has high biodiversity and should have a value for protection.

Seasonal rainfall is described as the squared of highest monthly rainfall (of observations during the time of recording) divided by

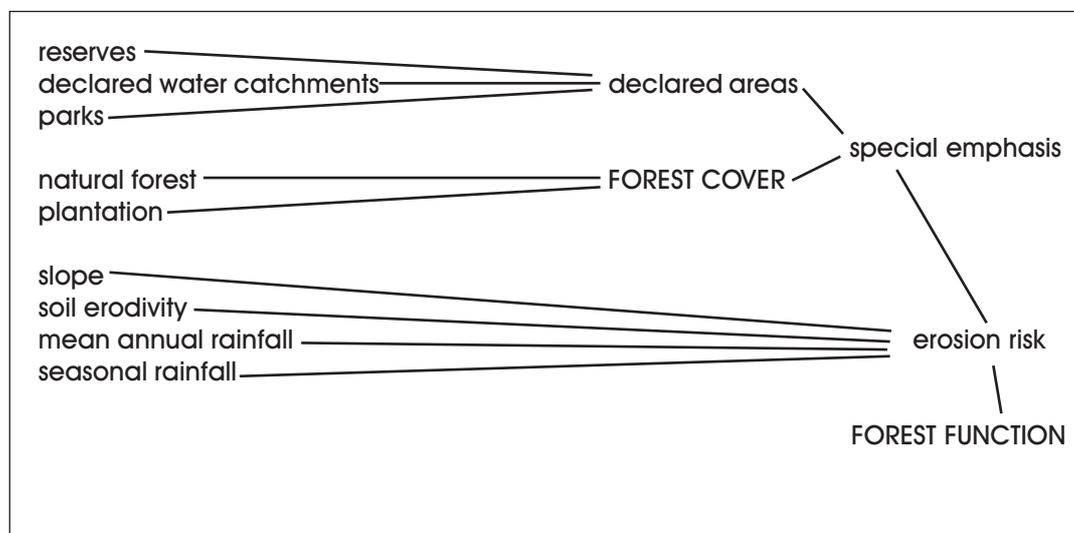


Figure 1. Determination of Forest Functions in the GIS. The forest cover was combined with other information to analyse its impact and interrelation.

mean annual rainfall (of all observations for the station during the time of recording).

Rainfall data was based only on the validated data of the rainfall stations recorded at the Hydrology section, Tamavua (PWD). A seasonal factor was then calculated using a small programme based on the following formula,

$$s = \frac{(\text{monthly extreme})^2}{\text{mean year}}$$

Stations with continuous records (giving a more reliable seasonal factor), were used to define the seasonal boundary.

The *Mean Annual Rainfall* quantifies the erosive force of rainfall and as well as run-off. The record of collection range from 0 to 4,0000 mm and above on an annual bases. This was the second part of the rainfall data source; captured from PWD, also from a erodent map. As prescribe (in Publication No. 1 of Fiji Meteorological Service report in 1980), this rainfall map was prepared by plotting a rainfall Factor R at each rainfall recording station. The information was provided by the Meteorological Section, Nadi Airport.

It was received in A4 size paper without any scale shown. There were geographical coordinates marked which was exactly the same when compare with the 250,000 scale map. The scale was calculated (equal to 1:760,000) and then enlarged to 1:250,000 scale, using a Planvariograph machine. This was later transferred to a 1:250,000 scale map for digitising.

The *Soil Erodivity* information was extracted from the existing soil raster files stored at MSD-Forestry. These different soil types were regrouped into their erodability ratings shown below:

Soil Type	Ratings
2	low
1, 5, 9	moderate
3, 11, 6, 8	high
4, 7, 10	severe

The *Slope Classes* derived from recoding the slope maps which contain for every pixel (25 x 25m) a GIS value showing the slope of the pixel in degree. The slope information was recoded into 4 separate categories.

GIS:	Categories:	Slope Ranging:
1	low	0°-16°
2	moderate	16°-27°
3	steep	27°-31°
9	extreme	> 31°

The *Erosion Risk* information layer tells the level of risk (1-10) for potential erosion. The "erosion risk" layer is an output of the combination of following GIS layers: a) slope classes b) soil erodability c) seasonal rainfall d) mean annual rainfall.

Infrastructure

The infrastructure derives from transparencies provided by the Lands Department. One transparency shows the river

by Fiji Land Information Service

COMPUTERISATION OF BUREAU OF STATISTICS BOUNDARIES

The Bureau of Statistics (BOS) conducts a population census once every decade and the next one is scheduled for 1996. Maps are an essential part of population census and preparations are underway to have enumeration area (EA) maps updated and ready for this census.

However, traditional census map making methods have proven to be tedious and time consuming on BOS staff with the increasingly high number of new developments and population growth and redistribution every year. Such changes have there-

fore resulted in additional work for the census staff in splitting. EAs and redefinition of boundaries which have accumulated over the years. Through the years BOS has worked with unsuitable maps, most of them were dated back more than 30 years old. These maps were generally on 1:50,000 scale and are also too congested to accommodate all these changes.

BOS was grateful to the Government's initiative and commitment towards the establishment of the Fiji Land Information Centre in early 1992 for the compu-

terisation of land data. The FLIS strategy adopted by cabinet in 1991 as the blue print for the FLIS programme highlighted the importance of developing an integrated geographic database that would avoid duplication and meet the needs of a wide range of potential users. The strategy also identified the significance of the enumeration area maps for the 1996 national census and the importance of a topographical database for a more statistical mapping.

The project actually started in early 1993 with the participation of FLIS and BOS staff. The main aim of this joint project was to digitise all existing census boundaries to provide an automated system and focus towards the production of the 1996 national census. However, due to financial constraint the project work was abandoned later in that year. The project work was reactivated in July, 1995 when the required funds were again available through the BOS. The introduction of this new mapping technique in BOS census mapping work has simplified census work and would solve the prob-

lems that have accumulated over the years.

In view of the time frame and the importance of this project for the 1996 census, a second shift work programme was designed and activated for the CCMS staff in an endeavour to speed up data capture. The shift work programme started in July, 1995 with a team comprised of four CCMS staff and a staff from BOS. According to Mr Josefa Uluibua, the acting supervisor CCMS, things look promising and about 90% of the total 1976 and 1986 census boundaries have been captured. Mr Uluibua believes, this is an excellent achievement realised within a very short period which staff should be commended.

While digitising of the 1976 and 1986 EA boundaries continues, a team of Bureau staff are currently concentrating in the definition of the 1996 boundaries. This has yet to be completed and submitted to FLIS for digitising. The task is complicated one especially in urban areas where a lot of development changes and population redistribution occurs. However, it is expected to be completed soon and data sub-

system and another shows the road network together with village names and spot heights. These transparencies have been scanned in Germany and the produced digital raster data was combined with the Forest Type / Forest Function Layer for printing.

The *Roadnetwork* of Viti Levu was scanned from the latest Lands Department topographical map 1:50,000. The map edition is completed for all sheets of this island. For Vanua Levu and Kadavu transparencies of the old map sheet coverage (DOS maps of United Kingdom) have been physically cut and reassembled to the new map sheet coverage before the scanning process. This implicates that the road network is not the up-to-date status for these maps. This also implicates a few small gaps between the joint transparencies and different form style within one map sheet. The roadnetwork of Taveuni was mapped new from 1:25,000 aerial photography recorded 1994.

The transparency of the *Riversystem* was reassembled for

mitted to the CCMS to complete the work.

The close co-operation between the FLIS and BOS in regards to this project is vital and should be a long term one. Regular meetings organised between the two agencies' officials have proved very useful, discussing important issues and solving problems. It is hoped that such meetings would continue to maintain good working relationship between the two organisations and ultimately for the successful completion of this joint project.

Digitising of EAs is based on the census mastersheets (DOS 1:50,000) from BOS headquarters using INTERGRAPH MGE and ORACLE as database. For the safety of these mastersheets, photocopies are provided to the project staff to assist them in the identification of boundaries both in the urban and rural areas. Cadastral data available within the CCMS database are used for the definition of existing boundaries in the urban and peri-urban areas, whereas the topographical data are used in areas that are not covered by cadastral sheets i.e. 2, 8, 16 chains maps.

Since the digital topographical data are still being scanned in NZ, the latest 1:50,000 topographical maps available are being used for this purpose. With the help of available cadastral

data, appropriate census boundaries can be identified on these 1:50,000 topographical maps before they are registered and digitised. For the small outer islands that are not covered by the cadastral and topographical maps, the detailed Island Tracings available with the Lands Department are used to identify established census boundaries.

New features were created for the 1976, 1986, and the 1996 enumeration boundaries linked to the table containing EA numbers. These features are added to the existing feature lists already created for the CCMS. Once a feature is selected the system would automate all these processes i.e. selecting the levels, colours, line weight, etc. EA boundaries are digitised over the CCMS digital cadastral boundaries using the CCMS maps as the base layer.

According to Mr Uluibua, the availability of the digital topographical data from NZ when combined with the captured digital BOS data will provide a high level of accurate census boundary definition.

This project is scheduled to be completed by March, 1996 before the actual 1996 census taking, sometimes in August next year. It is expected that once the project is completed the 1996 census will be the first census in the history of Fiji to benefit from this new GIS mapping technology.Ⓜ

the islands Vanua Levu, Kadavu in the same like the roadnetwork. However, the riversystem does not change that fast. It can be used for many years.

Change of Natural Forest Cover

The current mapping reflects the forest situation of 1991/1992. The area calculation is not finalised yet, Table 1 shows the first area estimation of the revised Forest Type / Forest Function maps.

Table 1. Results of the forest area calculation for the first forest type / forest function maps. (The forest stratification was not accepted)

dense forest	medium dense forest	scattered forest
308,000	420,000	97,000

Table 2. The forest area calculation of the second map edition (not finalised yet). Digits behind the point do not present the actual accuracy. The table is the output of a statistical program which calculates the sum for figures stored in the area data bank at MSD-Forestry. The trend is already visible: after the reclassification of forest densities more area is stratified to less dense forest types and more non forest area is classified as scattered forest.

	DF	MF	SF	SUM
MUF	175657.61	272110.30	120405.35	568173.26
PRF	24518.99	24314.82	8705.50	57539.31
PTF	75541.62	130329.80	39408.89	245280.31
SUM	275718.22	426754.92	168519.74	870992.88

The area estimation cannot be compared directly with the last inventory, because many parts of the west in Viti Levu as well as Taveuni were mapped for the first time. In 1994, a comparison was carried out for those map sheets which show the forest cover 1969 (LRD maps) and the current mapping. Considering this information 20% of the forest area mapped 25 years ago has disappeared. This figure does not include intensive logging, leaving remaining trees, tree ferns or bamboo. This will be recognised by the satellite image analysis as forest cover. This 20% of forest area loss is covered by sugar cane area and farmland around the villages.

More than 7% of the forest area was converted into *hardwood plantation*, assuming that these plantation areas are established on areas previously covered with natural forest.

Even with such deforestation, *the total forest area did not decrease*. More than 20% of the forest area, mapped now, covers parts which have been classified as "non forest" by the 1969 inventory. This is not due to change in forest definition, because also other sources such as the new map series of the Lands Department show "dense forest" in some of those areas. There are two reasons for increase of forest in such areas.

- 1) The LRD maps have some inaccuracies.
- 2) Fast growing introduced species formed forest on pasture and agricultural land.

This new forest with dominance of African Tulip can be a dense forest from the biological view, but these forests have very low commercial value. However, also these forests pro-

tect the soil and build a forest environment which probably allows other species being dominant at a later stage.

In summary it can be noted population pressure in rural areas decrease the natural forest cover. Statistically the forest area is stable because fast growing species cover areas which were not covered before. The total forest area is larger than 25 years before, because many parts of Fiji were mapped the first time.

From Mapping to Monitoring

The importance of the forest cover is growing and the impact to the forest is increasing. This requires a permanent observance of the forest cover. An inventory every 25 years is insufficient. Because of this the inventory project also established a remote sensing and GIS unit in the Forestry Department.

It would be too expensive to map the forest cover every four years by aerial photo interpretation. However, it could be possible to apply satellite data for this. The first repetitive satellite data coverage is paid by German Aid and MSD-Forestry is analysing the first recently recorded satellite data. Applying simple techniques every conversion from forest to non forest can be visualised and mapped.

First results comparing the Forest Type/Forest Function map with satellite data taken in 1995 covering the map sheets Suva and Nausori show a reduction of mangrove area of approximately 10%¹ and a visible reduction of natural forest cover. These first figures have to be checked in the field. Fur-

¹ Mangrove areas shown on the Forest Type / Forest Function map derived from aerial photo analysis. The aerial photographs were taken 1986, the period of comparison is not four it is decade!

✦ by Eberhard Kobler, Vanuatu

Vanuatu Resources Inventory System (VANRIS)

A Land Use Planning Project (LUPP) started in September 1995 in Vanuatu. The project runs over a period of five years, is funded by AusAID (AUD 3 million total) and is managed by AACM International, a consulting firm operating worldwide out of Adelaide, Australia.

The project provides for the establishment of the Vanuatu Land Use Planning Office within the Department of Lands.

The Land Use Planning Office will prepare a directory of operational databases in Vanuatu and guidelines and standards for database management. It will provide a technical service for maintenance of VANRIS hardware and software, updating the database and development of new applications for both current and new users. It will also ensure the integrity of VANRIS data and the regular back-up of VANRIS derived material.

LUPP will use the previously established Vanuatu Resources Inventory System (VANRIS) as its main interface with the user.

ther, there is also an increase of forest cover due to fast growing species which is not analysed yet. However, it can be stated that a decrease of natural forest cover can be notified and proved. A monitoring system can show where and can calculate the amount in hectare.

Summary and Recommendations

The inventory faced the situation that there was no *legal definition* in Fiji about forest cover. It is essential from the legal side to define an understandable and definite description of forest. At present there is an undefined transition zone of forest and pasture land or forest and coconut plantation. If possible, legal criteria should be used which can be recognised also by remote sensing data.

Forest cover now changes more rapidly than . Forest cover get more importance because its impact increases:

- on water resources
- on coastal change
- on erosion in land
- on supply for local timber industry

A mapping cycle of every 25 years is insufficient. Forest cover information should be *updated every 4 to 5 years*.

Forest type mapping has to be carried out by foresters

VANRIS is based on FoxPro for Windows and uses a DDE link with MapInfo to map the results of queries. While VANRIS, in its present form, concentrates mostly on data on natural resources, VANRIS in the improved format, will contain all - or at least most - data needed by central and local governments for planning in general and for planning of land use in particular.

At present, the Resource Mapping Unit (RMU) is the smallest mapping unit which is defined as an area in which natural conditions such as land form, vegetation, soil type etc. are mainly the same. Exceptions to the general conditions of an RMU might exist within for a surface of mostly not more than 1 hectare. The boundaries of an RMU are digitised while only the center of an RMU is identified by

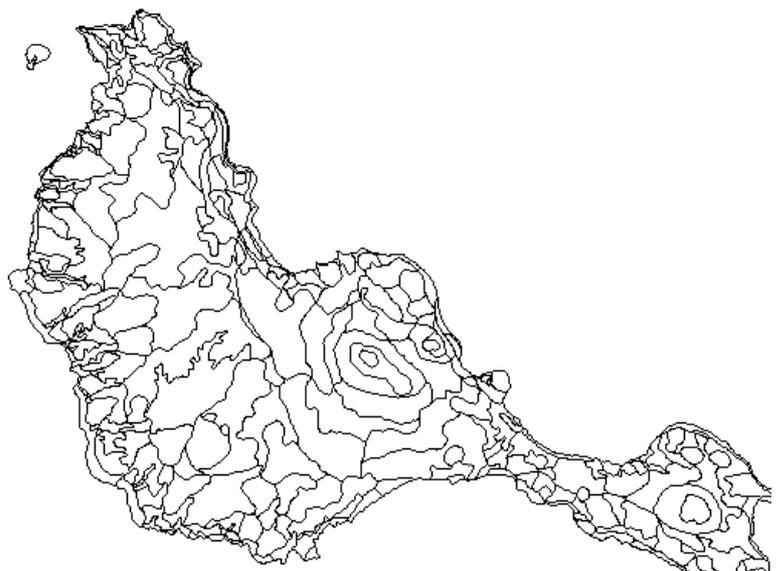


Figure 1. A map of Epi with all RMU's.

and by foresters who are familiar with the situation in the field. The satellite data analysis required for the Forest Type /Forest Function map was handed over to an overseas based company and the communication and missing field knowledge caused unacceptable delays in the project. Further *updates should be produced by foresters of Fiji's Forestry Department.*

The American satellite cannot download data from Fiji because of technical problems. The French satellite data costs about four times more. Fiji should arrange an agreement to *share satellite data amongst different departments.* Satellite data used for forestry could be also utilised for further land cover mapping.

A Forestry Department should be able to analyse satellite data for forest monitoring. However, it will be impossible for a department of South Pacific Island country to keep up with the updates of image analysis and GIS software and hardware. *A regional organisation should get the mandate for assisting forestry departments in the South Pacific.*

Assumed that there is a regular requirement for satellite data, it would be advisable to have a *portable ground receiving station* for the south pacific. Fiji or other South Pacific Island countries would not be limited to buy the French SPOT data and could receive other data such as Landsat. Every path of a satellite over Fiji could be used to receive and download data because data recording is not limited to the onboard tape drive.☺

longitude and latitude.

An RMU serves as geographical reference point for a large variety of data. There are two data groups. Data on natural resources and conditions and other data (socio economic etc.) that is, for convenience, stored for the same RMU for which the boundaries are defined by the first set of data. The first data group is about natural conditions such as:

Land form	Rock type	Relief	Altitude
Annual Rainfall	Cyclone Frequency	Vegetation	Land Use Intensity
Regrowth	Soil Group	Stoniness	Depth
Drainage	Reaction	Salinity	Base Saturation
Erodibility	Mineral Reserves	Texture	etc.

The following table is an extract of the Vegetation Reference Database showing all types of midheight forest that VANRIS keeps track of:

VegCode	Description of Midheight Forest Type
Fme	Midheight forest with emergents
FmeAgCl	Midheight forest with Agathis-Calophyllum
FmeCl	Midheight forest with Calophyllum
FmeClAg	Midheight forest with Calophyllum-Agathis
FmKh	Midheight forest with Kleinhovia hospita
Fmm	Midheight forest with small to medium crowns
Fmm1	Midheight forest with small to medium crowns; dense remnants
Fmm2	Midheight forest with small to medium crowns; medium dense remnants
Fmm3	Midheight forest with small to medium crowns; sparse remnants
Fmo	Midheight forest with an open canopy
Fmo1	Midheight forest with an open canopy; dense remnants
Fmo2	Midheight forest with an open canopy; medium dense remnants
Fmo3	Midheight forest with an open canopy; sparse remnants
FmoCl	Midheight forest, open canopy, with Calophyllum; local Agathis
Fmoe	Midheight forest, moderately open canopy, with emergents
Fms	Midheight forest with small crowns
FmW	Midheight forest with Metrosideros-Weinmannia

The second data group associated with RMU's, at present, is restricted to those data that come from the national census 1989. Those data are based on households. VANRIS contains for every RMU the total number of households and for all households within an RMU information about:

Total males in RMU	Total Females in RMU	Water Supply ¹
Livestock keeping/selling	Copra growing/selling	Cocoa growing/selling etc.
Kava growing/selling	Fishing activities	

VANRIS, also, contains a complete database of all villages (and places within villages) in Vanuatu. At present, villages and places are geographically identified only by the number of RMU in which they are located and by the number of the Enumeration Area to which they belong.

The new Land Use Planning Project (LUPP) will digitise both the village locations and the boundaries of the enumeration Areas.

In addition, all rivers and roads, hospitals and schools and other places of importance will be digitised and made available through MapInfo for mapping.

LUPP will widen the content of the second database group by including data from departments such as Education, Health, Geology and Mines, Agriculture, Forestry etc. and by also including information from the private or semi-private sector.

One of the main duties of the Land Use Planning Project is to establish a mechanism which assures that VANRIS data are updated regularly and by local resources without foreign assistance. For that purpose, a VANRIS Users Group has been formed with members from almost all Government Departments and from the private or semi-private sector such as the Chamber of Commerce and the Vanuatu Commodities Marketing Board. The Group's members discuss:

- subjects of common concern in order to learn one from the other
- standardisation of data collection and
- exchange of data between the members and the VANRIS system.

The Land Use Planning Office has started to negotiate 'Data Transfer Agreements' with members of the VANRIS Users Group. In those agreements, all details are outlined for the regular transfer of data from the data provider to the VANRIS system and for the distribution of such data through VANRIS.

For example, there will be a 'Data Transfer Agreement' between the Department of Agriculture and the Land Use Planning Office outlining all details about kind and format of data from the current Small holders Survey that will become part of VANRIS.

As another example, negotiations have started for a similar agreement between the Forestry Department and the Land Use Planning Office with the goal to make data about logging licenses and logging activities available to VANRIS users.

It is hoped that the update of VANRIS data can be more or less automated for those data that come from operational databases of Government Departments. For example, when data about schools and school population is kept at the Ministry of Education, a pre-arranged subset of those data can be transferred to VANRIS at agreed intervals and in the agreed format.

Except for data update coming from VANRIS users through the above mechanisms, LUPP does not provide for an update of data in the first data group (natural resources and conditions). This will be left for one or more different and additional projects.

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¹ Individual water supply by pipe or by tank, communal tank, river, well etc.

Computer Assisted Visual Forest Change Detection

Introduction

Fiji's natural forest have been mapped with Landsat TM data recorded 1991/1992. Overlaying SPOT data recorded 1995 on these maps, deforestation is visible¹. It is necessary, now, to calculate the area which has changed to non forest. At the same time it is essential to visualise the area of change to demonstrate to decision makers. In order to do this, simple techniques have been chosen to map forest and non forest of the SPOT image, overlay this new digital map over the old digital map and enhance areas converted to non forest. This result then is interpreted together with the image to reduce the impact of image disturbance such as cloud and cloud shadow. Only the clearly visible non forest areas have been used to update the forest cover map.

Visualisation of Forest and Non Forest in the Satellite Image

To combine the SPOT image with digital maps, it was geometrically corrected and cut into map sheet size. Such a file is called a *Satellite image map*.

Ratio images are enhancements resulting from the division of image picture element values in one spectral band by the corresponding values in another band. A major advantage of ratio images is that they convey the spectral or colour characteristics of image features, regardless of variation in scene illumination conditions. Ratioed images are useful for discriminating unclear spectral variations in a scene that are masked by the brightness variations in images from individual spectral bands or in standard colour composites.

The *normalised difference vegetation index* (NDVI) is pre-

ferred for vegetation monitoring because the NDVI helps compensate for changing illumination conditions, surface slopes, aspect and other extraneous factors. In highly vegetated scene areas, the NDVI typically ranges from 0.1 to 0.6, in proportion to the density and greenness of the plant canopy.

$$\text{NDVI image} = \frac{(\text{SPOT band 3}) - (\text{SPOT band 2})}{(\text{SPOT band 3}) + (\text{SPOT band 2})}$$

Density slicing is used to segment an input image into two classes; one for those pixels having values below an analyst defined grey level and one for those above this value. The boundary of forest to non forest was determined on the ratio image by moving the cursor from the edge of the forest to the middle of the forest in order to get the extreme range of values. It was found that the values for forest reflection range from 97-125. All values between 0 and 96 which is lower than the forest reflection is re-coded to 10. Forest reflection which ranges from 97 - 125 is re-coded to 20. For values higher than the forest reflection 126 - 255 is re-coded to 30. The image output can be coloured, if the value 20 get the colour green and the values 10 and 30 the colour sand, the viewer sees forest and non forest of this normalised vegetation map.

Combining the Old Forest Map with the Satellite Image Map

INDEX creates a composite GIS file by adding together the class values of two input GIS files. The corresponding cells from each file are added, and the composite output GIS file contains the resulting sums.

Table 1. Indexing the normalised vegetation map containing the values 10, 20 and 30 with the old forest map containing the values 1 to 9. (1 = water, 2 = mangrove, 3 = non forest, 4 = hardwood plantation, 5 = pine plantation 6 = coconut plantation, 7 = scattered forest, 8 = medium dense forest, 9 = dense forest).

		1	2	3	4	5	6	7	8	9
non forest	10	11	12	13	14	15	16	17	18	19
forest	20	21	22	23	24	25	26	27	28	29
non forest	30	31	32	33	34	35	36	37	38	39

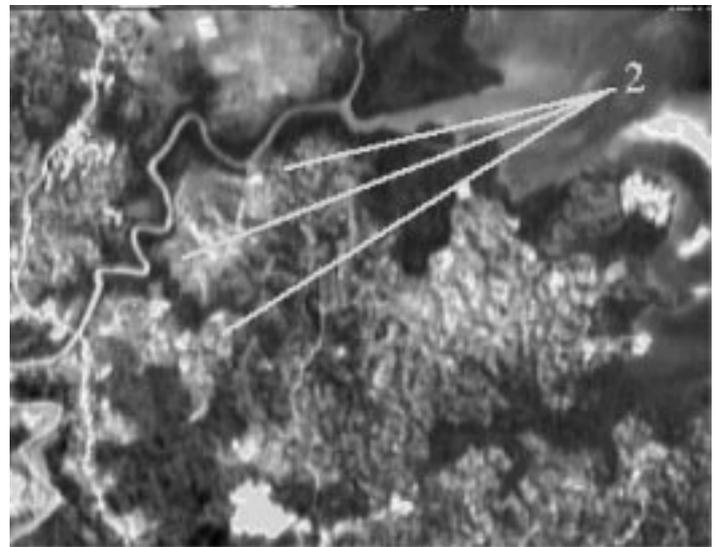
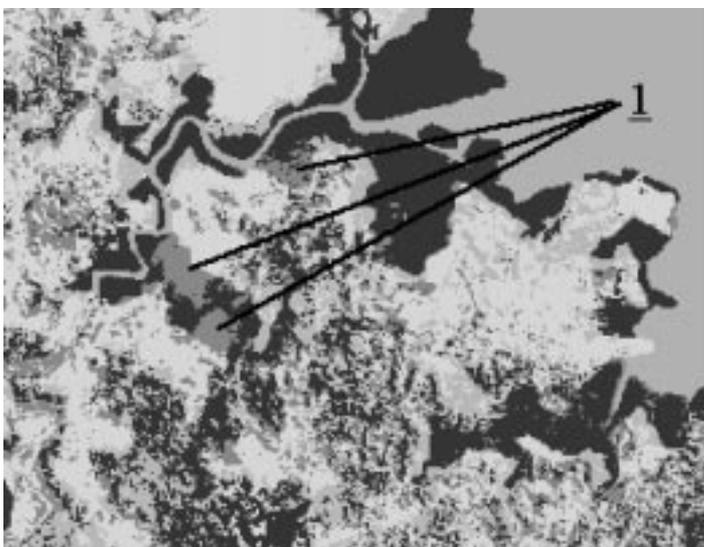


Figure 1. Clear cut within forest areas near Wailaici river (1) (2), right the change detection file, left the satellite image map (SPOT band 1, green light). Areas with tone of grey (1) indicate loss of forest, black indicates forest or mangrove areas without change. In the satellite image map (2) clearings are detectable by their high reflection. The white area at the bottom is a cloud.

¹ see Wakolo, J. Visual Forest Change Detection, Newsletter 9503

The output of the index process contains the values from 11 to 39. This can be coloured and converted to a *change detection map*. The values 22 and 24 to 29 indicate forest in the satellite image map where forest was already mapped in 1992, this is coloured in pine green. The values 32, 12, 34 to 39 and 14 to 19 indicate non forest in the satellite image map where forest has been before, this is coloured in red. The values 33 and 13 indicate non forest where non forest was mapped 1992 this is coloured in sand. The value 23 indicates forest on areas mapped as non forest before. These areas were not investigated yet, detailed field checks are necessary, to investigate the invasion of fast growing African Tulip and other pioneer species stocking on former pasture and agricultural land.

Visual Interpretation of change Detection Map

Ratio images or the special form of normalised vegetation index are created by an automatic process. This has to be checked by an interpreter knowing the situation in the field and the characteristics of a satellite image. ERDAS Imagine allows an *image link* of the change detection map with the satellite image map.

By moving the cursor along the boundary of an area indicated as deforested in the change detection map the cursor in the satellite image map is moving correspondingly. If the indication of deforestation is due to cloud or cloud shadow which effects the rationing process, this part is converted back to

GIS values indicating "no change" (see Table 1, values 22 and 24 to 29). Areas where bare soil can be detected in the satellite image map stay without change. This *readjustment of the change detection* must cover the complete area and is the most time consuming process.

Update of the Old Forest Cover Map and Results

The digital map sheets showing the forest cover 1991/1992 were updated by a ERDAS-GISMO program. The program checks for every pixel indicating forest cover if the corresponding pixel of the interpreted change detection file is forest as well. If this is not the case, the program *converts the pixel* to non forest. The created output is the forest cover 1995. At this stage the additional forest visible in the satellite image was not included!

For the same map sheet e.g. sheet Nausori there are two files a) showing the forest cover of 1991/1992 and b) showing the forest cover of 1995. The *area calculation* can be compared after printing by the program which just counts the number of pixels indicating forest cover and non forest cover.

The results shows an *alarming decrease of mangrove* forest which is greater than 10% for map sheet Nausori! The period of comparison is from 1986 to 1995, nevertheless the situation is critical because mangrove forest protects the coast and is an important biotop. The decrease mainly appears near villages which indicates the conversion to farmland. During former field visits negative impact on the mangrove due to seawalls, flood gates and drainage was noted as well.

The *loss of dense and medium dense forest* seems to be high as well (>10%) within a period of only four years. However, the interpretation of forest decrease is difficult due to its scattered appearance. This requires actual field verification. The forest loss occurs on the transition zone to farming areas where clear cuts are necessary for the extension of such farms. New roads through forests are visible as well.

There is also *new forest* visible on areas mapped as non forest 1991/1992. This could most probably be related to fast growing, introduced species e.g. African Tulip which stocks on former grazing land.

Recommendation

The results have to be proven in the field before a clear statement can be given. However, a period of four to five years is sufficient to note differences in forest cover. It is therefore recommended to continue the monitoring and investigate the causes of forest changes.☺

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