# GIS & REMOTE SENSING NEWS

FIJI USER GROUP, Number 8 (9406), September 1994

Welcome to the eighth issue of this newsletter. It's the sixth for 1994, but the eighth for the whole series [Number 8 (9406)] It is late, as Les and Wolf were both on leave for most of August. We hope that next issue will be more prompt, and it will be if we can count on your continuing support through articles, tips and hints.

Osea Tuinivanua, MSD, gives us an overview on detecting change to Fiji's forest cover using remote sensing and GIS techniques. The versatility of these techniques is further demonstrated in the article "GIS for Land Use Planning in Shifting Cultivation areas" by G. Schmitt-Furntratt & S.P.S. Kushwaha. There are also system development articles from Australia and Samoa and of course the many news items and tips. Please keep them coming.

# JULY NEWS

The July meeting was held at SOPAC.

- Hervé Dropsy (MRD) explained the Hydrological Data Base. Several separate databases contain information about boreholes, soil characteristics and water level. The databases can be linked together, and are established with Fox Base.

- A. Vial (MRD) gave a presentation regarding the resource assessment using the Geological Data Management System. The purpose is the possible establishment of mining sites, where this management system provides, assistance to locate the best location All available information including contour lines, geological fault lines, deepness of layers can be visualised with this software.

- Osea Tuinivanua (MSD, Forestry) spoke about a new forest type dominated by the African tulip and Raintree. This type of secondary forest can be mapped with GIS technique and satellite data analysis. This forest was mapped as non forest area 25 years ago and is now recognised as forest by satellite data analysis. A change detection can easily visualise the area. To date, image enhancement techniques could not separate this secondary forest from remaining **rain** forest.

- Hervé Dropsy (MRD) demonstrated the match of different data sources for geological mapping, and used the Suva peninsula as an example.

## Updates and Discussions

- A further Digital Terrain Model (DTM) is now available at MRD which they obtained from Japan. The DTM has 50 x 50 m pixel and derived from digitising the topographic maps 1:50,000 like the DTM available at MSD.

- An Environment Officer arrived in the Department of Environment who will be responsible for GIS work. He will visit MRD and MSD to learn about GIS application before the department decides the type of GIS to be purchased.

- NLTB has completed the 16 chain data capture. The 16 chain maps will be transferred to the new 1:25,000 sheets of the new Lands Department map series. The mataqali boundaries will then be available on the Fiji Map Grid (FMG).

- FLIS announced that an expert from Intergraph, NZ, will arrive about the middle of July and manage the format transformation from the internal NLTB Synercom file format to DXF (see Newsletter 3, January 1994).

- MSD advised that most of the satellite TM data is now stored on optical disks. All computer hardware is now connected with the network "Windows for workgroups". Two members of MSD will go on a ten weeks training course to Australia end of the month. It was highlighted again, that the road network, the river system and the mataqali boundaries are needed by forestry in digital form.

# SATELLITE NEWS

- SPOT continued data recording without problems known to us. MSD-Forestry will acquire a multispectral scene of the Serua-Namosi area of Fiji even if there is high cloud cover, because of time constraints.

- There is no confirmation that the Landsat marketing program will be transferred from private hands to public. We will try and confirm this for the next newsletter.

- Radar images from the ERS1 have become a useful tool for flood detection by merging them through IHS transformation with Landsat or SPOT images.

- The Permanent Secretary B. Dutt from the Lands Department will go to the Ministerial Meeting on "Space Application for Development" in Beijing, China, 22 September. He will explain the need for a mobile ground station to be placed in Fiji for receiving Landsat and Indian Satellite (IRS) images from Fiji, Vanuatu, Samoa, Tonga, New Caledonia and other islands.

■ *by Osea Tuinivanua, Management Services Division (MSD), Forestry Department*

# Change Detection of Fiji National Forest Cover Using Landsat TM Data and GIS Techniques

Summary

Fiji's natural forest was mapped from digital satellite images (Landsat TM). These maps were overlaid over the maps of the last inventory (LRD) carried out in 1969. The change detection shows a loss of forest and also new forest areas which had been mapped as non forest in 1969. The initial field investigations noted a new forest type with a high presence of introduced species, namely African tulip and Raintree.

## Forest Cover Definition Under Land Resources Study, 1969

The LRD identified 9 main groups of forests and 45 forest types defined by their recognisable patterns on the aerial photographs, structure, field composition and terrain siting. The LRD forest cover was derived from aerial photos of 1954 (scale 1:40,000) and 1967 (scale 1:24,000). However, the three management categories that contained the 9 groupings were:

*Non-Commercial Forest (NCF)* : Forest having a stocking of less than 30 cum./ ha including commercial species of groups l-4 and trees greater than 30 cm. diameter breast height.

*Protection Forest (PTF)* : Forest having slopes in excess of *30°* usually 40 - 60° with shallow soil and long slopes. The forest cover ranges from partial closed woodland to closed canopy of high quality forest types.

*Production Forest (PDF)* : Forest having a standing volume greater than 30 cum. /ha of commercial species groups 1 - 4 and greater than 35 cm. diameter breast height (dbh).

## Forest Cover Definition 1992 Using Landsat TM data

The Fiji German Inventory Project (1992) defined the forest cover in relation to the canopy exposure recognisable with Lansat TM image data.

*Scattered Forest (Low Density) (SF)* : Shrub forest including scattered coconut stands, dense bushland (thickets) with single trees and crown density by trees and/or ferns represent 15-50 %, Ground coverage by grass, coconuts and/or bamboo represent 50-85 %.

*Medium Dense Forest (MDF)* : Crown density by trees and/or ferns represent 45-80 %, Ground coverage by grass, coconuts and/or bamboo represent 20-55 %.

*Dense Forest (DF)* : Crown density by trees and/or ferns represent 75-100 %. Ground coverage by grass, coconuts and/or bamboo represent O-25 %.

## Change Detection

The raster based GIS of MSD was used for the change detection. The digitised forest cover of the LRD formed one layer This layer was overlaid and compared with the forest cover determined under the recent digital image analysis of Landsat TM data. From 28 LRD map sheets only 21 map sheets were used as the base, because of cloud cover replacement in the new forest type maps. The change in forest cover that occurred within these two layers was analysed and the difference in forest areas was calculated.

There is a 7 percent increase in mixed-hardwood plantations within the native forest cover. Approximately 20 percent of the areas now classified under forest cover was listed under non-forest in the previous study This figure does not include the logged over forest, which has a very poor biodiversity, but a canopy closure which classifies such areas as scattered or even medium dense forest. Beside the decline of natural tropical rain forest cover, an increase of forest area was noted (24% of the total forest area in 1992). This area was mapped as non forest in 1969.

The change from dense forest to scattered forest and change of mangrove forest has not been investigated to date.

## First field Checks

The Wainibuka area was selected for the initial field visits, because it is well known from previous training areas selected for the satellite image classification.

The loss *of forest* appeared on this map sheet was mainly in the north, where conversion to sugar cane took place during the sixties. Other areas which were converted to non forest generally followed the rivers. Here the agricultural area increased from the lowest parts of the valley uphill. The later one has to be investigated in more detail after overlaying the maps with the river system.

The *increase of forest* appears on sites which most probably had been non forest area 25 years ago. The visual impression showed a dominance of the fast growing African tulip *(Sparodae campanulata)*, Raintree *(AIbiza saman)* and Drala *(Eritima fusca)*. It is possible that this land in the Wainimbuka area was once non-forested because of cattle grazing. With the decrease of diary farming the regeneration was no longer controlled by animals and a new forest type of secondary regrowth appears.

Some of the raintrees are quite old and they must have been there 25 years ago. However, they are an introduced species not recognised with a commercial value at this time. It can be assumed that such forests containing these scattered forest type of raintrees were wrongly classified as non forest at that time.

The analysis of initial field plots in this type of regrown forest showed that the percentage of Raintrees and African tulip were not as dominant as the visual impression. Guava trees *(Spsidium guajava)* were found under the umbrella of Raintrees in some areas.

## Investigations of Image Contrast Enhancement

Investigations were carried out to separate the new forest type from other forests by digital image contrast enhancement. A subimage which was cut out of Landsat TM scene 74/72 recorded by the satellite on 27.07.1991. This subimage covered the area of investigation, the map sheet "Wainimbuka River" (sheet No.7).

A *special contrast stretch* was done separately for all bands to enhance the grey value difference between the new forest type and the natural rain forest.

Several *band combinations* and different assignments to the three colour tubes "red", "green", and "blue" were tested with the contrast stretched bands. The combination and assignment: red -> band 7, green -> band 4, and blue -> band 2 appeared to be best for this purpose. However, it was not possible to clearly separate the new forest type from the rest of the forest types.

The following ratio *images were* produced: a) (band 4/ band3 x 40 b) (band 5 / band 2) x 40 c) (band7 / band 3) x 350. None of these ratio images allowed a clear separation between the new forest type and the rest of forest cover.

In order to combine the contrast features of the best ratio images a *synthetic image* was produced. This consisted of : red -> ratio 5/2, green ->.ratio 4/3, and blue ->.ratio 7/3. Even with such a product it was impossible to enhance the Contrast in a way that the separation of the new forest type is clearly visible.

Conclusion:

GIS techniques can separate a new forest type which cannot be separated by image enhancement techniques. Further investigations have to be carried out to isolate this forest type with remote sensing data alone, because the change detection was only done for areas mapped by the LRD inventory. The new forest type has to be included in the forest cover stratification because of its different species composition.@

■ *Jim Leitch*

# FORESTRY INFORMATION SYSTEMS DEVELOPMENT IN AN AUSTRALIAN COMMERCIAL PLANTATION ENTERPRISE

**THIS NOTE** summarises the strategy and issues encountered in designing a Forestry Information System (FIS) for a large Western Australian saw- and chip-mill group's plantation development subsidiary. The design brief decreed that the FIS would be a fully integrated enterprise GIS relational database management system. Of relevance and interest to Fijian readers are that:

- Plantation land is leased from farmers for 20 years or two chip wood rotations;
- Annual rental is fixed for the lease duration (aside from CPI adjustments ) and based on the plantation stocked area at age one.
- Technical self sufficiency is important as the off ice is in a small town

From a modest planting programme in the mid eighties, over 4000ha are now planted annually. Hence the need to upgrade the information systems. The strategy adopted to define the FIS system design was to:

1. Identify critical information needs and bottlenecks in delivery and or quality;
2. Prioritise information needs and classify them according to complexity (achievement ease);
3. Review others' FIS, available digital data sets, infrastructure, training needs and technology;
4. Data modelling and specification of an idealised modular FIS;
5. Map the idealised FIS onto available applications software and prepare an implementation plan.

During this work a number of quite crucial issues surfaced.

1. Managers initially had little practical conception of the realities of FIS system complexity and the long pay back periods of GIS .
2. The distinction between CAD/ Mapping (pretty maps) and GIS analysis was a subtle but important one.
3. To obtain early results with minimal in-house software development, means the vision of a fully integrated FIS/GIS is a two stage process (see below).
4. As there is only one plantation administration site, a PC based solution rather than a UNIX platform serviced from a 300km distant head office seemed a more viable option.

Accordingly in the first phase the following FIS set up will be implemented:

- A PC Based mapping/CAD system, GIS plus the relational database management system; and,
- Other specialised data capture systems such as forest inventory, growth , tree taper modules and GPS

Reporting will be handled on PC terminals in a peer to peer network using Windows based software suites and or the native reporting facilities of the more specialised applications software.

After using this basic FIS set up for up to two years we will review and develop the second stage. This would involve integrating the accounting functions and plantation budgeting and operations monitoring into an enterprise decision support system. At this point too, the decision would be made whether to upgrade GIS functionality and to invest in more forestry software such as linear programming modules for plantation valuation and yield control.

We have tried to emphasise the fact that it is a decision SUPPORT service not an end in itself. Also since we have a reasonably complex information system the strategy is to gain experience with the basic GIS, RDBMS, raster and vector and attribute data sets before tyring to produce a fully integrated system. This two phased development allows for the production of useful outputs along the way too. In our next report we will outline the physical FIS architecture.@

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# SUVA PENINSULA

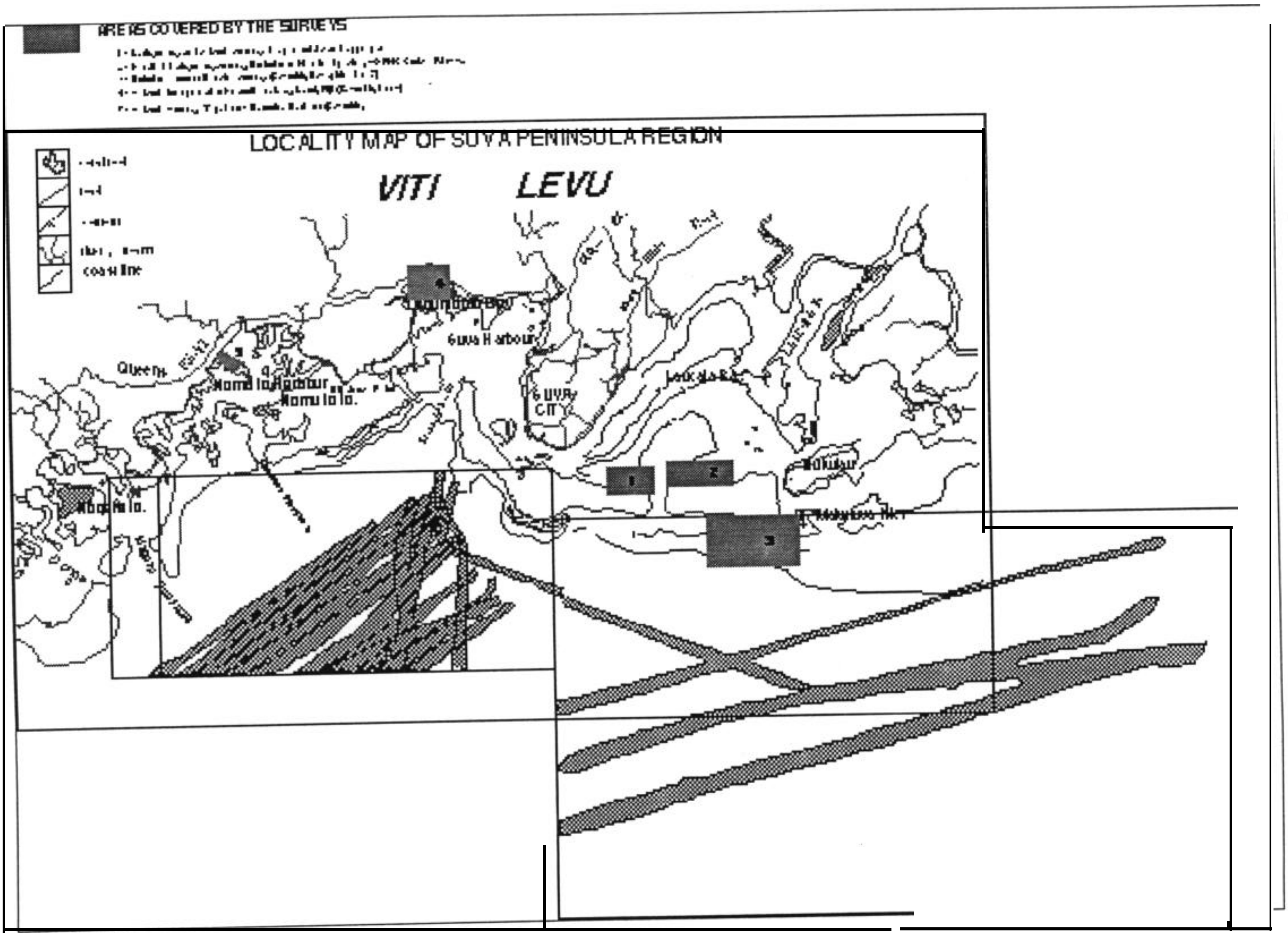
## Coastal and Nearshore Project

### 1 Introduction

Fiji Group with more than 300 islands have relatively very long coastlines in comparison with most other countries - when judged by either total land area or population. Furthermore, the majority of people live on or close to the coast, and most development capital has been invested there, especially true for the capital Suva. Consequently, coastal and nearshore environments have always been of great significance, a significance which is increasing as this critical and often sensitive environment is developed. It is thus becoming increasingly important to establish baseline conditions against which the effects of development can be monitored. Coastal geology is an important part of these baseline studies particularly the evaluation of the geological processes which can seriously affect development if ignored.

Unfortunately this environment is always under threat by decision makers, developers, engineers and also from the public A proper understanding of the natural coastal processes, is therefore necessary for sound coastal development planning and the formulation of environmental and coastal management policies.

Suva Peninsula Coastal and Nearshore Project is the beginning of a long-term baseline study of Fiji's coastline. It is intended that the densely populated and more developed coastal cities and towns plus resorts be studied first.




The figure above represents the proposed project area east and west of the Suva peninsula.

## 2 Objectives

The main objective of this project is to provide scientific baseline information about the coastal zone as a prerequisite for coastal development such as seawall, resorts, jetties, groin, marina, reclamation, etc. This project will also help to evaluate the use of GIS (advantage, limitation) for the production of nearshore land-use map and for coastal processes study.

## 3 Data

Scientific data concerning the existing coastal processes and environment in the Suva peninsula region will be acquired by:

a) Monitoring on-going coastal processes along the Suva region coastal area.
b) Monitoring sediment budget/load within the region.
c) Carrying out geophysical and geological sampling to assist in evaluating overall sediment thickness and type distribution in the area.
d) Evaluating geotechnical properties of the unconsolidated sediment types of the region.

In addition to these surveys, compilation and digitalisation of existing data will be carried out covering dataset such as:

a) geomorphology information (coastline, reefs, trigstation, main road, rivers);
b) bathymetry and hydrography;
c) sampling site and drillhole;
d) geophysical surveys;
e) coastal geology (rock type, dip, fault...);
f) soil type & land-use;
g) coastal processes (sediment transport, littoral rift, ripe current...).@

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# A GIS for Landuse Planning in Shifting Cultivation Areas

**Summary**

For making land use planning in the north-eastern region of India more efficient and swift working especially in shifting cultivation areas an optimal Land Use Plan was generated semi-automated using remote sensing and GIS techniques. Three input data types viz., satellite image classification of forest cover, land degradation information and slope conditions were used resulting in seven new land use classes. The exercise clearly demonstrated that remote sensing and GIS could conveniently be used for land use planning.

## 1 Introduction

Remote sensing plays an important role in assisting the fragile equilibrium between economic development and the environmental protection. Remote sensing provides a source of data, often the only one, as well as the capacity for data processing and analysis, assessment, monitoring and forecasting tasks. Geographic information system (GIS) provides the capacity for integration of remote sensing with georeferenced data from various sources, enables digital overlays of different datasets, their joint spatial analysis and generation of user required cartographic and statistical products from integrated databases. They jointly provide geo-inforrnatics support, in terms of relevant, reliable and timely information needed for economic development and environmental protection (Kalensky, 1992; Gugan, 1993; Marble et al., 1983; Tomlinson, 1972). Some of the practical examples of the applications of GIS can be found in Smith and Blackwell (1980), Hellden et al. (1982), Johnson et al. (1988), Marsh et al. (1990) and Welsh et al. (1992).

While hardware and Software for GIS have improved exponentially during the last decade, implementation of the technology for management purposes has grown lineary. Many landuse planners now recognize the potential value of remote sensing and GIS but find little direction for effective manipulating the data. Through interfacing remote sensing with GIS technology, different management scenarios can be processed allowing the manager to analyze many management alternatives before selecting an alternative that would be most suitable (Nellis et al., 1990). By now it is, however, clear that the full potential of both techniques can not be exploited until they are suitable integrated (Shelton and Estes, 1979). Some even go further and see the success of remote sensing firmly linked to its capacity to serve GIS (Simonett et al., 1977).

Recent advances in remote sensing and GIS have greatly increased the capacity for assessment and monitoring of natural resources. This is particularly important for the developing countries whose economics primarily dependent on agriculture, forestry fisheries and mineral resources. Rational planning of their faster economic development has to be based on realistic base line data. Remote sensing in India is reasonably well developed although the application s of GIS is in infant stage. There have been many 'experimental' studies in different disciplines of natural resources reporting various degrees of success. The first major effort to integrate remote sensing with GIS has been the Integrated Rural Development Project of the Department of Space, Government of India being implemented by the National Remote Sensing Agency (NRSA), Hyderabad in close collaboration with district planning boards. The project encompasses one hundred and thirty districts in arid and semi-arid regions of India and aims at the application of remote sensing techniques and GIS for district level development planning. Entire project functioning is based on the 'ecosystem approach' and various parameters of the system are defined in spatial database. So far, the development plans for twentyfive districts have been completed. These plans have found wide acceptance among planners, managers and environmentalists because of their practicability

Shifting cultivation in India as also in other parts of the world, has been catastrophic for the land and the forests, the two main components of the ecosystem. Besides being wasteful in terms of loss of valuable biomass, it is in no way sustainable and no amount of reduction in jhum (= shifting cultivation) cycles seems to be sufficient compared to the number and requirements of those who practice it. Therefore, it is obvious that unless alternate sources of income and livelihood are developed, the future of environment and the flora and fauna seems to be bleak. Majority of the forests in the region are owned privately and there exists no guideline or control on exploitation of these forests. With increasing environmental awareness it is, however, being increasingly realized that the use of the land should not be driven simply by the immediate need of the people but by suitability of the land for a particular landuse. So far, neither Government of India nor state governments in the North-East have initiated any serious effort toward optimum landuse planning in the northeastern region. Remote sensing and GIS offer a potential solution of landuse planning. Present study, which is the first of its kind for any shifting cultivation area, deals with the application of two technologies for landuse planning in such areas.

## 2 Study Area

A 20 km x 20 km area in West Garo Hills district of Meghalaya in north-eastern India having typical shifting cultivation was selected for this purpose. The classified image for this area was generated during previous exercise on applications of texture for classification purposes.

## 3 Data and Methods

### 3.2 *Generation of the Database*

To be compatible with the format of digital satellite imagery i.e. their classification results a raster GIS was considered to be most appropriate.

Three types of the data were selected as input to GIS. The first was the classified image generated by conjunctive use of image tone and texture of IRS data. Before smoothing, the six forest classes i.e. evergreen, 5 year, 4 year, 3 year, 2 year and 1 year forests were merged into four classes namely very dense (evergreen), dense (4+5 year), open (2+3 year) and sparse (up to 1 year) forests to give a more meaningful expression to the forest cover information. The resultant image with five classes, the fifth being the non-forest, was then subjected to majority filter to remove the 'salt and pepper' effect. The smoothed image was then used as input to GIS.

The other important variable considered for this purpose was the information on land degradation. A line map showing four land degradation classes viz., undisturbed, moderately disturbed, disturbed and severely disturbed was generated by visual analysis of enhanced color composites pertaining to 1989, 1990, 1991 periods. The map was digitized using 36.5 m x 36.5 m grid size (equal to one pixel of IRS Liss-II data), geometrically corrected and. registered to classified image using image-to-image registration techniques. Each class was assigned a grey value for further referencing.

The third parameter selected for this task was the information on the slope conditions in the study area. A slope map depicting six slope classes viz., O-l %, l-5%, 5-l0%, l0-20%, 20-35%, > 35% slope was prepared from Survey of India (SOI) toposheet on 1:50.000 scale. This too was coded with grey values, digitized and registered to the other two maps for further use. The three information layers were then stored as three bands of a single image. This was a prerequisite of the software program written for this purpose. Figure 1 shows the paradigm for combining different images in a rule-based system.

### 3.2 *Development of fhe Software Program*

The next but major task was the development of a rule-based software user-program as a submodule of KALKÜL, special software allowing to generate so called ‘user-programs’ in FORTRAN computer language,to integrate human knowledge on land suitability and the computer ability on data superimposition and analysis. With 5 vegetation classes, 4 land degradation classes and 6 slope classes, 120 different combinations are possible. The program encompasses all the 120 combinations. With some modifications, the program can accept up to 28 information layers and 256 classes in each layer using S-bit geocoded data. The KALKÜL program is also versatile enough to perform a variety of other functions. For example, it can also be used to alter grey values, substitute the cloud-masked areas by real ground information, merge visually and digitally classified images for increasing classification accuracies. and many other per pixel manipulations. A black and white image containing desired number of grey values, each one corresponding to a land suitability class, is the end product of this user-program. Seven classes were generated showing suitability for: agriculture, agro-forestry, agro-horticulture, pasture, forestry, forest conservation and forest protection.

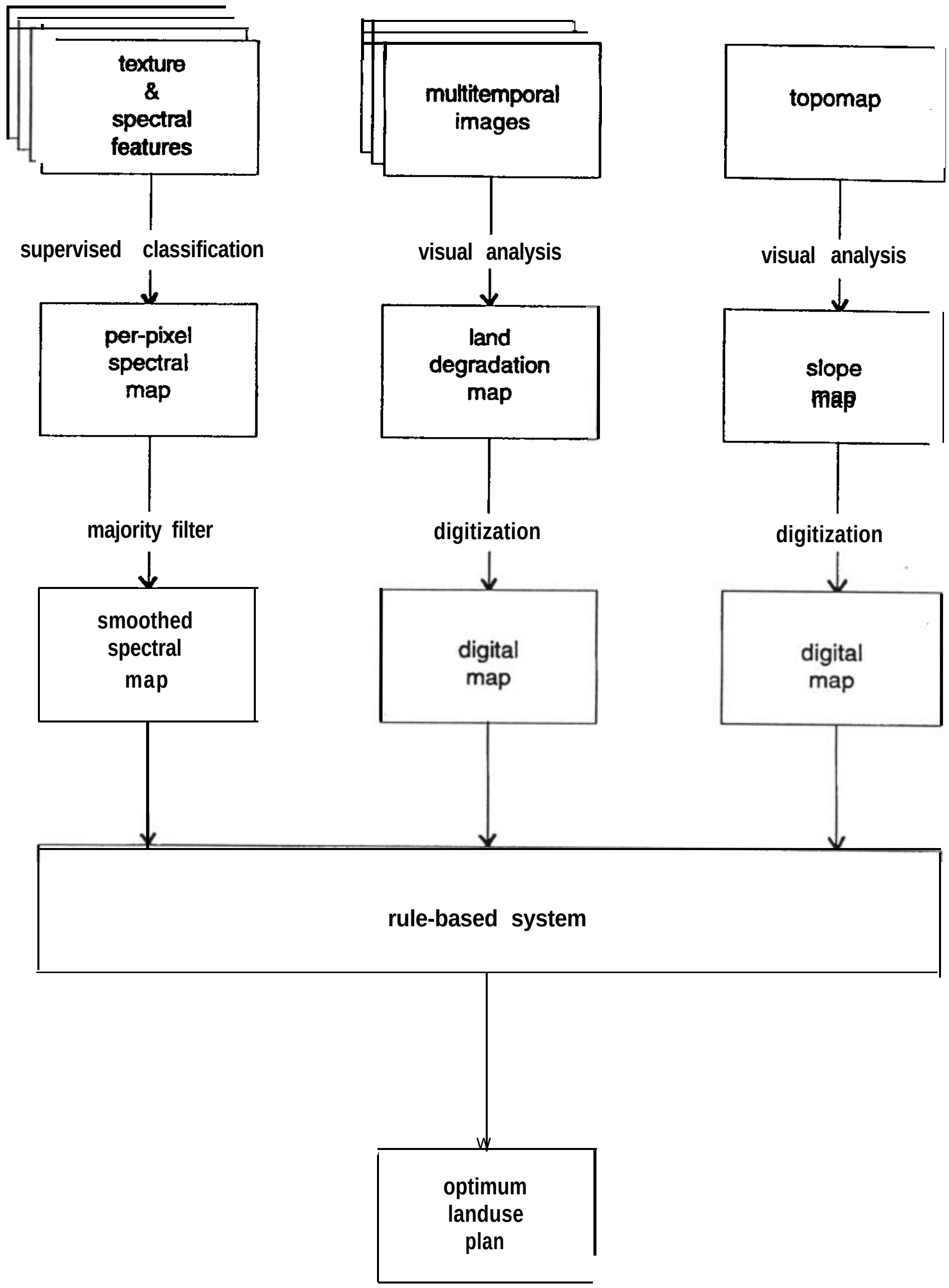


*Figure I. Paradigmfor combining diferent datasets in a rule-based system.*

## 4 Results and Discussion

The study demonstrated that the thematic information maps generated using remote sensing techniques can be used with post-classification processing like smoothing. Smoothed images can also be converted to polygon maps to make them more compatible with common topo-sheets as done by Mehldau and Schowengerdt (1990). This, however, is not a must. The study also showed that if reliable input information layers could be generated, developing an optimal landuse plan may not be a difficult task. Some of the more important issues are the accuracies, timeliness and the registration of the input databases used in GIS. Powerful GIS and digital image analysis software like ERDAS, ARC-INFO, PANMAP, SPANS, ILWIS are available on the world markets. Additionally KALKšL software can be ordered from Freiburg University/ Germany. In future the upcoming Regional Remote Sensing Center at Shillong should be the ideal central facility to carry out this job for the north-east as this would help to minimize the travel cost and time spent to a great extent.

The exercise also indicated a wide gap between the desired and the ongoing landuse practice in the study area which is also true for the whole region. it showed that jhumming is being done even on lands having up to 35 % slope although it is hazardous to practice any landuse involving soil disturbance on the lands having more than 5 % slope in high rainfall regions. Such land fits only for horticulture, pasture and forestry purposes. More than 85 % of the study area was found suitable for horticulture, pasture or forestry The forestry areas having more than 35 % slope are rather suitable for environmental conservation as they contain some rare and endemic species of flora and fauna.

## 5 Conclusions

This exercise clearly demonstrated that remote sensing and GIS could conveniently be used for landuse planning in the north-eastern region. Care should, however, be taken to generate accurate database which is the backbone for any sustainable development planning. It also showed that the current practice of jhumming is unsuitable seeing the terrain conditions and the degree of land degradation although it might be desired by the local people for their immediate needs. For the sake of demonstration effect only three input variables viz., forest cover, land degradation and slope conditions were used. Accuracies of such studies increase further by the inclusion of other important parameters like soil, local rainfall etc. in a GIS environment.


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■ *WolfForstreuter, Asesela W. Cokanacagi*


# Automating ERDAS procedures using dBase

**Introduction**

Some repetitious operations are very time consuming. Many operations are user specific and cannot be included as part of the standard software. ERDAS allows dBASE to operate without leaving the ERDAS menu. Therefore, it is possible to rationalize repeating procedures using the dBASE data bank and its programming potential.

**Situation**

Procedures such as the calculation of area statistics must be done for about 40 different map sheets to estimate Fiji's forest cover. ERDAS software allows the user to create a batch file which contains all instructions necessary to carry out an overlay analysis (e.g. combination of the old forest cover with the up to date forest cover in order to calculate the change), the area statistic calculation and the copy process of the printfile to an ASCII file. The operator does not have to wait for the termination of every substep until he can type in the next instruction. Once he has created the batch file the instructions come from this file.

However, it is still time consuming to create such a batch file, although many instructions are the same for all map sheets. Different are the filenames of the layers that have to be combined and the filename of the result that has to be statistically analyzed.

**dBASE Data Base Potential**

With dBASE software, a data base can be created containing one field of 80 characters. Using the command APPEND FROM "ERDAS-Batch File Name" TYPE SDF it is possible to import the batch file made for the first map sheet into the new created data base. Even very long ASCII files can be imported without any difficulty.

Once the dBASE data base is established containing the ERDAS batch file, a self written dBASE program can modify data base. Because the file names are always at the same defined position within the records of the data base an instruction can search for them and change them. The program has to be designed so that it asks the user for in the new file name and logically checks it before it replaces the old file name in the data base.

The changed or updated data base can be copied back to an ERDAS batch file by the dBASE instruction "COPY TO "ERDAS Batch File Name" TYPE SDF. This instruction should be a part of the program that changes the data base.

**Steering the Procedures by MS-DOS Tools**

It is time consuming to leave ERDAS, call dBASE, call the dBASE program leave dBASE and call ERDAS again. MS-DOS has the potential to rationalize this. From ERDAS the user can call a MS-DOS batch file that calls dBASE without eaving ERDAS. It also automatically starts the self written dBASE program stored in its own directory. The MS-DOS batch file should also be stored in an own directory and the path to this directory should be included in the AUTOEXEC.BAT. This allows the user to call the blatch file from any directory that he is working in. The MS-DOS batch file (extension: BAT) should have the following instruction line: DBASE/T PROGRAM-NAME. The "/T" reduces the time consuming dBASE advertising at the start of this software (of course this is not mentioned in dBASE manuals!). The last line of the self written dBASE program should have the instruction QUIT, which closes the dBASE software and allows the operator to start the newly created batch file within ERDAS.

**Limitations and Potential**

It was not possible to create a batch file in the way described when windows was running in the background. It was also impossible to create an MS-DOS batch file that does the job for more than one ERDAS batch file.

The described example of area calculation for change detection only includes a few steps that were automated. Other applications included more complicated procedures. i.e. the MSD carried out a reef mapping with Landsat data for which subimages had to be produced with reference points. Using the ERDAS-dBASE link it was possible to insert white crosses into the image data indicating the locations of the reference points.0

■ *A.C.Robinson, Resource Management Officer Division of Environment and Conservation, Department of Lands, Surveys and Environment, Western Samoa*

# The Samoa Biodiversity Database

'Biodiversity' is just the latest in a long line of important sounding concepts which sweep through the worlds of Science and Politics. It is, quite simply stated, the variety of life on earth. Pacific island nations, isolated as they are by thousands of kilometres of ocean and with relatively small land areas, support relatively few species of plants and animals so their biodiversity is said to be low in comparison with that of countries on the continental land masses of the world. With recent changes in the Pacific way of life, their rapidly expanding human populations and the apparent extra vulnerability to extinction of species that have been isolated on islands, the plants and animals of the Pacific nations are not faring very well at all. Now, more than ever before, we need good and quickly accessible information on what we have and where it occurs.

With this -in- mind the Division of Environment and Conservation (DEC) of the Western Samoa Department of Lands, Surveys and Environment with funding from the South Pacific Biodiversity Conservation Programme administered by SPREP let a consultancy in July 1993 to establish a Biodiversity Database for Samoa.The system was to be set up in the DEC office but with another version to be established at SPREP as a possible model to take to other countries in the region. Following a considerable amount of preliminary work in Western Samoa a consultancy was let to Viridans Pty Ltd, an Australian company based in Melbourne with considerable expertise in the establishment and management of biological databases.

For the technically minded, the Viridans Biodiversity Database system is designed to run on most IBM-compatible microcomputers. The performance of the system is greatly enhanced if 486 machines are used in conjunction with super-VGA colour graphics.

The DEC system has the following configuration:-

**Hardware**

*1) Central Processing Unit*
The main CPU is a 486DX2, 66Mhz machine. This is one of the fastest machines on the market and will operate at 5 to 6 times the speed of most 368-based computers. The 486DX chip has a maths-coprocessor built in so graphics and mathemetical calculations are carried out with great speed.

2) *Memory*
The computer has 8mb of RAM (random access memory) installed. This capacity has been shown to be optimal for most operations on 486 computers. Any less (usually 2mb or 4mb) and the machine will run more slowly, any more (usually 16mb) and improvement in speed is minimal.

3) *Floppy Disk Drives*
One high density, 3.25" floppy drive - 1.44mb capacity.

*4) Hard Disk*
A single 340mb Western Digital hard disk. Western Digital is one of the worlds leading manufacturers of hard disk drives

*5)Colour Card*
Diamond Stealth, super-VGA. This card is probably the leading colour in the world. It has the capacity to dispaly images up to 1024x786 pixels at 256 colours or 640x480 in 16 million colours. It is one of the fastest display cards so that graphic-based packages such as Windows and Viridans software will operate very quickly

6) *Colour Monitor*
The monitor is a Viewsonics 14", non-interlaced, super VGA. This screen can show unlimited colours and display an image of up to 1024x768 pixels (the limit of the colour card). The non-interlaced function means that the screen will be flicker-free at all resolutions, unlike interlaced monitors (as most standard colour monitors are) which flicker noticeably at screen displays of 800x600 or 1024x768.

7) *Tape Backup*
An internal, 250mb Colorado tape drive has been installed to handle backups from the system. Two tapes will handle all backups from the 340mb hard disk. The tapes used are 3M brand

8) *Printer*
The printer is a Hewlett-Packard, 300 dpi (dots per inch), colour, inkjet model Deskjet 500C. It has the capacity to produce both colour and black and white outputs on A4 paper. Both outputs will produce satisfactory results on ordinary white paper but the colour output is much better on special clay-impregnated paper manufactured by Hewlett-Packard.

**Software**
The software installed on this system is principally written and marketed by Viridans Pty Ltd. In addition other commercially available software complementary to the Viridans software has been installed in a WINDOWS environment including WORD, COREL DRAW and HALO DESKTOP IMAGER. In addition DR PROTO and parts of the DBASE software are accessible from the Viridans menus

Databases such as these are of course only as good as the data that you put into them and in this regard Western Samoa is quite well-placed. To get the best out of the Viridans software you need the following data components:-

*1) Digitised topographic maps of a suitable scale registered to UTM coordinates*
The whole of Western Samoa is covered by topographic maps at a scale of 1:20 000 and these were digitised in ARC-INFO format by ANZDEC Limited Consultants (1990). In addition to the topography, digital cover included land tenure, soils,

erosion, land use and land suitability ratings. For the Samoa Biodiversity Database the topographic, land tenure and land use covers were incorporated directly into Viridans formats from the ARC-INFO data. In addition the 'natural ecosystems' of Western Samoa were classified, mapped and digitised by Pearsall and Whistler (1991) and this mapped information was also incorporated into the Viridans system

2) *Taxonomic information on p/ants and animals*
Taxonomic information on the plants and animals of the Samoan Archipelago is widely scattered through the scientific literature and a major task in establishing this database was to accumulate this information and ensure that it was as up-to-date as possible. Although I initially gathered the species lists from a variety of published sources I was greatly assisted in updating the taxonomy by Art Whistler (vascular plants), Robert Cowie (land snails) and John Dugdale (Butterflies). The other components of the database, reptiles and amphibians, birds and mammals are well enough known taxonomically for me to establish the basic lists unaided. At the beginning of this process I decided to include all species known to occur within the Samoan Archipelago (Western and American Samoa) and to give you some idea of the size of this flora and fauna, the database currently consists of the following numbers of species:- Vascular Plants (1200 species), Butterflies (28 species), Land Snails (110 species), Reptiles and Amphibians (23 species), Birds (including migrants and vagrants) (84 species) and mammals (including marine) (29 species). All species which are 'naturalised in the archipelago' are included whether they are endemic (found nowhere else), indigenous, were introduced by the Polynesian or the European settlers.

3) *Good quality photographs of plants and animals*
In 1991 there was a detailed biological survey carried out in the remaining areas of lowland forest in Western Samoa and Paddy Ryan, a New Zealand wildlife photographer took an extensive series of slides of plants and animals as part of this survey work. Since then I have taken over 3000 colour slides in association with DEC field work in Western Samoa and a high proportion of these photos are of the local wildlife. Many of these photographs together with material from posters and books has now been scanned and incorporated into the Viridans database.

4) *Species records that can be accurately located*
Sources of geocoded data on the plants and animals of Western Samoa are available from Pearsall and Whistlers ecosystem mapping survey (plants) and from the 1991 lowland survey (plants and birds mainly). A variety of scientific papers also provide useable locality records. All these records have been incorporated into our database. In addition, all records collected on DEC field survey work are now routinely entered into the database.

Finally and most importantly, how much did it cost and how easy is it to use. It is difficult to put a total price on setting up a similar system in another country as it depends on the availability of a digital map base or whether maps will have to be digitised the quality of the taxonomic data for the groups chosen and the availsbility of suitable wildlife photographs. In DEC we asked Viridans to provide a full package with purchase and provision of both hardware and software and in mid 1993 this component of the project cost approximately AUS$5000 for the hardware and AUS$7000 for both the Viridans and the associated commercial software packages. There was also an additional cost in digitising the pictures for the database and the Viridans consultant spent one month in Apia setting up the database system at DEC and SPREP. As for how easy is it to use, the Viridans database is a menu driven system and works exclusively from the keyboard with single character commands for all operations and very clear and detailed manuals written in simple English and assuming no previous computing experience supplied. To set up and work within the system obviously requires a greater level of computing skill in areas such as digitising, scanning and desk-top publishing to set up display screens. Most of the people in the DEC office were able to access information from the database and set the output up for printing in Corel Draw after only a few days of basic training. Data entry into the database is just as simple to learn.

The attached illustration of Hawksbill Turtle tagging records was produced quickly and easily in the DEC office (and in full colour) using digitised map bases and data from the Samoa Biodiversity Database.

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### References
ANZDEC LIMITED CONSULTANTS. (1990) Land Resource Planning Study Western Samoa, Final Report. Asian Development Bank TA 1065-SAM.

PEARSALL, S. H. AND WHISTLER, W.A. (1991) Ecosystem mapping for Western Samoa: Technical Report and Appendices prepared for the Government of Western Samoa under a contract between the South Pacific Regional Environment Programme and the East-West Center Environment and Policy Institute.@

# THE GEOGRAPHIC CALCULATOR

**Overview**

The Geographic Calculator is a coordinate transformation program that converts data from one coordinate system to another, as well as performing geodetic forward and inverse calculations. Used with any GPS, surveying, engineering, or mapping system the Geographic Calculator provides accurate geographic coordinate transformations and geodetic calculations.

The Geographic Calculator can convert coordinates between Geodetic, Universal Transverse Mercator (UTM), US State Plane, XYZ Cartesian Earth Centered Earth Fixed (ECEF), Landsat 4 Worldwide Reference System, Military Grid Reference System (MGRS), the New Zealand Map Grid, Carter County Kentucky Grid and User-Defined Coordinate Systems. You can interactively transform coordinates or process coordinate files in several formats, including ASCII, NGS Blue Book, AutoCAD DXF, Arc/Info Generate, Kork

Systems PTLIST and the SEC Pl coordinate file formats. Standard horizontal datum transformation algorithms are implemented, including the Molodensky, DMA Multiple Regression Equations, Seven Parameter Bursa/Wolfe, NGS High Accuracy Reference Network (HARN) and NGS NADCON methods.

Conversion Transformations

You can perform complex coordinate system and geodetic datum transformations very easily from within the Geographic Calculator. All coordinate conversion transformations are accomplished by applying the following steps in order:

1) A source coordinate in the source coordinate system and geodetic datum is converted to a geodetic coordinate by applying inverse map projection equations. This step is not performed if the source coordinate is already in the geodetic coordinate system.

2) The geodetic coordinate in the source datum is converted from the source datum to WGS 84 by applying a datum transformation method and related shift parameters. This step is not performed if the source and destination geodetic datum transformation and shift parameters are equivalent.

3) The WGS 84 geodetic coordinate is converted to a geodetic coordinate in the destination datum by applying a datum transformation method and related shift parameters. Again, this step is not performed if the source and destination geodetic datum transformation and shift parameters are equivalent.

4) The geodetic coordinate in the destination datum is converted to the destination coordinate system by applying forward map projection equations. This step is not performed if the destination coordinate is to be in the geodetic coordinate system.

If the source and destination geodetic datum transformations are equivalent no datum transformation is performed.

Summary

This version of the Geographic calculator (Version 3.01) is a big improvement on previous versions. An extensive list of transformations is provided and being added to. Unfortunately, there are no paramaters at the present time for Fiji. The Lands Department are currently in the process of determining the accurate transformation parameters form WGS84 to WGS-72. When these become available, they could be set up in the Geographic Calculator and readily used for transformation work.

The Geographic Calculator is available from: Blue Marble Geographics, 46 Water St. Gardiner MAINE 04345 USA, Ph (207) 5826747, Fax (207) 5827001.

*Forfurther information call Mike Poidevin, MSD - Forestry (679) 320814.*

# CONTACTS

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Department of Town and Country Planning/303515
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Fiji Forest Industries Ltd/813088
Fiji Pine Commission/661784
Fiji Posts and Telecommunications/313362
Forestry Department, Management Services Division/ 320311
Forum Secretariat/305573
French Embassy/300937
Harrison and Grierson/301986
Japanese International Cooperation Agency/302452
Lands Department, FLIS Support Centre/305029
MacPacific/303681
Mineral Resources Department/370039
Ministry of Agriculture, Fisheries and Forestry, Drainage and Irrigation/305546
Ministry of Primary Industries, Drainage and Irrigation/ 305546
Ministry of Primary Industries and Cooperatives, Land Use Section, 400262
Native Lands Trust Board/303164
Public Works Department, Hydraulics Section/303023
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Queensland Insurance1300285
South Pacific Applied Geoscience Commission1370040
South Pacific Commission/370021
UNDP, Department of Humanitarian Affairs!304942
UNDP, Regional Water & Sanitation Project/302487
UNDP/FAO South Pacific Forestry Development Programme1305212
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CSIRO, Division of Fisheries, Australia
SPOT Imaging Services Pty Ltd, Australia
Ministry of Agriculture, Cook Islands
Ministry of Foreign Affairs, Cook Islands
Ministry of Marine Resources, Cook Islands
Department of Resources & Development, FSM
Department of Conservation & Resources Surveillance, Division of Forestry, FSM
Bureau of Planning, Guam
Department of Agriculture, Guam
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Ministry of Foreign Affairs & Trade, Kiribati
Ministry of Home Affairs and Rural Development, Lands and Survey Division, Kiribati
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Ministry of Foreign Affairs, Marshall Islands
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*It would be appreciated if contributions could be sent on floppy disk in Word for Windows (preferred), WordPerfect for windows or WordPerfect for DOS format0*