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P17

DTM AS AN AID TO LAND USE CAPABILITY ATIU, COOK ISLANDS

LE MODELE NUMERIQUE DE TERRAIN (MNT) UNE AIDE AUX ETUDES DE POTENTIALITES D'UTILISATION DES SOLS. L'ILE D'ATIU (ILES COOK)

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ABSTRACT

Atiu Island of the Southern Cook Group is susceptible to soil erosion. Slopes greater than 2 degrees, which were previously stable under fern vegetation, have been converted to pineapple plantations and are now eroding. During intense rainfall, water runs over the ground in sheets, rills form and then gullies. Not only is the eroded land being degraded, but the excessive sediment poses a threat to the ecology of lowland swamps which are planted in taro (the main cash crop in Atiu).

In collaboration with the Cook Islands Department of Survey and Department of Agriculture, DSIR Land Resources recently compiled a land resource inventory of physical factors affecting land use. An important product of the inventory is a land use capability map which provides a basis for recommending sustainable land uses and planning soil conservation measures. This paper describes the creation and use of a digital terrain model (DTM), as a practical aid in mapping.

RESUME

L'île d'Atiu (groupe Sud des îles Cook) est le siège d'érosion du sol. Les pentes supérieures à deux degrés,

précedemment revêtues de fougères et stabilisées ont été conquises par des plantations d'ananas et sont désormais en cours d'érosion. Lors des pluies intenses, l'eau ruisselle en petites nappes puis en ruisselets enfin en ravines. La dégradation ne touche pas seulement le sol qui est érodé mais l'excès de sédiment transporté à l'aval induit un impact sur les marais des plaines côtières plantées de tarots, la principale ressource agricole de l'île.

En collaboration avec le Service Topographique et le Service de l'Agriculture des îles Cook le département des ressources terrestres du DSIR a réalisé un inventaire de ces ressources et des facteurs qui affectent l'utilisation des terres. L'un des composants importants de cet inventaire est la carte des potentialités agricoles qui sert de base aux conseils en matière d'utilisation des terres et à la planification des mesures de protection des sols. Le présent papier décrit la mise en forme d'un modèle numérique de terrain en tant qu'outil d'aide à ce type de cartographie.

LAND USE CAPABILITY

Land use capability (LUC) denotes the capacity of land to sustain various uses. Classes are mapped between 1 and 8. At the extremes, Class 1 represents land which is capable of sustaining a wide variety of productive uses, and Class 8 represents land which cannot sustain productive use. For example, the generalised land use suitabilities for each LUC class on Atiu are shown in Table 1.

A LUC survey consists of an inventory of physical factors important to land use. These are rock type, soil type, slope, landform, erosion, vegetation cover. These factors together with climate and the effects of past land use provide the basis for determining LUC.

A prerequisite for any land resource inventory is an accurate basemap for recording of LUC unit boundaries. On Atiu the land use patterns are complex requiring a mapping scale of 1:10 000. A recent base map or topographic map, at this scale was not available. Thus, a basemap had to be made.

The highest resolution satellite data, SPOT panchromatic, can only map accurately down to 1:25 000, hence aerial photography was required.

AERIAL PHOTOGRAPHY

The Department of Lands, Cook Islands, acquired the natural colour aerial photography using a small format 55mm x 55mm Hasselblad camera. The lens focal length was 50mm. A flying height of 2000 m gave a film scale of approximately

1:40,000. Two surveys had to be done to get a complete cloud free and stereo coverage of the Island : one in December, 1988 and one in May, 1989. The negatives were printed at a scale of approximately 1:10 000.

These prints were used by the Department of Survey and Land Information, New Zealand, to produce a DTM on a 30 m grid using an analytical stereoplotter.

THE DTM

The 30m DTM was interpolated to produce a DTM on a 21.213m grid. In otherwords, every 21.213m, in either the north/south or east/west direction, a surface elevation is recorded. The details of the DTM are recorded in Table 2.

PHOTO BASEMAP

Nineteen photographs were chosen to make a photo basemap of Atiu. They were scanned using an Eikonex scanning camera to create nineteen digital images each of 3 spectral bands (blue, green, red). In hilly terrain, relief displacement introduces geometric distortion into aerial photography, which needs to be removed before photographs can be accurately stitched together. The DTM was used to predict relief displacement in each digital image, which was then corrected (Dymond, 1986). The output is a differentially rectified image. The 19 differentially rectified images were then stitched together to form the photo basemap shown in colour fig. P17A. Most features are correctly positioned to within 5 metres.

The photo basemap was printed at a scale of 1:10 000, to be used for drawing boundaries of land use capability units onto, prior to input to a geographic information system. The original boundaries were drawn onto the original aerial photographs while viewed through a stereoscope. The boundaries were then manually transferred to the 1:10 000 photo basemap.

SLOPE MAP

Slope is a key factor in deciding land use capability. It was hoped that a slope map could be derived from the DTM in order to reduce field work. The slope map is shown in colour fig. P17B. However, 3 factors greatly reduced its usefulness.

1) It was difficult to determine average slope for an LUC map unit from a mixture of instantaneous slopes ;

2) The slope map was not very accurate because elevations were based on the top of canopies rather than on ground level ;

3) The grid was too coarse to give accurate maximum slopes. An abney level in the field proved far more useful.

RESULTS OF THE LUC SURVEY

From the resource inventory, 22 land use capabilities were identified, each with its own characteristic set of physical factors, potential, limitations and land use suitabilities. Comparison of LUC with present land use has highlighted some important points.

"Land within the interior lowlands is of high quality and the people are skilled in its agricultural use. In contrast, sloping land within the interior uplands is of low quality and it suffers from serious soil erosion, mainly as a result of pineapple cash cropping and the burning of fernland vegetation. The erosion problem demands urgent remedy - for the benefit of both present and future generations of Atiuans. It is timely to reduce cash cropping and concentrate on soil conservation on this eroding land" (Jessen et al., 1990).

CONCLUSION

The DTM was an invaluable aid for producing a digital photomap of Atiu. The slope map derived from the DTM was not useful mainly because of insufficient resolution.

ACKNOWLEDGEMENT

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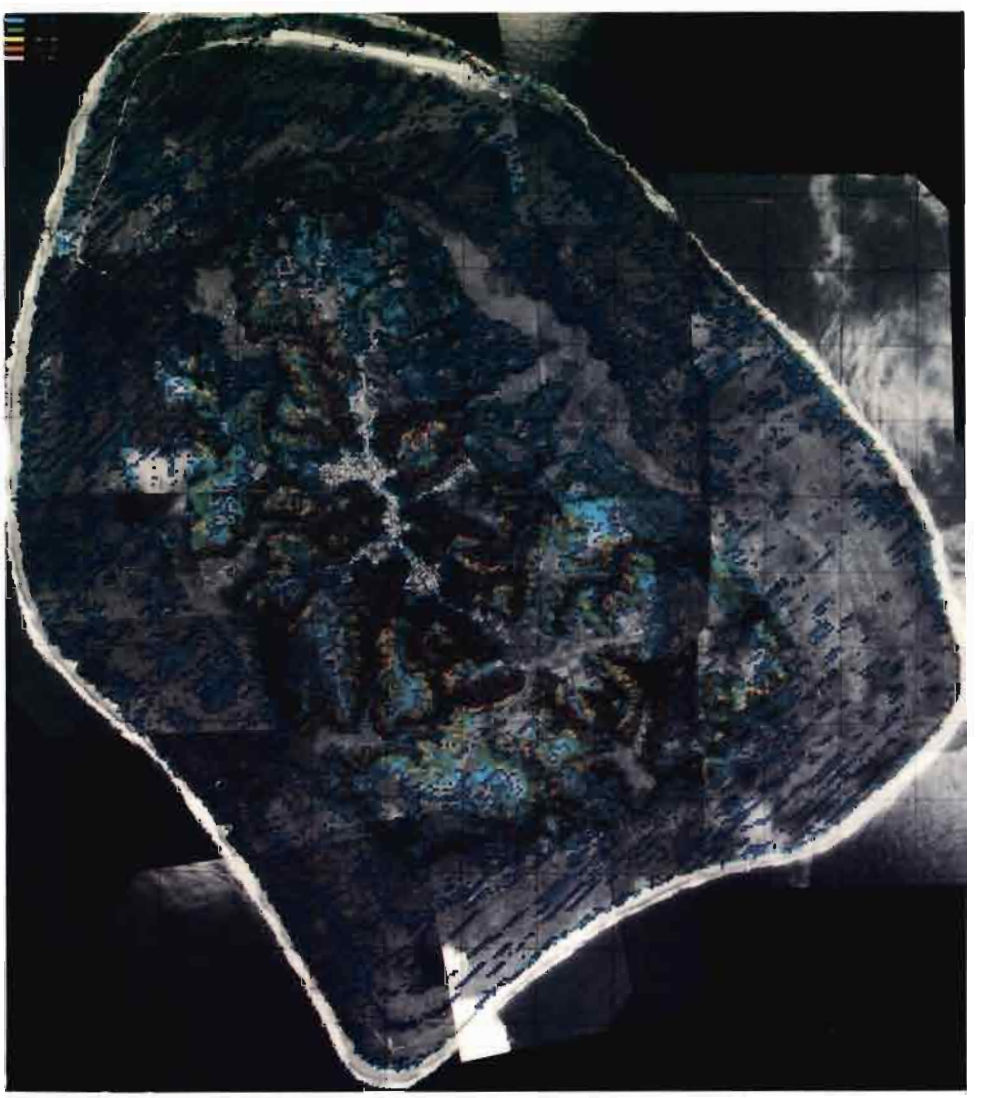
Table 1 : Generalised land use suitabilities and overall degree of limitation for LUC classes.

LUC class	Open field cropping	Tree and tree-like	Pastoral farming, production forestry
1	High	High	High
2	Mod. high	High	High
3	Medium	High	High
4	Low	Mod. high	High
5	Unsuitable	Medium	Mod. high
6	Unsuitable	Low	Medium
7	Unsuitable	Unsuitable	Low
8	Unsuitable	Unsuitable	Unsuitable

Table 2 : Details of Atiu DTM

size	331 lines x 296 columns
bits/pixel	16
elevation units	decimetres
grid	Atiu Local Grid
top left corner	- 2494.6 easting 3192.6 northing
bottom right corner	3799.6 easting, -3833.6 northing
grid size	21.213 metres
elevation accuracy	within 5 metres
positional accuracy	within 5 metres
source data	northwest-southeast profile points every 30m

P17A : Photo basemap of Atiu, Cook Islands at 1:50 000 scale. Grid lines are 500m



P17B : Slope map of Atiu, Cook Islands at 1:50 000 scale.

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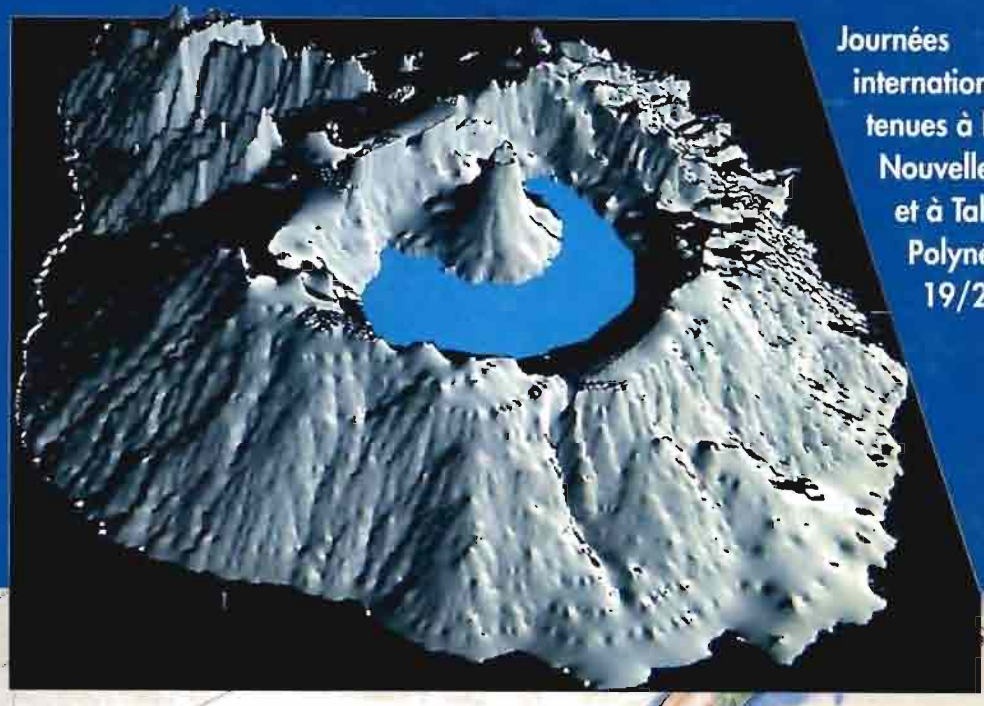

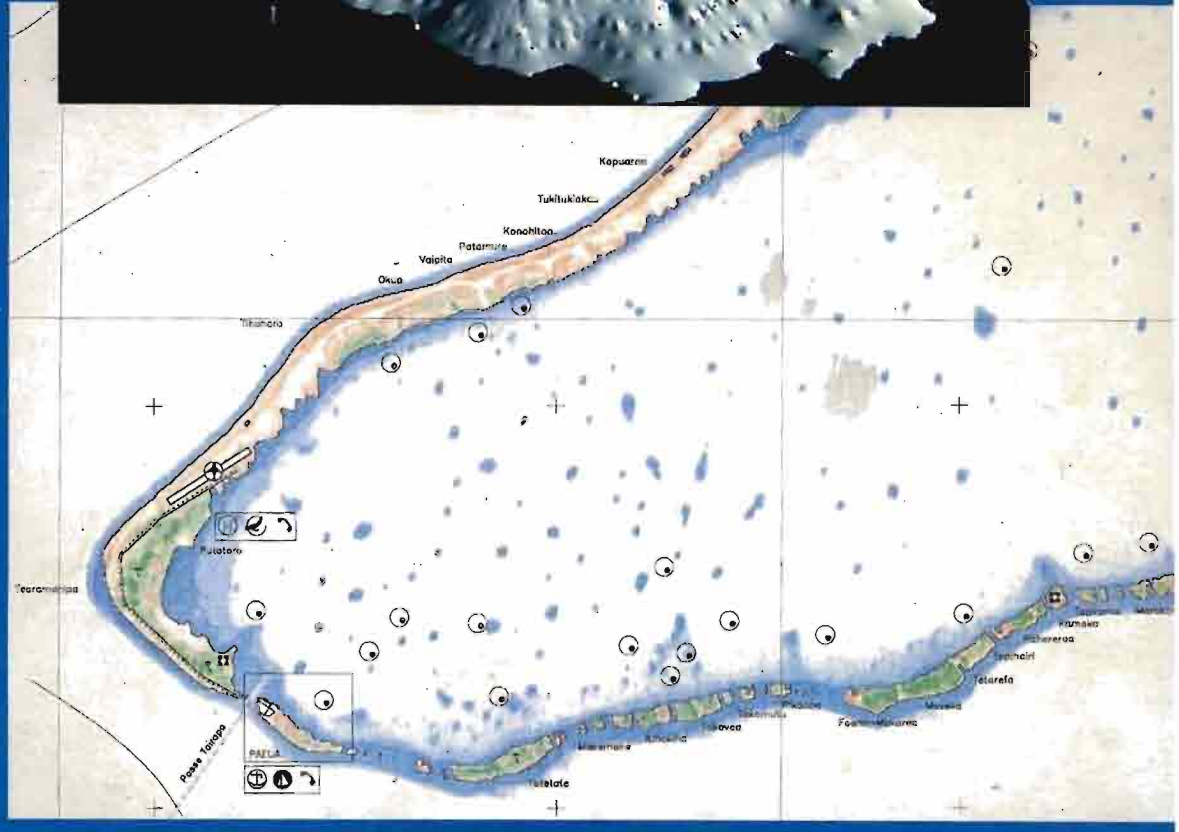

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