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STATUS OF REMOTE SENSING IN NEW ZEALAND

ETAT DE LA TELEDETECTION EN NOUVELLE ZELANDE

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ABSTRACT

In New Zealand the Department of Scientific and Industrial Research has been primarily responsible for the technological development of remote sensing and image processing, as well as the application of remote sensing. This has included the development of an image processing software package, the construction of a portable 8-channel radiometer, and a number of application projects developed to transfer this technology to the New Zealand user. Digital satellite data are used for weather forecasting, ocean temperature studies, cyclone damage mapping (erosion and sedimentation), and land cover mapping. Digitised aerial photographic data are used in conjunction with satellite and geographic information system data for mapping cyclone damage and land cover.

New Zealand does not have direct access to an earth resource satellite station capable of receiving high resolution digital data. Because of its on-board tape recorder, the SPOT satellite has been the only source of high resolution data during the 1980s. SPOT data are received by a station in Sweden and then flown to New Zealand. Landsat TM data can now be relayed via satellite to America prior to being dispatched to New Zealand. Coarse resolution NOAA (weather) satellite digital data are received and archived daily in New Zealand.

Several remote sensing courses are available in New Zealand to offer training in these remote sensing and image processing technologies.

RESUME

La Nouvelle Zélande n'a pas d'accès direct à une station capable de recevoir des données de satellite de ressources terrestres, digitales et de haute résolution. Grâce à son enregistreur de bord, le satellite SPOT est la seule source de données de haute résolution. Ces données sont reçues par une station en Suède qui les renvoie en Nouvelle-Zélande. Les données digitales du satellite NOAA (météorologie) de moyenne résolution sont enregistrées tous les jours.

Le Département Néo-zélandais de Recheche Scientifique et Industrielle a été chargé du développement technologique de la télédétection et du traitement d'image ainsi que de l'application de la télédétection. Ce développement qui s'étale sur une période de 15 ans comprend la réalisation d'un package logiciel de traitement d'image et l'élaboration d'un radiomètre portable à 8 canaux. Les données digitales satellitaires sont utilisées en météorologie (par le Service Météorologique Néo-zélandais), pour l'étude de la température de l'océan, de la cartographie des dommages créés par les cyclones (l'érosion et la sédimentation) et la cartographie de l'occupation du sol.

Les données digitalisées de photographies aériennes sont utilisées conjointement avec les données de satellite pour la cartographie de l'occupation du sol.

La Nouvelle-Zélande propose une série de cours de télédétection et de formation dans ces technologies.

INTRODUCTION

For a developed country, New Zealand's remote sensing history has been unique because it is not within the coverage circle of an earth resource satellite receiving station. Earth resource satellite data from early Landsat (I,II and III) and the SPOT satellites, both types having on-board tape recorders, have been evaluated for land and water applications. From 1980 Landsat became unavailable over New Zealand. As a consequence most applications of remote sensing have centred on the use of high resolution digital data from SPOT. SPOT satellite digital data have been used, operationally, for mapping cyclone damage and vegetative cover. Coarse resolution satellite data are routinely used for weather forecasting and some ocean studies (for example, sea temperature).

The Division of Land Resources (DLR) of the New Zealand Department of Scientific and Industrial Research (DSIR) has developed a number of applied remote sensing techniques using aerial photographs in both analogue and digital form. These techniques have been developed for soil conservation and land use issues.

EDUCATION AND TRAINING

Remote sensing education is part of existing courses at five of the seven New Zealand universities. Remote sensing undergraduate and post graduate courses are taught at the following universities : Auckland, Waikato, Massey, Canterbury and Otago. These universities also teach Geographic Information System (GIS) courses.

The DSIR Division of Physical Sciences (DPS) has provided the New Zealand contact point for the UN-ESCAP Regional Remote Sensing Program. DPS collates and distributes the New Zealand Remote Sensing Newsletter, as well as acting as the defacto New Zealand Space Agency. DLR has provided a New Zealand representative for the Asian Association on Remote Sensing. New Zealand is to host the 6th Australasian Remote Sensing Conference in late 1992.

DLR has conducted a number of specialist remote sensing and GIS training courses, principally for New Zealand trainees, but people from China, Indonesia, Western Samoa, Thailand and Iran have also attended. DLR staff have been involved with a remote sensing training course held in Fiji organised by the Australian Key Centre for Information Studies.

Both DLR and DPS have a guest worker program operating from time to time. This program offers training and experience at an advanced level.

A Hastings based company, NZ Aerial Mapping Ltd. (NZAM), offers training in aspects of aerial photography (for example, flight planning and aircraft navigation).

AERIAL SURVEY AND MAPPING ACTIVITIES

There are five aerial survey companies in New Zealand, four of which have modern mapping cameras capable of exposing colour film. Three companies have photogrammetric plotting capabilities.

One company, NZAM, has undertaken aerial photography of most South Pacific countries, commencing in 1943. Photographic sorties in the Pacific have been conducted on a frequent basis since that time, mostly funded by the New Zealand Ministry of

External Relations and Trade, for a wide range of land use and mapping projects.

Some private companies and government departments conduct their own aerial photography for natural resource inventory purposes and for research. Medium format cameras mounted in light aircraft are typically used.

There are two main mapping agencies in New Zealand - the Department of Survey and Land Information (DOSLI) and NZAM. DOSLI is the Crown mapping agency and is responsible for all national topographic mapping. A digital cadastral database is presently being prepared for the nation. NZAM has modern computerised photogrammetric and plotting equipment which is used for a range of mapping activities.

REMOTE SENSING TECHNOLOGY

DPS has been primarily responsible for the technological development of remote sensing and image processing in New Zealand. This has included the development of a sophisticated software package, EPIC, which is suitable for a number of image processing tasks, especially remote sensing (McDonnell, 1986). EPIC is typically hosted by Digital VAX computers and is presently operated at 7 major sites in New Zealand and 5 sites in China, Australia, and America. EPIC has recently been modified to run on PC computers. Five PC versions of EPIC are operating at New Zealand sites. DLR staff have contributed to the development of the EPIC software library.

The New Zealand Meteorological Service staff have been responsible for the technological development associated with the routine use of coarse resolution National Oceanographic and Atmospheric Administration (NOAA) imagery (Kidson et al., 1986). Both the Meteorological Service and DPS operate NOAA reception facilities. DPS routinely archives the daily coverage.

A portable 8-channel (visible and near-infrared) radiometer was manufactured and sold world wide by DPS. The radiometer has been used on two Space Shuttle missions.

DPS stores and maintains the New Zealand archive of satellite data - mainly Landsat MSS, NOAA AVHRR and SPOT. These are stored on optical disk. DPS holds the licence to distribute SPOT satellite data in New Zealand for SPOT IMAGE in Toulouse.

APPLICATION OF REMOTE SENSING

Most remote sensing applications in New Zealand have been developed for land related issues. These techniques have

included the use of aerial photographic, satellite, digital terrain and GIS data.

Land related applications

With one exception, all land related applications have involved high resolution data. The exception is the work by (Taylor et al., 1985) which involved the use of NOAA Advanced Very High Resolution Radiometer (AVHRR) data to study the relationship between normalised vegetation index and pasture growth rate for some intensively used agricultural areas of the North Island.

Application of aerial photographs

Aerial photographs have been used for a range of purposes related to landslide erosion mapping and research associated with impacts of landslides on land use sustainability. Sequential aerial photographs have been used to determine the effect that landslide erosion has on pasture production (Trustrum et al., 1984). The combination of aerial photographs and field observations provides a rapid technique to map erosion, sedimentation and vegetation damage caused by rainstorms and cyclonic winds (Stephens et al., 1983; Harmsworth et al., 1987). (Stephens et al., 1989) describe the use of natural colour aerial photography to map cyclone damage, and to produce a natural hazard map, of part of the Solomon Islands.

Aerial photography has also been used : to delineate stress in New Zealand horticultural crops (Stephens et al., 1984) ; for a range of agricultural purposes including weeds surveys, pasture and crop disease research, and planning land drainage; and for geological (Homer and Forsyth, 1983) and forestry purposes.

Use of airborne video

(Carr and Stephens, 1986) describe the use of colour video for mapping erosion caused by two intense rainstorms in New Zealand. In both surveys, airborne video proved effective in providing base information for storm damage assessment. Video proved to be a near real-time tool, providing storm damage information over large areas in a hitherto impractical time frame. Thermal infrared video has been used for geothermal environmental monitoring (M.A. Mongillo, DSIR, pers comm.).

Use of digital data from aerial photographs

Digitised aerial photographs have been used to map vegetation changes on sand-dunes (Stephens, 1985) and to assess landslide damage caused by an intense rainstorm event (Pain and Stephens, 1990). The use of digitised aerial photographs for both of these applications proved to be

superior to techniques involving visual interpretation of the photographs. Aerial photographs have been used by Dymond (1990) to provide a detailed digital base map for land resource mapping and land use planning in the Cook Islands.

Use of SPOT satellite data

Evaluation of SPOT satellite digital data in New Zealand showed that identification and quantification of land cover and land use may be achieved with levels of accuracy acceptable for most routine investigations (Belliss et al., 1987).

Panchromatic SPOT satellite data have been used to determine the total area of bare ground, on a farm-by-farm basis (Trotter et al., 1989). The bare ground (comprising landslide scars and debris-tails) was caused by a cyclone in New Zealand. However, the landslide scar and debris-tail components could not be resolved on the basis of radiance levels. These components were instead determined from representative landforms in the region by a combination of photo-interpretation and digitisation/classification of 1:5000 scale colour aerial photographs which covered a small part of the affected region. An estimate of the average ratio of scar to debris-tail for an individual farm was then obtained by intersection of a regional landform map and a farm boundary overlay, using a GIS.

Panchromatic SPOT digital imagery has been used with digitised time-sequential aerial photographic data to determine the amount and areal extent of vegetation and bare ground changes that have occurred over a 23 years time period (Stephens and Cocks, in press).

Multispectral SPOT data have been used to map percent vegetative cover of the semi-arid rangeland in the central South Island (Dymond et al., in prep). In a raster GIS this percent vegetation cover map, along with soil and rainfall data, has been used to determine the extent to which soil class can be correctly predicted by percent vegetation cover alone (Wilde et al., in prep). Further, this work has indicated the possibilities of using these data as an independent quality control for natural resource mapping.

Water related applications

Applications of remotely sensed data to water issues have been developed by DSIR and Meteorological Service staff. NOAA AVHRR digital data have been used to determine the distribution of sea surface temperatures for most of New Zealand's Extended Economic Zone (EEZ) (Kidson et al., 1986). (Barnes, 1986) described the use of NOAA AVHRR thermal data to monitor the position of fronts, eddies and upwelling regions within the New Zealand EEZ. Barnes (ibid) has also used data from the Coastal Zone Color Scanner (CZCS) sensor carried on the NIMBUS satellite. He used the colour data to obtain near-

surface distribution of chorophyll pigment which is related to the primary productivity of the ocean. The colour data have been used in combination with the AVHRR thermal data to monitor upwelling zones. AVHRR data are also being used to track the direction and velocity of ocean current boundaries (Wu et al., in prep).

CURRENT RESEARCH

Current remote sensing and image processing research in New Zealand includes the following :

- Generation of digital elevation data from stereoscopic SPOT data.

- Enhancement of methods to model the landscape and to map and monitor land cover using integrated spatial information systems (remote sensing, GIS and expert systems).

- Development and application of airborne videography for natural disaster and environment monitoring, and assessment of mass movement and flood damage.

- Development of rapid and accurate methods involving the use of Landsat TM and SPOT imagery to update natural resource maps containing erosion, vegetation and land use information.

- Development of methods to map vegetation damage caused by animals and to investigate the feasibility of modelling/predicting animal movements across the landscape.

- Development of techniques to detect shipping automatically in both SPOT and Landsat TM data.

- Mapping movement of non-rigid features (such as ocean currents) in satellite imagery.

New Zealand workers are very interested in using a number of new (for New Zealand) data types, especially Landsat TM and synthetic aperture radar. It is perceived that the high spectral resolution of Landsat TM will assist vegetation and land use mapping. With our large expanses of ocean to monitor and persistent cloud cover it is anticipated that radar will have many useful applications in the New Zealand (and South Pacific) environment.

REFERENCES

BARNES E.J., 1986. An overview of oceanographic remote sensing. Proceedings of the First New Zealand Image Processing Workshop. *Division of Information Technology, DSIR, Report No. 30* July 1986, pp. 36-37.

BELLIS S.E., P.R. STEPHENS, I. McINDOE, K. MUSCROFT-TAYLOR, G. WARD, P.F. NEWSOME, 1987. SPOT-1 over New Zealand: Analysis of SPOT imagery for land use investigations. *In SPOT 1 image utilization, assessment, results*. Paris, November 1987. Centre National D'Etudes Spatiales. pp. 675-679.

CARR K.S., P.R. STEPHENS, 1986. Airborne video for real-time resource surveys. In Recent developments in aerial photography and image processing, and the application of remote sensing to soil and water management. *Remote Sensing Workshop Proceedings* (Ed. L.A. Benny), 10-12 September 1985. Soil Conservation Centre, Aokautere, Publication No. 8, 1986, pp. 92-104.

DYMOND J.R., 1986. Digital photomaps from aerial photographs. *New Zealand Journal of Technology,* vol. 2, pp. 143-148.

DYMOND J.R., 1990. DTM as an aid to land use capability, Atiu, Cook Islands. In Proceedings of "PIX'ILES 90", an *International Workshop on Remote Sensing and Insular Environments in the Pacific: Integrated approaches.* Noumea and Papeete, 19-24 November 1990.

DYMOND J.R., P.R. STEPHENS, P.F. NEWSOME, R.H. WILDE, in prep: Percentage vegetation cover of a degrading rangeland from SPOT. *International Journal of Remote Sensing.*

HARMSWORTH G.R., G.D. HOPE, M.J. PAGE, P.A. MANSON, 1987. An assessment of storm damage at Otoi in Northern Hawkes Bay. *Soil Conservation Centre, Aokautere, Publication No. 10,* 76 p.

KIDSON J.W., B.F. TAYLOR, P.W. DINI, 1986. Image processing in the Meteorological Service. Proceedings of the First New Zealand Image Processing Workshop. *Division of Information Technology, DSIR, Report No. 30* July 1986, pp. 3-12.

McDONNELL M.J., 1986. The EPIC image processing -system : A status report. *In Proceedings of the First New Zealand Image Processing Workshop. Division of Information Technology, DSIR, Report No. 30* July 1986, pp. 13-24.

PAIN C.F., P.R. STEPHENS, 1990. Storm damage assessment using digitised aerial photographs : Eltham, New Zealand, 24-25 February 1986. *New Zealand Geographer, vol. 46(1),* pp. 21-22.

STEPHENS P.R., 1985. Measuring changes in areal extent of bare sand-dunes using digital image analysis. In Proceedings of the Soil Dynamics and Land Use Seminar, Blenheim, 20-24 May 1985. (Ed. I.B. Campbell). *New Zealand Society of Soil Science and New Zealand Soil Conservators Association,* pp. 368-379.

STEPHENS P.R., N.A. TRUSTUM, D.L. HICKS, 1983 : Experimental aerial photographic survey of erosion and catchment condition, Gladstone District, Wairarapa. In Remote

Sensing for Soil Conservation (Workshop Proceedings, 29 June-1 July 1982). *A Remote Sensing Manual for Soil Conservators (Ed. P.R. Stephens).* Water and Soil Miscellaneous Publication, No. 52, pp. 129-154.

STEPHENS P.R., R.E. SMART, P.D. KING, M.F. CHRISTENSEN-WIDT, W.E. COTCHING, 1984. Aerial photography in New Zealand horticulture. *New Zealand Agricultural Science, vol. 18(2),* May 1984, pp. 49-53.

STEPHENS P.R., N.A. TRUSTUM, I.E. WHITEHOUSE, P. M. BLASCHKE, 1989. Remote sensing for cyclone damage and hazard mapping - Solomon Islands. *Proceedings of UN-ESCAP Workshop on Remote Sensing for Land and Sea Resource Survey and Evaluation in the Pacific,* Port Vila, Vanuatu, 7-11 August 1989, pp. 43-48.

STEPHENS P.R., J.S. COCKS, in press. Changes in vegetation and sand-dunes from digitised aerial photographs and SPOT data. In Applications of *Remote Sensing in Asia/Oceania, Asian Association on Remote Sensing.*

TAYLOR B.F., P.W. DINI, J.W. KIDSON, 1985. Determination of seasonal and interannual variations in New Zealand pasture growth from NOAA-7 data. *Remote Sensing of the Environment, vol. 18,* pp. 177-192.

TROTTER C.M., P.R. STEPHENS, N.A. TRUSTUM, M.J. PAGE, K.S. CARR, R.C. DE ROSE, 1989. Application of remotely sensed and geographic information system data to quantitative assessment of landslide damage. *Proceedings of the 12th International Geoscience and Remote Sensing Symposium,* Vancouver, Canada. 1989.

TRUSTUM N.A., V.J. THOMAS, M.G. LAMBERT, 1984. Soil slip erosion as a constraint to hill country pasture production. In *Proceedings of the New Zealand Grasslands Association, vol. 45,* pp. 66-76.

WILDE R.H, M.F. WHITE, P.R. STEPHENS, P.F. NEWSOME, J.R. DYMOND, in prep. Percentage bare ground as an indicator of broad soil class in the Mackenzie Basin. *Proceedings of the New Zealand Soil Science Society Conference,* Alexandra, November 12-15, 1990.

WU Q.X., D. PAIRMAN, S.J. McNEILL, E.J. BARNES, in prep. Computing adventive velocities from satellite images of sea surface temperature. Transactions IEEE.

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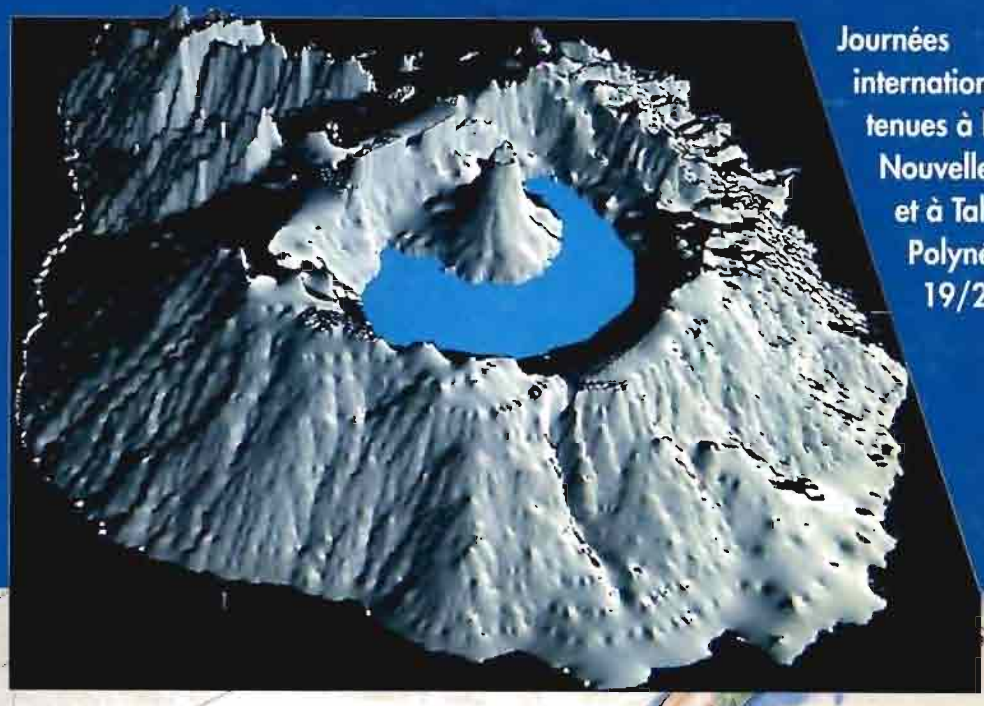

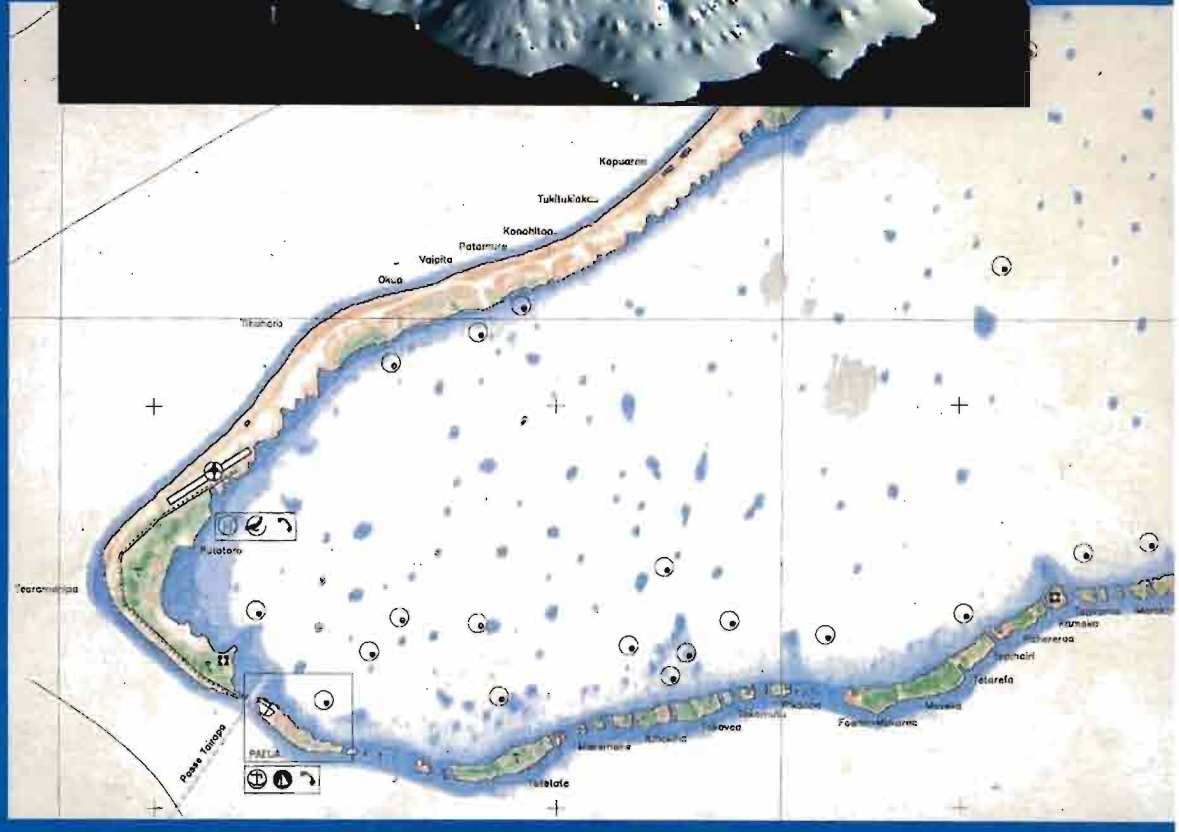

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