AN INVESTIGATION OF THE APPLICATION OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS FOR RESOURCE MANAGEMENT IN WESTLAND, NEW ZEALAND.

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ABSTRACT

Effective management of natural resources, and the side effects resulting from their use directly affects our environmental and economic wellbeing. This thesis was initiated to investigate the application of remote sensing, digital image processing and Geographic Information System (GIS) tools for natural resource management in Westland, New Zealand. From the multitude of potential applications, research was directed toward two issues: alluvial gold mining and indigenous forest management. This thesis focused on the use of personal computer (PC) applications.

A study of alluvial gold mining operations utilised black-and-white aerial photography taken at five dates in the period 1943 to 1988. The photographs were digitised, registered to a common base-image, and classified for bare ground, scrub and trees. A cadastral plan was also digitised, registered to the digital imagery and used to extract specific land-tenure parcels. The classified imagery was processed in an independent-classification change detection to identify change in land-cover between the dates of aerial photography.

The results demonstrated that digital image processing of black-and-white aerial photography could provide the quantitative and spatial land-cover information required for resource management in areas of alluvial gold mining. However, although the individual image classification accuracies exceeded 85%, error in the classifications generated areas of spurious change in the change detection imagery. Examination of subsequent change images revealed areas of land alternating between opposing change classes and indicated how a second, subsequent change image may be a useful tool to rapidly identify possible areas of spurious change.

An investigation of satellite imagery and digital image processing for management of indigenous forests compared a supervised classification of SPOT multispectral (XS) and Landsat Thematic Mapper (TM) imagery with an existing vegetation map. The images were classified with a maximum likelihood algorithm, applying vegetation classes derived from the map. The Landsat TM image achieved a higher overall classification accuracy (75%) compared to the SPOT XS (53%), indicating a superior information content for vegetation discrimination in the Landsat TM imagery. However neither image could achieve sufficient accuracy to be used for updating the existing map.

A second study of indigenous forestry applications investigated the use of integrated remote sensing and GIS analysis. A forest inventory comprising field-plots which recorded tree species and size-class information was interrogated within a GIS. The study illustrated

how GIS tools could be used to rapidly identify and map field-plots that contained trees suitable for harvesting in sustained-yield logging operations. This information is a prerequisite for any sustained-yield logging and would have been unfeasible to obtain without a GIS.

Two strategies were investigated for integrating the forest inventory with SPOT XS and Landsat TM imagery. The first approach applied a clustering procedure to generate the natural vegetative clusters within the forest inventory. A spectral signature for each plot was obtained by overlaying the plots on the digital imagery. A discriminant analysis was applied to determine whether the spectral information in the imagery could discriminate between the inventory clusters. The results revealed that this was not possible with overall classification accuracies of 39% and 48% for the SPOT XS and Landsat TM images respectively.

The second approach reversed the procedure and applied an unsupervised image classification to identify the spectral classes present in each image. The vegetative composition of each image class was investigated by examining the forest inventory plots within each class. The results demonstrated that the number of trees in the sub-canopy showed the most variation between classes, with minimal differences attributed to the species composition.

Analysis of the two approaches illustrated the difficulty of relating classifications derived from field survey and those from satellite imagery. While use of satellite imagery to map classes derived from field survey may result in disappointing results, an unsupervised approach provides a method to acquire an up-to-date, objective classification of the entire forest. The limitation is that the vegetation communities extracted from an unsupervised classification might well be different from those identified from analysis of forest inventory data and may not be of relevance to current resource management issues.

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