Estimating Spatial Thematic Uncertainty in the NZLRI

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1.0 INTRODUCTION

The New Zealand Land Resource Inventory (NZLRI) is a nationally significant dataset that holds spatial information of rock, soil, slope, erosion and vegetation for the North and South Islands of New Zealand. For many years this information has been used by resource and environmental planners within regional councils (and their forerunners) to support formulation of land-use policy and resource management decisions. Historically, these planners were trained in the limitations of interpretation of NZLRI attributes for these purposes. However, this same information is increasingly being used in raster-based spatial process models of climate change, carbon sequestration, hydrology, catchment erosion, and forest ecosystems by users less well acquainted with the data. Hence, there is an associated need for explicit quantitative estimates of the uncertainty inherent in the spatial data. This poster will illustrate a simple model for quantifying these spatial thematic uncertainties by inference from a range of knowledge sources.

2.0 PROBABILITY MODEL

Goodchild, Sun and Yang (1992) consider classified coverages in which the class assigned to a GIS polygon (or raster cell) is not necessarily a homogeneous property of the entire polygon. Associated with each polygon is the expected probability that the polygon could be classified as each of a discrete set of possible classes, rather than just a single (dominant) class.

The vegetation attribute of the first edition NZLRI contains up to five significant vegetation classes for each polygon, with sufficient information to estimate coarsely the expected areal proportion covered by each vegetation class within a polygon. Defensible use of these estimated areal proportions requires additional quantitative estimates of their uncertainty or variability. It is this type of uncertainty information that is required for spatial process models and that has not been available until now.

Sources of Uncertainty Information

Conservative estimates of the uncertainty are derived by considering the following sources of uncertainty information:

- Conservative estimates may be derived directly from the first edition NZLRI vegetation attribute definition. The vegetation attribute consists of an ordered set of up to five significant vegetation elements for each polygon, listed in descending order of areal proportion. An upper-case code is used to represent at least 40% coverage of the polygon area and a lower-case code is used to represent at least 10% but less than 40% coverage.

- Experts in natural resource mapping are often able to identify possible extremes of variability and explain the consistent or accepted practices for interpretation of the attribute definitions, including the presence of unvegetated land (bare ground), dominant vegetation and scattered vegetation.

- Approximately 30% of New Zealand has been remapped as a second edition NZLRI from which finer estimates of areal proportions and extremes of uncertainty may be inferred. The second edition vegetation classification can be translated into an equivalent first edition vegetation classification. If estimates of proportions and uncertainties are based on sets of polygons with common classifications, then these estimates can be extrapolated to the first edition NZLRI. It is not sufficient to extrapolate from first and second edition polygons that occupy the same spatial extent because of the time difference of 10 to 20 years between first and second edition mapping.

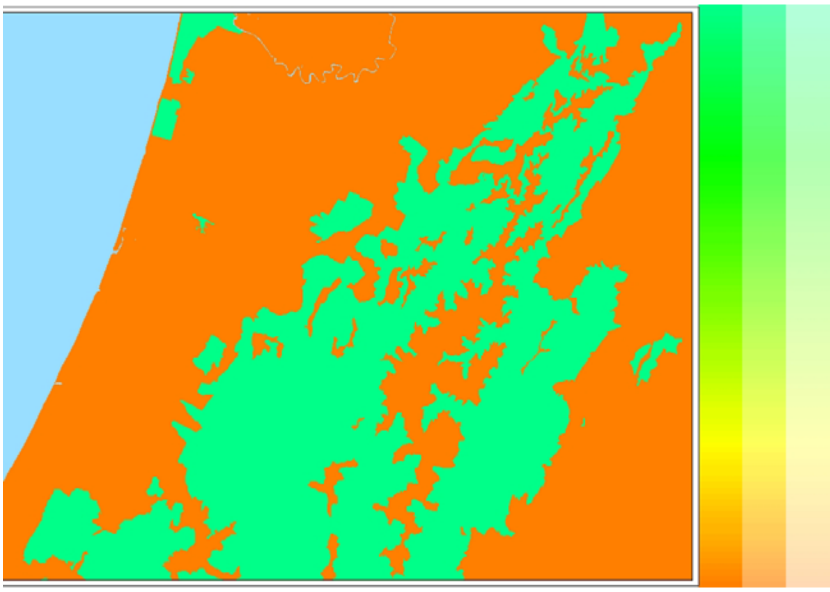
- Interpretation of the vegetation information in combination with the other NZLRI attributes (rock, soil, slope and erosion) may provide more refined estimates, e.g., unvegetated land must be either bare rock (recorded in the rock attribute) or unprotected soil (recorded in the soil attribute), and the severity of active erosion may imply the spatial extent of unvegetated land.

- Sample sets of original stereo pairs of panchromatic aerial photographs may be reinterpreted at a finer scale to provide more precise estimates of areal proportions. This is also useful to provide optimistic estimates of variability in conjunction with conservative extremes in variability.

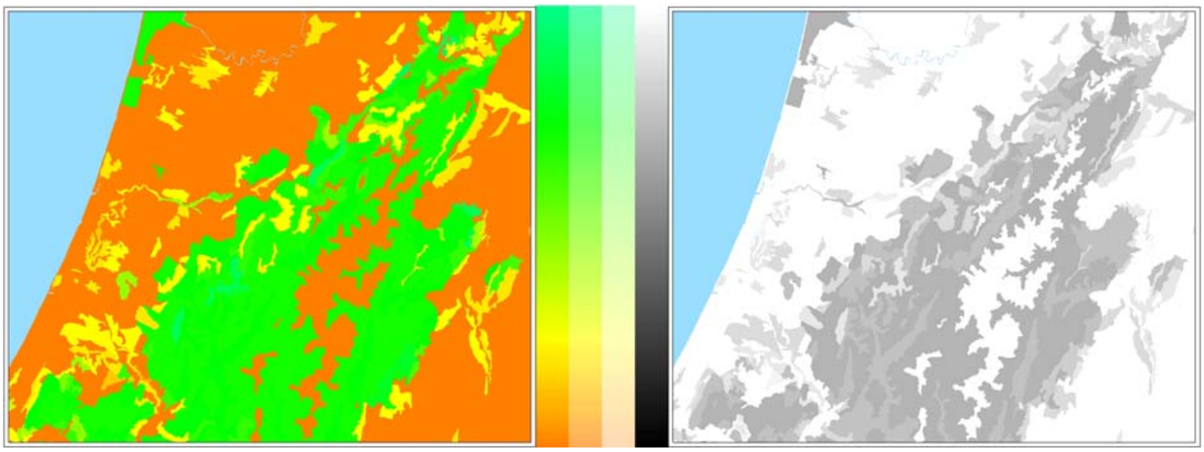
- When future second edition remapping is proposed it will be important to consider the recording by resource mappers of information that will be useful in quantifying or inferring uncertainty.

3.0 EXAMPLE

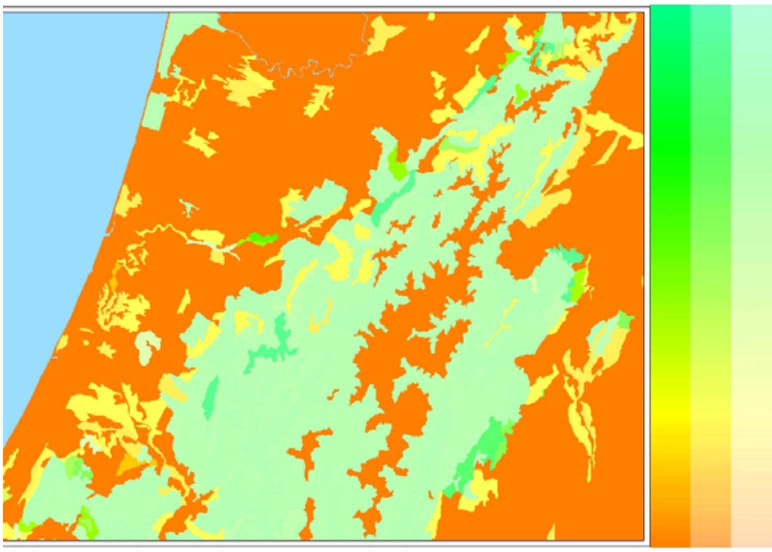
The full poster will illustrate the acquisition of uncertainty knowledge, application of the probability model to a portion of the NZLRI, and visualisation of the inferred spatial uncertainty. For example, Figure 1 extends the preliminary results of Gibb, Johnston and Harmsworth (1999) for the Levin NZMS260/S25 mapsheet. Figure 1(a) shows the distribution of forest using the dominant vegetation element alone as either present (green) or absent (orange). Figure 1(b) shows a conservatively estimated probability of forest (left) from zero (orange) through one (green) with the associated, conservatively estimated, extreme of uncertainty from least confidence (white) through greatest confidence (black). Figure 1(c) attempts to show both the estimated probability of forest (as hue) and the estimated uncertainty (as saturation).



(a) Dominant forest (green) and non-forest (brown).



(b) Estimated probability of forest (left) and estimated uncertainty (right).



(c) Visualisation of estimated probability (hue) and estimated uncertainty (saturation).

Figure 1. Probability of forest within Levin NZMS260/S25 mapsheet.

4.0 CONCLUSION

This poster paper illustrates progress towards modelling uncertainty in the NZLRI. Future directions include development of a system for collating uncertainty knowledge and for the inference of uncertainties within a GIS.

REFERENCES

Gibb, R. G., Johnston, M. R., and Harmsworth, G. R. (1999). An uncertainty model for the New Zealand Land Resource Inventory. Presented to the *International Symposium on Spatial Data Quality*, Hong Kong.

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