The Use of Artificial Intelligence Techniques and GIS for Predictive Vegetation Modelling

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In recent years, many ecological researchers have begun to examine non-parametric techniques that may explain and model environmental data (Bradshaw *et al*. 1999; Chon *et al*. 1996; Lek *et al*. 1996; Ozesmi and Ozesmi 1999; Recknagal *et al*. 1997; Tan and Smeins 1996). It has been suggested that neural networks and case-based reasoning may provide appropriate techniques for ecological modelling (Bradshaw *et al*. 1999; Holt and Benwell 1999; Tan and Smeins 1996). Due to the inherent spatial nature of ecological data, it seems reasonable that such modelling be done within a geographical information system (GIS).

The purpose of this project is to examine and compare these different techniques for predictive modelling of vegetation community distributions. Established parametric methods (for example, multiple regression, discriminant function analysis) will be compared with artificial intelligence techniques (neural networks and case-based reasoning) for use within a GIS. Predictive models will be created from an extensive dataset of peatland sites in the Otago and Southland regions of New Zealand. The dataset encompasses 17 of the 24 accessible sites within the regions (510 quadrats) (De Groot 1999). Climate and surveyed environmental data for the remaining 7 peatland sites (210 quadrats) will be used to predict both the broad vegetation community type and lower level community classifications. A vegetation and environmental survey will then be made for these 7 sites and used to assess the accuracy of each model both independently and as an integrated structure. This integrated model is expected to be a case-based system that relies on statistical parametric tests, neural network rule extraction and expert advice/literature to justify its indexing and weighting functions. With information from all these techniques, expert knowledge can be used to determine the most appropriate level and form of integration. Such a model would allow users to justify both the weightings of the similarity algorithms and the predicted community types in real world terms i.e. similar situations in the case-base.

The goals of the project are: 1) to assess the predictive accuracy and appropriateness of each spatial modelling technique independently and as an integrated model for such a dataset and; 2) to use these techniques to gain insight into important vegetation community functions and processes through rule extraction and factor sensitivity tests. It is hoped that such tests will enable the user to quantify the relative importance of the measured factors associated with the distribution of plant communities on peatlands in the study region. This would add to the understanding of peatland ecology as well as highlight a valuable set of techniques that may be applied to other ecological datasets.

REFERENCES

Bradshaw, C.J.A., Purvis, M., Raynov, R., Zhou, Q. and Davis, L.S. (1999) Predicting patterns in spatial ecology using neural networks: modelling colonisation by New Zealand fur seals. *Proceedings of the International Symposium on Environmental Software Systems (ISESS) 1999.*

Chon, T., Park, Y.S., Moon, K.H. and Cha, E.Y. (1996) Patternizing communities by using an artificial neural network. *Ecological Modelling*, 90: 69-78.

De Groot, A. (1999) *The Ecology of Peatlands in Southeastern South Island, New Zealand*. M.Sc. thesis, University of Otago.

Holt, A. and Benwell, G.L. (1999) Applying case-based reasoning techniques in GIS. *International Journal of Geographical Information Science*, 13(1): 9-25.

Lek, S., Delacoste, M., Bara, P., Dimopoulos, I., Lauga, J. and Aulagnier, S. (1996) Application of neural networks to modelling nonlinear relationships in ecology. *Ecological Monitoring*, 90: 39-52.

Ozesmi, S.L. and Ozesmi, U. (1999) An artificial neural network approach to spatial habitat modelling with interspecific interaction. *Ecological Modelling*, 116: 15-31.

Recknagel, F., French, M., Harkonen, P. and Yabunaka, K. (1997) Artificial neural network approach for modelling and prediction of algal blooms. *Ecological Modelling*, 96: 11-28.

Tan, S.S. and Smeins, F.E. (1996) Predicting grassland community changes with an artificial neural network model. *Ecological Modelling*, 84: 91-97.