Spatial data requirements for animal disease management in New Zealand

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Abstract

The science of geology has given rise to techniques for managing and analysing spatial data. The techniques often deal with samples that represent a continuum, such as mineral samples taken from various locations. Some animal health data is similar in nature to geo-statistical data, such as climate data or soil samples from various points on a farm. Animal health data is commonly discrete rather than continuous in space. Farms are represented as point or area features and attributes of the farm are attached to the features (Sanson R, 1993). Spatial analysis techniques were reviewed and comment made about their usefulness and validity in disease management.

The spatial data available in New Zealand for managing diseases was examined. Spatial data at a farm level is available in the national database management system Agribase, which records details of rural enterprises. The level of data completeness in Agribase was determined. The number of farms without spatial references varied from 10 to 18 percent, depending on the method used to update Agribase. Spatial data is available for cattle and deer herds in the National Livestock Database (NLDB). The number of herds without spatial data varied from 8 to 15 percent. Changes in the management of land information in New Zealand are resulting in an improvement in the quality and completeness of spatial data.

To determine the likely spatial data requirements for endemic disease management, bovine tuberculosis (TB) data from the NLDB was analysed. Possible applications of spatial data in TB management were developed and tested on point themes and polygon themes, both at different levels of completeness. All of the applications of spatial data that were tested required that a minimum of 85% of farms had spatial references.

The data requirements for sentinel surveillance were examined. A survey of farms in the Wairarapa and Hawke's Bay was undertaken to determine the contribution that slaughter surveillance makes to the TB testing program. The resulting slaughter surveillance information was combined with TB testing data and examined using point themes and polygon themes, and at different levels of data completeness. Polygon themes were found to be the most useful for the display of surveillance information. Gaps in surveillance were only visible using polygon themes. The relationship between vector control operations, testing zones, and TB surveillance could be assessed with a polygon theme.

The appropriate type of data for the detection of clusters of disease was determined. A cluster of farms with TB at Waipawa was used as an example. Polygon themes were preferred for cluster detection. Areas were superior to points in any spatial process that was concerned with contiguous farms. Measures of contiguity based on points were poorly sensitive and poorly specific, when compared with the actual contiguous properties. Some cluster detection processes were relatively insensitive to missing data.

Spatial data is used in the response to exotic disease outbreaks. EpiMAN is a decision support system for the management of exotic disease outbreaks in New Zealand. The purpose is to provide rapid information on the location of people and animals and to automate many of the control activities. EpiMAN includes a simulation model called Interspread, which allows assessment of the effects of different control strategies. The performance of Interspread was tested comparing point and area data at different levels of data completeness. Point data was recommended for use with simulation modelling, as it required less processing time. It was found that for spatial processes that use distance, point themes and area themes could not be used interchangeably. Interspread performed

differently with area data than point data. Some adjustment was required when shifting from one data type to another. An adjustment process was developed to account for the difference in distance between two point features and two area features. Incomplete spatial data had an effect on the simulation outcome of Interspread. Adjustment for incomplete data was also possible.

In summary for the management of endemic and exotic diseases, farms should be represented as area features. Point coverage's can be generated from these area features and used in some applications, such as simulation models, and for labelling purposes. To function acceptably the applications tested required that 85% of farms or herds were represented spatially.

Introduction

Modern information systems provide new tools for disease surveillance, control, and eradication. Animal health data can be examined from a spatial viewpoint using a geographical information system. The improvements of computing software and hardware and data management systems now allow a spatial component to be incorporated in disease management. There are a variety of spatial themes available. A simple and relatively inexpensive way for representing farms is to use a point theme. Alternatively a polygon or combination of polygons can be used to represent a farm.

Spatial analysis techniques have been incorporated in to software, so that at a push of a button they can be applied to data. In this dissertation the spatial analysis techniques that are useful and valid for disease management were examined. The level of data quality and type of data that is required for disease management was assessed. The validity of using points or polygons to represent farms was explored in this dissertation.

Chapter 1 contains a review of spatial analysis techniques. Chapter 2 reviews the quality of farm spatial data available in New Zealand. Chapter 3 assesses the spatial data requirements for disease surveillance. Chapter 4 assesses the spatial data requirements for the simulation models. Chapter 5 assesses the data requirements for disease cluster detection. Appendix 1 contains a paper headed "A cross sectional survey of cattle and deer movements in the Hawke's Bay and Wairarapa Regions of New Zealand." Information gained from this survey was used in Chapter 3 to assess the data requirements for TB surveillance.

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List of Abbreviations

CSR	COMPLETE SPATIAL RANDOMNESS
DCDB	DIGITAL CADASTRAL DATABASE
DOSLI	DEPARTMENT OF SURVEY AND LAND INFORMATION
FMD	FOOT-AND-MOUTH DISEASE
ICS	INDEX OF CLUSTER SIZE
NLDB	NEW ZEALAND VETERINARY JOURNAL
TB	BOVINE TUBERCULOSIS
SUFI	STATIC UNIQUE FEATURE IDENTIFIER