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Geographical Information System Integration and Utilisation of the Foot and Mouth Disease Dispersion Model

G. McGrath, R.F. Hammond and K. Towey

Introduction

Earlier models used to estimate the dispersal of foot and mouth disease (FMD) virus by wind were designed to include the factors shown in Figure 1.

![Figure 1. FMD Model parameters.](image)

In the present study the Agricultural and Environmental Unit of Met Eireann provide the model output. This consists of a text file and graphic illustration of the generated wind plume (Figure 2). This plume is then integrated into a Geographical Information System (GIS) to allow spatial selection of land parcels based on the plume values.

![Figure 2. Graphic illustration of the wind plume provided by the Met Eireann.](image)
Materials and Methods
Over 90% of land parcels in the Republic of Ireland are contained on a GIS. When a suspect case of FMD is identified here or in Great Britain or Northern Ireland, the coordinates are taken from the GIS and supplied to the Meteorological Office, along with information on the number of suspect animals, animal type and time and duration of infection. This information is entered into a model that generates a wind plume (that potentially could carry a calculated dose of FMD virus) based on the local climatic conditions over the specified time frame (Figure 1). The text file produced by the model must be translated into a ‘real world’ coverage in the GIS. A GIS coverage was created in Arc/Info© to best represent the FMD model data. The coverage extends in 1km intervals to 10km from the point of origin. Each of these concentric 1km circles was divided into $10^\circ$ intervals giving a total of 360 cells (Figure 3). Each cell is assigned a unique identification value that enables the data to be joined from the FMD model.

![GIS coverage generated to spatially represent FMD model output.](image)

Figure 3. GIS coverage generated to spatially represent FMD model output.

The coverage generated within the GIS has an origin of 0,0 on the Irish National Grid. Using a custom script within ArcView©, the coverage is translated to the origin of the suspected FMD outbreak. The model results for the suspected outbreak are joined into the coverage, thus enabling spatial queries based on predicted virus loading to be performed. From this, land parcels can be identified that fall within areas of a specified predicted virus loading (Figures 4 and 5).
Figure 4. Section of wind plume coverage showing the concentration of FMD inhaled Units.

Figure 5. Land parcels in section of plume coverage.
Discussion

From the initial notification/confirmation of a suspect case of foot and mouth disease the National Disease Control Centre (NDCC) and Local Disease Control Centre (LDCC) require, in the shortest possible time frame, relevant data in order to assess risk factors associated with the spread of the virus. The protocol described had initially a turn around time of approximately 2-3 hours, including map output. However, the Agricultural and Environmental Unit of Met Éireann made considerable improvements through modification of the wind dispersion model of the 1980s by using their High Resolution Local Area Meteorology (HIRLAM) Foot-and-Mouth Disease Dispersion Model programme (FMD_HIRLAM). Turn around times producing the necessary text files for incorporation into the GIS system were brought down to 20 minutes, considerably reducing the overall time for delivery of map output to NDCC and LDCC.

Foot and mouth disease is a highly contagious disease and spread is by animal-to-animal contact, and by day-to-day farming practices which lead to spreading of the virus through fomites, subject to the weather factor. The application of the viral plume model in the County Louth outbreak indicated that there was no likelihood of the aerial spread of the virus. This conclusion was attributed to the unstable weather conditions prevailing during the course of the outbreak and the fact that sheep are low emitters of foot and mouth virus.

Map output at the different scales as illustrated in the text figures, was readily produced throughout the course of the outbreak. The Area Aid data maps, showing the location of land held by all farmers who had applied for deficiency payments from the European Union, were used as the large-scale base maps. Area Aid data maps are updated on an annual basis and verified data are available by December of that year. This digitised map set is defined as the Land Parcel Identification System (LPIS). These base maps, however, had a major deficiency in that land held by farmers who have never applied for a deficiency payment appear as blank areas on the output. In a crisis situation, real time identification of these latter areas is essential and requires updating on a daily basis into the national data set.

The Department of Agriculture, Food and Rural Development (DAFRD) have invested considerable resources into digitised map production and software programmes to interrogate the substantial databases they manage. The FMD outbreak in County Louth highlights the requirement to establish as quickly as possible the integration of the type of protocol described in this paper into i-Map. The i-Map project is being developed within the Information Services Department of DAFRD. This facility is to be rolled out as a “one-stop-shop” on the DAFRD intranet to allow specified personnel to browse the map libraries. The “Contiguous Herd Enquiry” software programme developed to trace herds contiguous to any disease outbreak will also be available incorporating the GIS Mapinfo system. This project, which is due to be completed in 2002, will be an invaluable resource for the NDCC and LDCC when implementing an efficient response to a Class A disease alert.