A GEOGRAPHICAL INFORMATION SYSTEM APPLICATION
FOR ANIMAL HEALTH MANAGEMENT

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Abstract: The potential use of a Geographical Information System
(GIS) as part of a Decision Support System (DSS) for the control of
foot-and-mouth disease (FMD) is discussed. During an outbreak of
FMD, an GIS may be helpful for several tasks that require spatial
information. In this study, data were collected in the Netherlands, to
test the functionality of the GIS application. It was concluded that the
GIS application was functional. However, digitized data with farm
information and farm locations have to be available in advance of an
outbreak of FMD in order to fully utilize the system.

Keywords: GIS, decision support system, foot-and-mouth disease

1. INTRODUCTION

A prototype decision support system
(DSS) for the control of foot-and-mouth
(FMD) disease is under development
within the EpiMAN(EU) project
(Donaldson 1993, 94, 95). The DSS
consists of a central database for farm
information, a geographical information
system (GIS) for spatial data, epidemiological and economic
simulation models, and expert systems
containing factual knowledge about
FMD. The DSS was originally designed
in New Zealand (Sanson, 1993). The aim
of the DSS is to support the decision
makers in both the operational and
tactical management during an outbreak
of FMD, but the system may be used as a training tool for all people involved as well (Jalvingh, et al., 1995). In this paper, the GIS application of EpiMAN(EU) will be discussed.

1.1 Potential GIS tasks

When an outbreak of FMD occurs in the European Union (EU), the afflicted country has to control the disease as quick as possible, and has to follow EU requirements for the control procedures (Anonymous, 1985). Certain control tasks require spatial information, such as the definition of restricted areas around an infected premise (IP), the census of all farms and livestock within the restricted areas, the calculation of a potential virus plume emitted by the IP, the identification of farms covered by the calculated virus plume, and the definition of disease free areas (van der Meijs, 1993). These spatially oriented tasks may be facilitated by using a GIS (Mackay, 1994).

1.2 EpiMAN(EU) GIS application

The GIS of EpiMAN(EU) is programmed in Arc/Info, and runs on a Unix machine. However, the user is provided with a menu-driven interface, and does not need to know Arc/Info to carry out the GIS tasks. The database for the GIS is not kept in Info, but in Oracle, a relational database. This database is available to the users through Access, a PC-based relational database. The users of EpiMAN(EU), with the exception of the GIS tasks, will therefore only work on PC's.

To use the GIS functionality of EpiMAN(EU), digitized spatial information is needed. Ideally, digitized maps of a sufficient precise scale should be available, as well as the exact locations of all farms. However, most EU countries do not have this information readily available at the moment, so information needs to be gathered or updated during an outbreak. The EpiMAN(EU) software was developed to be flexible with regard to the availability and quality of digitized data.

The goal of the current study was to test the GIS functionality of the EpiMAN(EU) software, and to define the quality and (non)availability of data in the Netherlands.

2. MATERIAL AND METHODS

To test EpiMAN(EU), data were collected in a geographically defined area of approximately 33 km² in the eastern part of the Netherlands (Nielen, et al., 1995, Nielen, et al., 1996). Farm records of the farms in the study area were provided by the Dutch Animal Health Service, which keeps updated records of all commercial farming enterprises. Farm records are identified by a unique 7-digit number (UBN) and include name, full address, type of animals, and type of establishment, among others. In addition, data had to be collected for the GIS database, specifically, farm locations were needed.

For the study, data on contacts between farms were collected from all participating farms (N = 152), and all farms were visited (Nielen, et al., 1995). During the farm visit, the location of the farm building(s) was recorded on a copy of a 1:10.000 black-and-white paper map, as available from the Dutch Topographical Service (TDN). The 1:10.000 maps are based on satellite photographs, and show all the buildings, to the detail of each separate farm building.
In the Netherlands, digitized maps are commercially available. The TDN offers vector maps of scale 1:10,000, but also raster (scanned) maps of scale 1:25,000. The coverage of the buildings of this map is the same as on the 1:10,000 maps. In the EpiMAN(EU) GIS application, 2 coloured raster maps of scale 1:25,000 covered the study area, and were used as backdrops.

Using the EpiMAN(EU) software, the farm locations were transferred from the paper map to the GIS database. To do this, the mouse was placed on the farm buildings, clearly visible on the scanned 1:25,000 map, and the UBN had to be typed into a menu screen. The combination of UBN and resulting x,y coordinates was automatically combined with the other farm data.

A potential source of farm locations was available through the Dutch Cadastre, which is in the process of digitizing their information. Currently, approximately 60% of Dutch addresses, based on postal code and house number, are georeferenced. The resulting x,y coordinate is the centroid of the land parcel that is connected to the postal address. As a test, the x,y coordinates of the farms according to the cadastre were compared to the manually digitized coordinates.

To test the GIS functionality of the restricted zones and the virus plume menus, a pig farm in the pilot area was declared infected (IP), with 10 pigs with 1 day old lesions at the day of clinical diagnosis. Weather recording data were provided by counterparts in the EU project for a 2-week period, with hourly data of the relevant parameters.

3. RESULTS AND DISCUSSION

The GIS application made it easy to digitize the farm locations on screen.

During an outbreak, missing farms can be easily added by this method, and wrongly located farms can be easily moved with the same user interface. However, digitizing on screen does not seem to be a feasible option to georeference all farms in the Netherlands.

The cadastre data seem a better option to quickly collect an approximate farm location, if the quality is adequate for the goal of disease control. Quality was defined as percentage coverage and distance from hand digitized farm locations. In total 155 hand digitized farm locations were available, with 119 corresponding cadastre data, a coverage of 77%. The results of the comparison for the study area are in Table 1. Approximately 50% of the cadastre data were within 53 mtr from the hand digitized location, and 80% were within 110 mtr. A few outliers occurred, 3 observations were widely off, between 1 and 3 km, possibly caused by a wrong address (owner does not live on farm).

Even if the cadastre data are not perfect, they seem to be the easiest way to achieve a quick approximate location of farms in the Netherlands. In case of an outbreak, the farm locations in the outbreak area will have to be edited, which is possible with the EpiMAN(EU) software.

Table 1. Distance (in meters) between hand digitized x,y location of farm buildings, and x,y coordinates according to the Dutch Cadastre (N = 119).

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Mean</td>
<td>134</td>
</tr>
<tr>
<td>Median</td>
<td>53</td>
</tr>
<tr>
<td>Minimum</td>
<td>7</td>
</tr>
<tr>
<td>Maximum</td>
<td>3353</td>
</tr>
<tr>
<td>95% CI for Mean</td>
<td>60 - 208</td>
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</tbody>
</table>
3.1 Spatial disease control tasks

With the small database as described, a simulated outbreak was used to test the performance of the GIS.

In general the GIS software was relatively user-friendly. During demonstrations, animal disease fighting people were impressed with the drawing of the restricted areas around the IP, combined with the automatic risk lists of farms within the restricted areas. In the Netherlands these tasks are now very time consuming.

The calculation of the virus plume was simulated within a submodule of the GIS and was based on estimated virus excretion of affected animals (source), hourly weather recording data, and a flow dispersion model (Donaldson 1993, 94, 95). The GIS software provided the user with a friendly interface. The plumes are presented on screen with different colors for virus concentrations. The farms that are covered by the simulated plume are placed on an automatic risk list again.

4. CONCLUSION

The EpiMAN(EU) GIS application can be used in the Netherlands, and has potential for other countries as well. However, digitized data have to be available in advance of an outbreak, which is not the case yet in the Netherlands. To fully use the possibilities of a DSS such as EpiMAN(EU), a permanent, updated database with farm information, including farm locations, is necessary.

REFERENCES


