Article 100

Use of Geoinformatics in Livestock Disease Management

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The epidemiology of animal diseases could be understood in a better way by using advantages of mapping locations of farms and other facilities for livestock. In case of a disease outbreak it could make the management of the situation efficient and easier, and also provide a tool to evaluate different strategies in preventing the spread of infectious diseases. The present paper aims to describe and give an overview of the possibilities and potential uses of a Geographical Information System (GIS) in the field of surveillance and monitoring of animal diseases. Prime areas in which GIS could be incorporated are recording and reporting information, epidemic emergency, cluster analysis, disease spread modeling, and planning control strategies. Different sources of data; geographical data, farm locations and disease information are used in the development of the GIS.

KEY WORDS
Geo informatics, livestock disease, management.

INTRODUCTION

A Geographical Information System (GIS) or geo informatics can be used as a significant tool for any discipline which deals with data that is related with geographical locations, such as countries, regions, communities, or co-ordinates. The systems have been developing rapidly increasing the number of different software which are more user-friendly. The need for using this system in the field of veterinary medicine has been emerging during the last decade with many disease reporting systems and projects related to this field being actively carried out all over the globe and particularly in India. In 1991 Sanson et al. described the systems and possible applications in the field of veterinary medicine. Still, the most used application of GIS is to produce descriptive maps. However, the potential of GIS is much larger. Reviews in the field of environment and human health (Briggs & Elliot 1995), and in the field of animal health (Sharma 1994) have been undertaken. GIS has been included in decision support systems for control of infectious diseases in animals (Sanson 1994). Geographical information system GIS is a computer-based system for analyzing and displaying digital geo-referenced data sets (Fig.1). The data can be stored in two formats; vector based and grid-based. The maps of the vector-based format display models of the real world using points, lines and polygons. Vector digitizing captures a point as x,y co-ordinate, while a line is captured as an ordered string of such co-ordinates. A polygon is a closed line. The grid-based format of data is captured as information of each quadratic cell in a screen and could be looked at as a photo of the area. GIS displays the geo-referenced data as theme layers which can be displayed one at a time or on top of each other, like overheads on a projector. These are stored in a geo-relational database. Each feature has attribute data linked to it which is stored in a table. Attributes can be any item of a feature which relate to the map, without being a part of it. The attribute data of the object with a geographical connection is stored in tables which can be joined with the geographical data through a common identifier (ID). An ID relevant to animal disease data could be a farm or region. Numbers

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are preferred as IDs since character variables often can be misspelled. The farm scan is visualized using points, and regions such as veterinary districts, municipalities or counties are stored as polygons. Description of GIS-functions useful in the veterinary surveillance, recording and reporting disease information GIS can be used to produce maps of disease incidence, prevalence, mortality, morbidity on farm, region, or national levels. The information is more easily understood when visualized on a map.

Another way to describe the incidences of diseases in a defined area can be to create density maps by using the density function. The density function creates a grid with a defined cell size and gives each cell in the area a density value of the infected farms. To adjust for the underlying population, a density map of the whole population at risk is created with the same cell size. The density maps are then divided to provide a map that shows the incidence of the particular disease in each area unit at the time unit chosen. This function can further provide maps which show the spread of the disease by displaying the maps as a movie. The GIS can also be incorporated in a real time outbreak notification. Maps displaying the updated situation in a region, together with farm information are important tools for field personnel and can also be incorporated in reports to producers, administrators and the media.

EPIDEMIC EMERGENCY

In case of an outbreak of an infectious disease, GIS can provide an excellent tool for identifying the location of the case farm and all farms at risk within a specified area of the outbreak. Buffer zones can be drawn around those farms as shown in Fig. 2 and with a link to tables of the addresses of the farms at risk; the farms can be informed within a short time after a notified outbreak. Buffer zones can also be generated around other risk areas or point sources, such as roads where infected cattle have been driven or around market places. Further, the maps can assist the field veterinarians to plan their work in the current situation, and for the veterinary authorities in how to handle a potential outbreak.

ANALYSIS OF CLUSTERING OF DISEASES

To analyze whether a disease is clustered in space, time or in time and space GIS programs are used as a standard tool in the available GIS-packages. The visualization of the disease rates on digital maps can be misleading because the eye tends to interpret point patterns as clusters more often than what is real. Therefore, a cluster analysis should be carried out for an objective evaluation of the reported disease cases. The results of some of the cluster analyses can, thereafter, be imported into a GIS to visualize the location of clusters or cluster areas.

Model disease spread simulation models using program packages can be integrated within a GIS. Such simulation models can incorporate farm information such as herd size, production type as well as spatial factors like distance to the source of outbreak, population density and climate conditions, vegetation and landscape, all of which have been defined as risk factors for the spread of the modeled disease. Sanson (1994) has developed a model of a potential outbreak of foot and mouth disease in New Zealand (Fig. 3).

PLANNING DISEASE CONTROL STRATEGIES

The neighborhood analysis function (Fig. 4) can be used to identify all adjacent farms to an infected farm. It is a function that identifies all adjacent features with a certain criteria to a particular feature. Contact patterns such as common use of grasslands or sources of purchasing etc. could be visualized with a so-called spider diagram. This could provide insight into the possibility of transmission of infectious diseases between herds. In the planning of eradication of diseases, GIS has the possibility to perform overlay analysis to find high or low risk areas for diseases which depend on geographical features or conditions related to the geography. Studies of trypanosomiasis (Rogers 1991) and theileriosis (Perry et al. 1991, Lessard et al. 1990) are just some examples of usefulness of GIS in planning eradication of diseases depending on habitats of vectors or wild animal population. The geographic data consisting of themes of each geographical feature are complete for the whole country in the scales 1:1Million and 1:250000. The administrative boundaries can be divided into regions such as counties, municipalities, and in the veterinary field, veterinary districts which mostly consist of one or more municipalities.

CASE STUDY

In a preliminary study carried out in Srinagar themes of veterinary districts were created in GIS and derived from the themes of the municipalities with the use of ArcView 3.1. The farm locations are identified or provided by the Animal Husbandry Department with the help of Google maps. Livestock owners are identified in the database generated under livestock census and Dairy Entrepreneurship Development Scheme, which records all farms. This registry is updated every year. This registry contains the village names, owners and total livestock, DEDS number, name, address of the applicant and number of animals in each production category at the day of application. The information on the locations of the farms with animal production as well as their production type and herd sizes is collected from these registries. Also a disease recording system is generated that includes the results from all tests of samples tested according to surveillance programs as well as diagnostic purposes of disease investigation. All specific information about disease status in the districts, municipalities or on each farm can be collected from this database and imported into ArcGIS, ArcView as text files for joining with a geo-referenced theme such as farm, municipality, veterinary district or region. The GIS can there by show the summarized information at a specific time or over any desired time period. A goal of the introduction of GIS is to have maps continuously displaying the situation for each of the diseases included in the Disease Surveillance Programs. By the use of the registries described, it has been possible to obtain maps with all registered cattle and poultry farms. Density maps of the farms of each production category as well as density maps of the population of each species have also been produced (Fig. 5).

CONCLUSIONS

GIS or geo-informatics has evolved as an essential tool required almost everywhere in every field. Its application in Veterinary Sciences is undertaken at grassroots level and at research and management levels. Livestock Disease reporting, epidemiological mapping and disease management is a prime objective of every veterinary health system.

Management of livestock diseases has become easier and precise with this technology. Overlaid themes provide quick analysis and help decision making within shortest possible time. Strategies can be formulated after results generated with GIS analysis.

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FIGURES

Fig. 1: Geographical information system

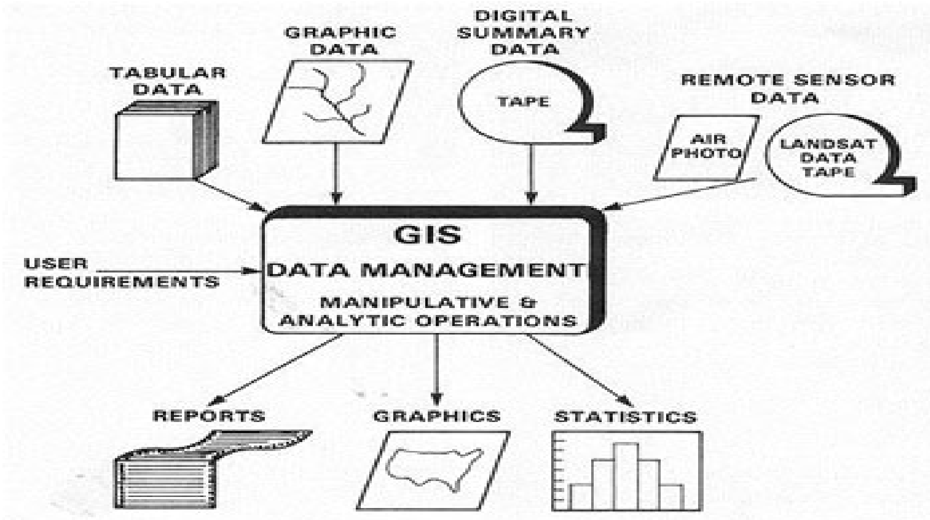

Fig. 2: Example of a Buffer Diagram overlaid on a topographical map showing real earth features like roads etc. Concentric circles represent buffer around outbreak prone areas.

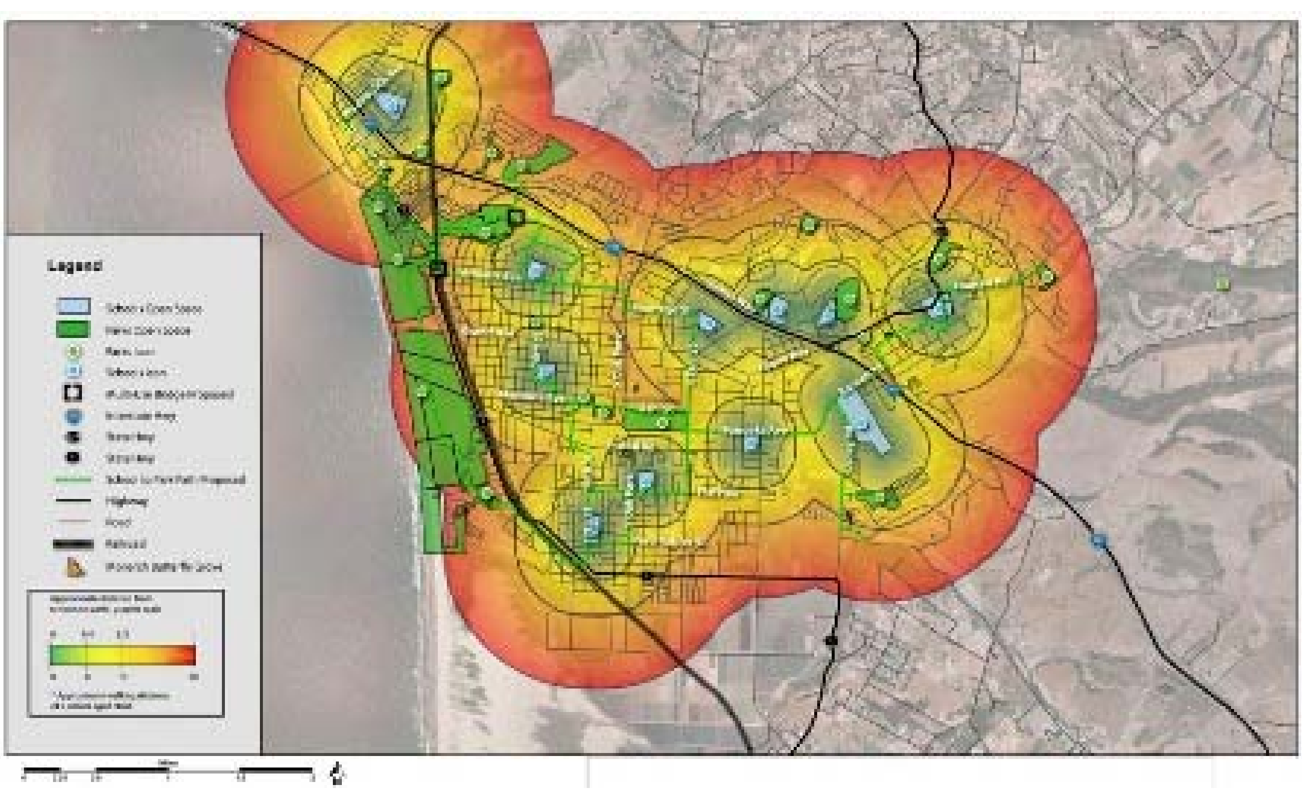

Fig. 3: Showing cluster outbreaks with buffer zones.

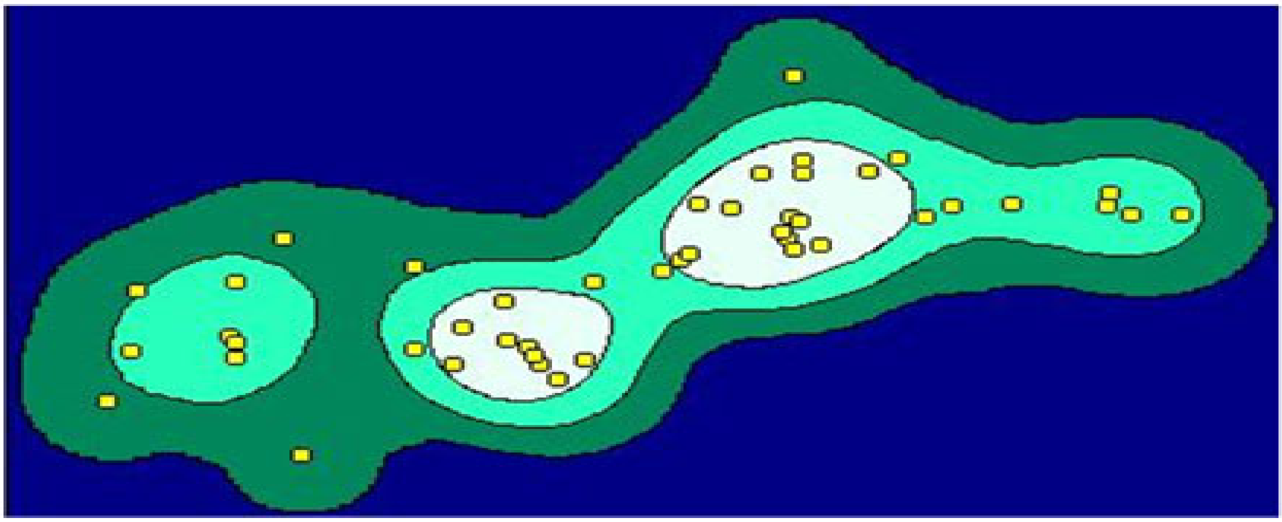

Fig. 4: Neighborhood analysis diagram in GIS.

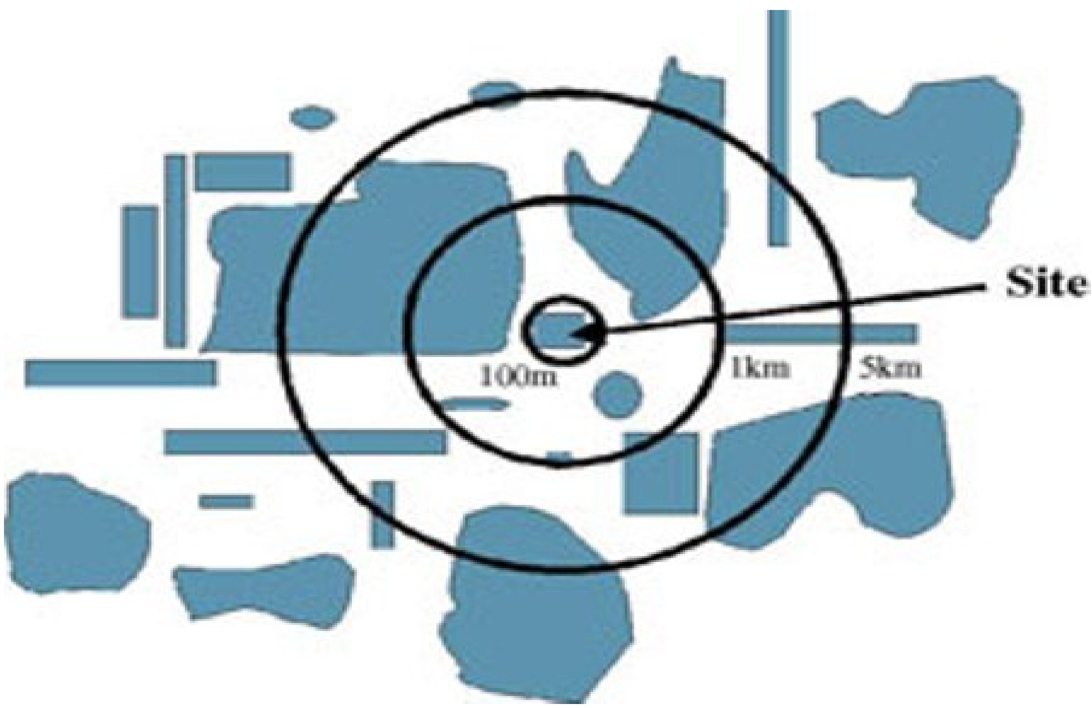

Fig. 5: Example of a Cattle density map prepared in GIS platform.