Geographic Information Systems and its Role in Biological Risk Management

September 2004

Author: Alex Ramirez, DVM

Co-authors: Babasola Olugasa, DVM, MS; Danelle Bickett-Weddle, DVM, MPH

Center for Food Security and Public Health
2160 Veterinary Medicine
Ames, IA 50011
515-294-7189
www.cfsph.iastate.edu

Introduction

As technology advances, so do our capabilities of disease diagnosis and tracking. Geographic Information System (GIS) is an exciting technology which is becoming a more common part of everyday life. The ability of cell phones to send a signal and establish your location at the time of an emergency is a good example of a GIS application. GIS is a computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to location. What separates GIS from other types of information/databases is that everything is based on location (georeference). This georeferenced information is nothing more than "where things are," such as latitude and longitude coordinates. With today's availability of Global Positioning System (GPS), obtaining georeferencing information is simple and inexpensive. As several types of information are added to a GIS project, analysis can then be evaluated based on associations involving locations. So as the GPS system on your cell phone establishes your location, the GIS software can then look at your location in combination with other types of information (such as roads and house addresses) to help the nearest emergency responders find you. GPS is a data collection technology, whereas GIS is a data analysis technology.

GIS and GPS are technologies which have been around for some time. One of the first major uses for computer-based GIS was in 1964 when the Canadian Geographic Information System (CGIS) was started in an effort to assess the productivity of Canadian farmland. Shortly thereafter, several other organizations were created such as the Harvard Lab and ESRI (Environmental Systems Research Institute, Inc., one of today's leading companies in GIS software production) which further researched and developed GIS applications/programs. The use of GIS in veterinary medicine and epidemiology dates back to the late 1970s. Canadian Scientist, Dr. Rowland R Tinline, applied GIS retrospectively to the pattern of spread of the foot and mouth disease (FMD) epizootic of 1967-1968 in England. The goal was to better understand the disease's incubation period and how it spread from herd to herd (Tinline 1970, Tinline and Singh 1976). By using GIS, much was learned about FMD that could be applied in the control of future outbreaks worldwide.

Examples of GIS in veterinary medicine

Today, GIS is being utilized for disease monitoring in the U.S. The USDA's Veterinary Services utilizes the benefits of comprehensive and integrated monitoring and surveillance to demonstrate where a particular disease does or does not occur. This is important when trading partners ask the U.S. to document testing amounts and locations for a particular disease and species. For example, one GIS map can show the population density of any agricultural species using National Agricultural Statistics Service census data. A second map can show all disease monitoring testing done in a specific timeframe. A comparison can then be made to make sure that disease monitoring and testing corresponds to the population density of that species in the area. Finally, a third map can be generated to depict changes or areas to concentrate on for future monitoring. This will help in assuring that funds for monitoring be spent in the proper areas.

One possibility for future GIS use would be to use geographic visualization for possible biological risk management. Geographic visualization is an offshoot of scientific visualization. Scientific visualization is a method that incorporates the graphic capabilities of today's computers to transform data into visual models that can make visible things that ordinarily

could not have been seen. The advantage of this is that the general public and almost all professionals use visual approaches to communicate and exchange ideas. Biological risk management visualization may be a good way to communicate biological risk management ideas through a computerized simulated walk through of an operation.

Another possibility related to this same computerized simulation concept would be to use GIS for scenario playing. Special software like Community Viz can be utilized for setting up a possible scenario involving the accidental release of a biological agent on a farm. The GIS software can be programmed to multi-task in the risk assessment of a farm and take into account the type of agent used, the route of transmission, and the estimated susceptibility of animals to calculate the risk impact at stake. The scenario can also be set up to relate with different potential sources of accidental release of biological agents. For example, vehicle parking areas, along with wind speed and direction, can be manipulated to increase or decrease the disease outcomes on the farm. The same could be done to any other route of transmission in order to better evaluate an operation's possible biological risk vulnerability to different agents.

Currently, Kansas State University is working on a Rapid Syndrome Validation Project –Animal (RSVPA) as an animal health surveillance system. It is similar to the one used to gather human health information for early detection of emerging health problems. Cattle herds are the only species of animal currently testing this project. One of the two main goals of the project is to build a means to assemble data efficiently for practicing veterinarians. Practicing veterinarians are currently the basis for detection of emerging and exotic animal disease incidents in the U.S. The second main goal is for this information to serve as an insight into current endemic disease patterns for practicing veterinarians and their clients. To accomplish this, RSVPA collaborators have specially developed data capture and information systems that are usable wherever cattle and their owners are located. On site, veterinarians use a hand held device to record their location (GPS) and clinical observations. This information can then be transmitted to a central database. Veterinarians can also receive the latest information about recent disease trends in this same manner. Currently the GIS component is rudimentary due to the early stages of the program. Due to client confidentiality and Freedom of Information Act, the data is currently being captured and reported at the county level. As the National Animal Identification Programs develops, there will probably be changes in the legal realm of information reporting.

The one advantage of GIS is that information can be collected with a precise location, but when reported, it can be manipulated to a coarser level (such as zip code or county) in order to protect client confidentiality. This brings up an important issue of privacy. As information technologies such as GIS are able to pinpoint locations within a few yards or feet, where should it stop? We must acknowledge livestock producer's rights to keep their herd health information private. At the same time, if an emerging disease could put another producer's operation at risk, should e owner be entitled to know ahead of time so extra biological risk management steps could be implemented to possibly minimize damages? At what point do the neighbor's rights outweigh the privacy rights of an individual? These questions are yet to be answered.

Conclusion

As veterinarians, you may never be involved in entering or manipulating data, but GIS is a specialized tool that is becoming more widely used in the agriculture and public health sectors of many states. You may be asked to be a part of a data collection team for your state, so

having an understanding of what the information is used for and applied to is important to its future success. Depending on your role in your community, GIS could be a tool of the future for you to help design appropriate biological risk management plans. We need to better understand the potential benefits, as well as the limitations, of any new technology. Hopefully this overview has demonstrated some of the capabilities of GIS with regards to veterinary medicine and biological risk management. Let us also not forget the issue of privacy and the limitations of any computer system. All a computer is designed to do is manipulate the data we give it in the way it is presented. The validity of data manipulation and the data integrity must be considered at all times when evaluating results; garbage in equals garbage out. So as technology continues to improve, we need to continue to learn the benefits and applications so as not to be overwhelmed with information. For this information to be useful, we need better ways to manage the information and utilize it for the benefit of everyone. This is the ultimate goal of GIS.