

# Investigation on the Applications of GIS Methods in Epidemiologic Study

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**Abstract.** In this study, the application of GIS methods for disease outbreaks were summarized, which could provide some useful systematic epidemiological information for disease surveillance and control. The results showed that the application of GIS technology played an important role in the effective monitoring and control of emergency outbreaks. so far, the applications of GIS in epidemiological research are mainly focused on the understanding of the space-time laws of disease, genetic analysis, intervention and defense. With the rapid development of GIS technology, the strong spatial data analysis capability of which provides huge potential and strong technical support for studying the epidemic problem. In view of the good spatial analysis capacity of GIS, GIS has been widely applied in epidemiology and public health researches in recent years, and it will have great foreground in epidemiologic study in the future.

## Introduction

Epidemiological distribution is greatly related to geographical environment, meteorological factors and seasonal difference, with the help of geographic information processing technology, we can collect more useful information of the aetiological agent, epidemic law, prevention and control measures, which is important in the prevention and control of an epidemic.

Geographic Information Systems (GIS) is a computer system for collection, storage, processing, analysis and display of geospatial data [1, 3, 12]. In recent years GIS in combination with satellite remote sensing technology have played an important role in epidemic prediction and control. The spatial query and analysis function of GIS can integrate spatial data and related attribute data through the overlay of data and layers, which has strong spatial data analysis and visualization ability. Therefore, the application and development of GIS in epidemic diseases provide a useful research tool for public health [9]. GIS can be used to analyze the epidemiology of spatial data, to analyze the distribution and change of disease with the area, and to explore the pathogenic factors and related influence factors, consequently providing useful decision-making basis for the prediction of early warning, prevention and control measures of an epidemic.

Combining the features of GIS technology and epidemiological research, this study mainly introduced and analyzed the important application of GIS technology in the field of epidemiologic study.

## The Application of GIS in Epidemiologic Study

The emergence and development of Geographic information system (GIS) have provided new means for the prevention and control of many diseases. GIS is a database handling geographically-referenced information for the data's input, management, analysis and display [15]. GIS has increased the range and availability of tools which can be used to analyze epidemics [20]. The environmental determinants may create manmade factors and conducting environment, which were the possible causes of the epidemics occurrences across a country. The most frequently

application of GIS in the epidemic investigation is to create maps displaying the locations of cases, potential risk factors and sources, which can well describe the spreading patterns of the disease and identify outliers of the outbreak. Historically, GIS technology had been used in epidemiologic study very early, and the powerful data management and analysis functions of GIS had been used to obtain a large amount of useful information related to the outbreaks. The application of web mapping GIS has become an important tool in the public health information management for disease control in some nation [7].

An investigation into an outbreak is usually cross-agency exercises, involving examination of the outbreak in terms of person, place and time [20]. Impoinvil et al. [8] studied the influence factors of the geographical environment of the incidence of encephalitis in Nepal, and found that the spatial pattern of cases during the 2005 epidemic in Nepal was significantly associated with the percentage of irrigated land and low precipitation. Speer et al. [21] studied the etiology of acute myeloid leukemia and multiple myeloma by GIS analysis, and found that people living more than 10 years in six emission points in adjacent to large quantities of petroleum refining waste might have higher onset risk. Poulstrup et al. [17] studied the relationship between dioxin release and soft tissue tumor, and the level of exposure to dioxin concentrations was determined by using GIS in accordance with address information of the case and control.

It is worth noting that GIS has played a significant role in the field of infectious diseases research. While cholera out broke in London in 1854, John Snow demonstrated the close relationship between cholera deaths and the distribution of contaminated water sources of Soho area by using many maps, and made the public aware of the importance of urban water system and take concrete actions to block the outbreak, this well showed the importance of space mapping applications in the epidemiological studies [18]. Palaniyandi et al. [14] used remote sensing and GIS to analyze the environmental determinants of chikungunya vector breeding habitats and dengue in the environment, and found that landscape, climate and environment play an important role on the disease transmission across a country, hence the application of GIS and remote sensing was very useful for epidemic management and control. On AIDS surveillance, the integration of AIDS surveillance information, high-risk groups and population data through GIS can effectively monitor the disease infection status of certain dangerous people [5]. In addition, Pierce and Fulcher analyzed the high-risk groups and medical needs of HIV/AIDS in the United States and Canada respectively, and found that the uneven distribution of medical resources and low service level were common in the study areas, and the two countries all had weak populations having difficulty accessing services [4, 16]. Glass et al. [6] analyzed the prevalence of lyme disease in Baltimore in the United States by using GIS methods in 1990, and the development situation of the epidemic was compared with the reference of the random setting and logistic regression analysis was carried out, finally the risk prediction model was constructed and the epidemic range was predicted. In terms of malaria research, a study showed that malaria epidemics were more likely to occur in regions with a relative humidity of 60% and above [2], at the same time malaria outbreaks were usually characterized by periodic variations [23], which was high in April and November every year [22]. A malaria computer detection system was established by using GIS technology in Israel in 1992, which can estimate the risk of transmission and automatically analyze the cause of the outbreak and the source of the disease in small outbreaks [10]. Maciel et al. [11] used GIS technology to explore the spatial distribution pattern of the incidence of tuberculosis, and concluded that the high incidence of the disease was highly correlated with regional geographic information, and the results provided a scientific basis for the formulation of the control policy of tuberculosis. The mode of cholera transmission, the distribution of cholera cases and the risk factors affecting cholera infection in Lusaka were analyzed by using a matched case-control method and GIS, and the results showed that there was a significant association between high incidence of cholera and the lack of latrine and drainage systems surrounding houses, and hand washing with soap as well as chlorination of drinking water might play a preventive role in the epidemic [19].

As a result, Geographical Information System (GIS) can offer a practical and efficient method to directly visualize the transmission and distribution of diseases and analyze the risk factors of the

outbreak. Because GIS has good abilities of manipulation, analysis and seamless integration and display of large quantities of environmental data, as well as it can give researchers grand support in epidemiological surveys, GIS has been widely applied in public health safety studies in recent years [13].

## Summary

Epidemiological studies have found that the spread of many diseases is strongly associated with geographic spatial factors, and most epidemic diseases have some differences in time distribution, spatial distribution and ethnic distribution, and this might result from the different external factors such as climatic factors, topography and vegetation conditions in different regions. In addition, the discrepancies in regional social background, cultural level, economic level, cultural environment and other factors may also contribute to the differences among the regional disease. So reasonable application of GIS technology in epidemiological study can provide people with more disease related information, and can provide more reference information for understanding disease, the application of GIS in epidemiologic study will have broad research prospect.

In recent years, GIS technology has been well applied in epidemiological studies, providing a new path for the in-depth study of many epidemic diseases. The application of GIS spatial analysis technology played an important role in the effective monitoring and control of emergency outbreaks. The greatest advantages of GIS technology in epidemiology research are that: dynamically, accurately and intuitively showing the temporal and spatial distribution of disease; helping researchers identify risk factors and predict risk of disease; extensive study space-time range, free of geography and time limits; providing policy-making support for public health policies, and so on. Among them, the visualization and risk prediction of epidemics are the most intuitive manifestations of epidemic transmission, and are also the most important applications of GIS in epidemic field.

To sum up, with the rapid development of GIS technology, the strong spatial data analysis capability obtained after the organic combination of epidemiology and GIS methods provides huge potential and strong technical support for studying the epidemic problem. According to the analysis of this paper, so far the applications of GIS in the field of epidemiological research are mainly focused on the understanding of the space-time laws of disease, genetic analysis, intervention and defense, and the specific applications are as follows: 1. the GIS technology can be used to analyze the time and space rules of the disease and explore the external influencing factors that may affect the occurrence of disease; and 2. the GIS technology can monitor the spatial and temporal distribution of diseases and realize the visualization of epidemic diseases; and 3. the GIS technology can be used to monitor sudden public health events; and 4. the GIS technology can be used to predict the development trend of epidemic diseases; and last 5. the GIS technology can be used for the disease intervention and evaluation and control measures.

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