·论著·

Geographic information systems (GIS) in the application of data management for schistosomiasis control

Zhang shiqing, Simon Brooker, Wang Tianping, Zhou Xiaonong

【Abstract】 **Objective** To explore the time and spatial distribution and fluctuation of snail and acute schistosomiasis in Anhui province using geographic information systems (GIS). **Methods** The data of snail distribution and acute schistosomiasis were collected from 1980 to 2000 in Anhui province. All GIS database were developed using ArcView 3.3. Digit map at a 1:1 000 000 scale was input into Arc view3.3 as a shape file. **Results** Snail distributed mostly in the counties which situated in both sides of the Yangtze River. The most serious areas were focused on the Yangtze River basin. The distribution of snail dispersed in the uncontrolled counties and some controlled counties adjacent to the uncontrolled counties. Three years,1989, 1990, and 1991, were the serious outbreak years for acute schistosomiasis in the twenty years, and three counties, Dangtu, Dongzhi and Susong, were always showed much more cases in the outbreak year. Most cases were distributed in the counties along the Yangtze River. **Conclusion** GIS can be use as both a database and a graphical tool. It can reveal the prevalence of schistosomiasis more directly and clearly and help the manager to make out the most reasonable strategies for schistosomiasis control.

【Key words】 *Geographic information systems (GIS), Schistosomiasis, Snail distribution, Data management*

地理信息系统在血吸虫病防治信息管理中的应用

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【摘要】**目的** 应用地理信息系统探索安徽省钉螺和急性血吸虫病的时空分布和变化趋势。**方法** 收集安徽省 1980-2000 年钉螺分布和急性血吸虫病发病资料,将 1:1 000 000 的数字化电子地图作为图形文件输入 ArcView 3.3。在 ArcView 3.3 系统建立 GIS 数据库并进行相关分析。**结果** 钉螺多分布于长江两岸地区,血吸虫病流行最严重的地区,也集中于长江流域,钉螺扩散主要见于未控制地区以及与未控制地区接壤的已控制地区。1989、1990、1991 是急性血吸虫病爆发最严重的 3 年,当涂、东至、宿松是急性血吸虫病发生最严重的 3 个县,大多数急性血吸虫病病例分布于长江流域。**结论** 地理信息系统可用于数据库和图形管理的工具,能够更加直接和清晰地揭示血吸虫病疫情现状,有助于管理者制定最合理的血吸虫病控制策略。

【关键词】 地理信息系统; 血吸虫病; 钉螺分布; 信息管理

Introduction

The first complete national atlas of schistosomiasis in China was published in 1980, which reflected historical epidemiological status in China[1]. After that, there is no map or atlas to reflect the distribution of schistosomiasis. More than 20 years past, China has made great progress in the control of schistosomiasis. Schistosomiasis has been successfully controlled in 5 out of 12 former endemic provinces and in 73.8% of endemic counties, the snail-ridden regions was reduced by 76.6%, and the number of infected individuals and infected cattle/buffaloes declined by 93.8% and 54.8%, respectively[2]. Therefore, it is impetus for us to renew the map. The advent of GIS has greatly

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facilitated the mapping process and, in particular, enables maps to be updated rapidly and presented in different ways [3]. Geographic information systems provide ideal platforms for the convergence of disease-specific information and their analyses. They are highly suitable for analysing epidemiological data, revealing trends and interrelationships that would be more difficult to discover in tabular format. Moreover GIS allows policy makers to easily visualize problems in relation to existing health and social services and the natural environment and so more effectively target resources. Geographic information system has been successfully used in the vector-borne diseases, especially in malaria[4], Lyme disease[5], trypanosomiasis[6], and schistosomiasis[7].

Geographic information systems were being used to collate and map available helminth survey data available from the formal and "grey" literature in Africa [8]. Such information on the distribution of infection will be central to successfully addressing the key operational questions of reliably estimating the target population numbers at risk[9]. The increasing use of geographical information systems (GIS) and remote sensing provides an opportunity to investigate the distribution of schistosomiasis at broad scales in Africa for the purposes of control[10]. China represents the largest endemic area of *Schistosoma japonicum* infection in the world[11]. Schistosomiasis japonica is still a serious public health problem and a major disease risk for more than 30 million people living in the tropical and subtropical zones in China[12]. Favourable environmental factors and other transmission parameters in the endemic area still exist which will result the disease re-emergence.

The application of GIS for schistosomiasis surveillance in China was initiated in the 1990s with the purpose to improve policy-making in the national control programme.

However, current research efforts have focused on particular endemic areas in a given region. No project has addressed the problem at the national level, and a national GIS mapping system for schistosomiasis has not been constructed. The present paper shows the result of the application of GIS for the time and spatial analysis on schistosomiasis in Anhui province. The study can also be used as basis for the application of GIS on the national scale.

Material and methods

Anhui province is located in 29°41′-34°28′ N, 124°54′-119°37′ E. The Yangtze River flows through the province with the length of 416 kilometres. It is one of the most serious endemic provinces in China, 41 counties ever had schistosomiasis. Digit map at the county level was obtained from the Digital Chart of the World at a 1:1 000 000 scale. The map was input into Arc view3.3 as a shape file. Epidemiological data of schistosomiasis from 1980 to 2000 were collected from the routine report records aggregated at the county level, these data reflected the prevalence status with the years, and the relevant GIS databases were established. All GIS database were developed using ArcView 3.3.In this study we selected snail distribution and acute schistosomiasis as analysis layers. For acute schistosomiasis, the years that the number of cases was over mean+1SD were displayed for the purpose of showing the "highlighting" places in the outbreak year. For snail distribution, 1980, 1990, 2000 year were selected for displaying and analysis of the fluctuation in the twenty years.

Results

The distribution of snail. From 1980 to 2000, the snail area increased by 21.54 %. The fluctuation of snail area in the twenty years can be divided into three stages. The first stage was from 1980 to the end of 1980s, the snail area declined gradually. The second stage was from 1988 to 1991, the snail area increased rapidly, and the third stage was from 1992 to 2000 year with a relative stability (Fig. 1). Snail data as a layer in the GIS revealed that the snail dispersed in the twenty years. Snail distributed mostly in the counties which situated in both sides of the Yangtze River. The most serious areas were focused on the Yangtze River basin. In 1980, there were two counties the snail area was over 50 million square meters, and five counties over 10 million square meters. Although the snail area in the two widely distributed counties diminished, the number of counties with thesnail area over 10 million square meters added up to 10 in 2000 year (Fig. 2). The snail area also raised in several controlled counties which are adjacent to the uncontrolled counties. The snail distribution remains stable in the mountainous regions in the south of the province. The fluctuation of the distribution of snail in time and space also reflects the change of control measures in the twenty years. From 1955 through 1980s. comprehensive control measures had been carried out with the emphasis on environmental management. Great success was achieved. Snail area declined gradually, and endemic areas were circumscribed in the marshland regions along the Yangtze River where the environment was very complicated. At the end of 1980s, a stepwise control strategy was employed.The first step was to control morbidity through mass chemotherapy in the severely endemic areas and selective chemotherapy in less severely endemic areas.Further steps included snail control through mollusciciding and/ or environmental modification, as well as health education and sanitation. As a result, snail re-emergence and dispersed in the province.

Acute schistosomiasis. Acute schistosomiasis is common in the high transmission regions. It is an important sign to predict the severity of schistosomiasis. The frequency and distribution can be used to monitor the progress in schistosomiasis control. Meanwhile, the symptoms of acute schitosomiasis are remarkable, and may give rise to serious social influence.The government pay much more attention for the outbreak of acute schistosomiasis. One of the importance tasks for the staff is to prevent the outbreak of acute schistosomiasis every year. Analysis on acute schistosomiasis occurred from 1980 to 2001 in Anhui province (Fig. 3). The results showed that the average number annually was 642. The number of acute case over mean+1SD was in 1989, 1990, and 1991 year. The theme in GIS was displayed by the type of standard deviation and break classes at one standard deviation (Fig. 4). The three counties, Dangtu, Dongzhi and Susong, were always showed much more cases in the outbreak year. There was no doubt that most cases were distributed in the counties along the Yangtze River.

Discussion

GIS are computer hardware and software packages concerned with the capture, storage, manipulation, query, display and analysis of all types of geographical information. The power of GIS is its ability to effectively integrate various sources and types of geo-referenced data, and to easily update, and efficiently manipulate and display the various spatial data from a large area in a single analysis. Various data sources can be incorporated into a GIS, including existing maps, aerial photographs and satellite images as well as censuses, route data, epidemiological surveillance data, and data from other specific studies.

The present study showed that GIS can be use as both a database and a graphical tool, and the results indicated clearly the prevalence status in Anhui province. It revealed great advantage than the tabular data. By mapping the distribution of snail and acute schistosomiasis, the two most concerned and sensitive

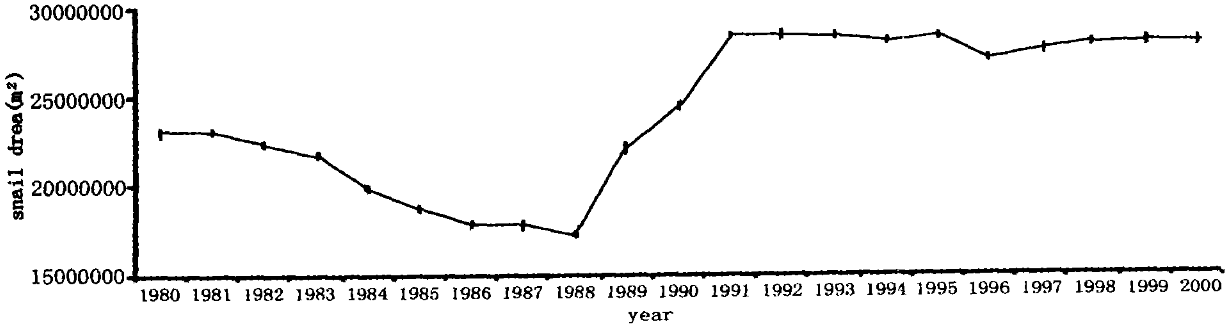

Fig. 1 The distribution of snail from 1980 to 2000 in Anhui province

Fig. 3 Acute cases from 1980 to 2001

index, we could easily find the problem existed in the province. The distribution of snail expanded in the uncontrolled counties and the some controlled counties adjacent to the uncontrolled counties. However, snail distribution was keeping stable in the mountainous regions in the twenty years. This suggested snail control should not be neglected in the uncontrolled regions, and snail surveillance should be strengthened in the regions that are near the uncontrolled counties in order to avoid re-emergence and dispersed on a large scale. Most of Acute schistosomiasis occurred from June to October, every year the government and the professional staff make great effort, usually through molluscíciding, as well as health education and treatment early to the risk people, to prevent the outbreak. The endemic area is so widely distributed in the province and the risk people are so many, also the finance is limited in the province for schistosomiasis control. It is impossible to carry out these control measures in the whole endemic areas. Therefore, highlighting areas should be confirmed and further control measures should be strengthened in these regions. Using GIS, three counties, Dangtu, Dongzhi and Susong, are the most seriously regions for the occurrence of acute schistosomiasis. This reminds the poor resources should be invested in theses regions, and the local professional station should pay much more attention on the control of acute schistosomiasis during risk seasons.

Generally, the first step in analysis the distribution of disease is to produce a map. After mapping the disease, the determinants and risk variables could also be linked on the map. This provides a clue for further statistical and epidemiological analyses.

The current use of GIS in mapping available data on schistosomiasis distribution builds upon the seminal Atlas of the Global Distribution of Schistosomiasis [13], which maps the occurrence of schistosomiasis in 76 countries worldwide. This work remains a valuable resource, but has the major disadvantage that the derived maps can not easily be updated, and comparision between different maps is difficult. GIS provides a dynamic, easily updated mapping system that can be used by health management officers to plan and monitor schistosomiasis control programmes. It can help exclude areas where schistosomiasis is unlikely to be a public health problem, and to help focus on priority areas where local targeting control measures should be undertaken. It also has important implications for the efficient allocation of scarce resources in developing countries.

Although the present study uses the example of

Anhui province, the approach can also be extended to the national level. In the context of national schistosomiasis control program, the rationale is to provide information on the time and spatial distribution of the disease so that the control resources are likely to be mobilized. Allow for the more targetd and rational implementation of control programs in China. We have abundance data; the endemic provinces must submit the control programme data to the Minister of Health every year, which reflect the fluctuation of snail area, chronic, acute, and advanced cases, and the control measures, et al. We carried out three times National Sampling Survey on schistosomiasis, which has high value for describing the distribution ofschistosomiasis in China. But all these data were separated each other and could not be used effectively. The Minister of Health has recognized that modern computer-based technology is essential to improve schistosomiasis control programs. A training course on Geographic Information Systems (GIS) has been held, and a project "development of a forecasting system of schistosomiasis by application of GIS/remote sensing technique in the middle and lower basin of the Yangtze River" was supported. Once we have mapped the distribution of schistosomiasis, we can analyse the patterns of that distribution and attempt to elucidate the causal factors. These factors have lead to an increased impetus.for those of us developing our ability to map spatial and temporal risk of disdisease. Therefore, the government may take interventions most rationally and economically. The easily updated mapping system also can be used by health management officers to plan and monitor reschistosomiasis control programme in China.

Fig2 & Fig4 see the back cover

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(For text, to see p.67-71)

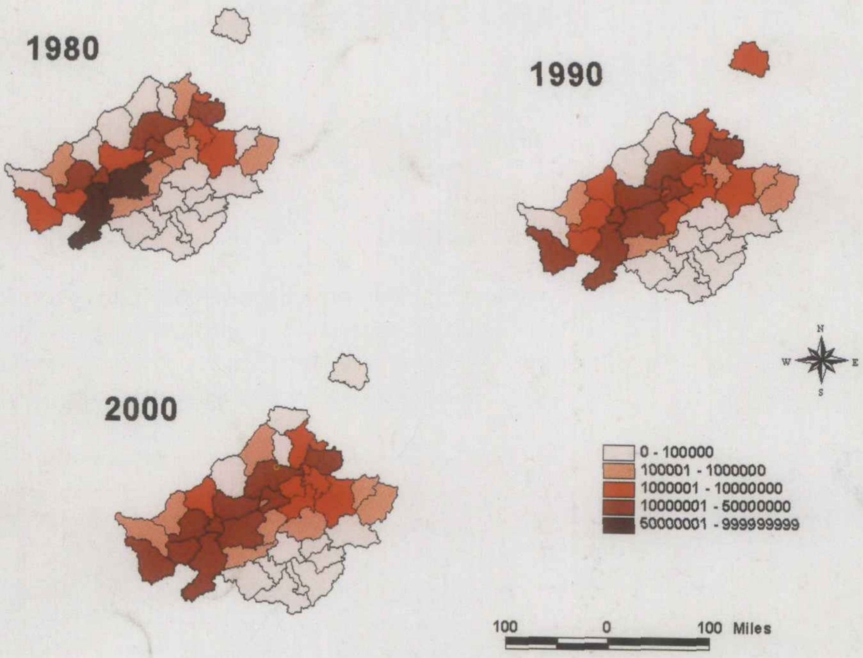

Fig 2 Mapping the distribution of snail at the county level

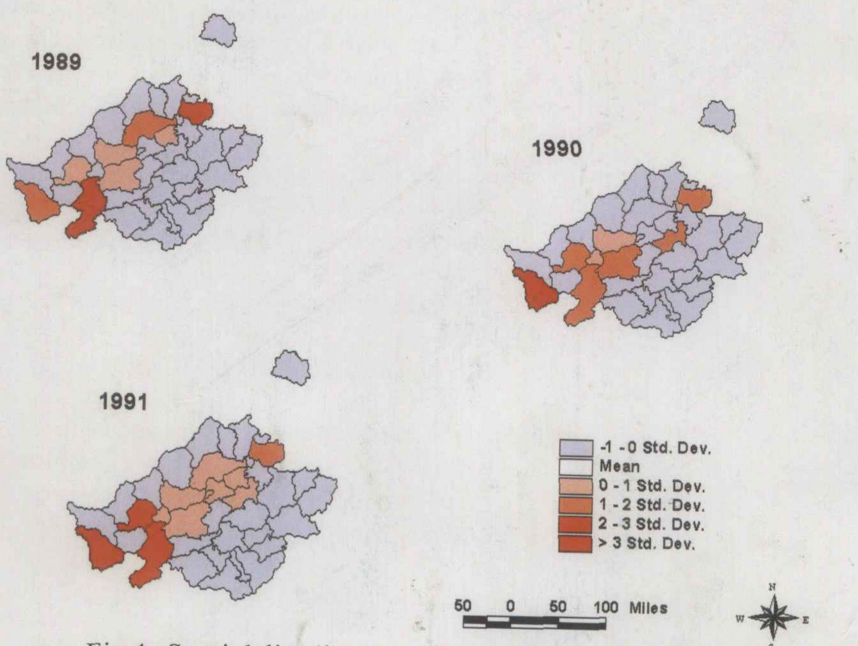

Fig 4 Spatial distribution of acute cases in the outbreak year

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