Role of GIS Technology during Leprosy Elimination Efforts in Pohnpei

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Abstract

This article summarizes Pohnpei State Department of Health Services' utilization of GIS technology and GPS mapping of leprosy cases during the leprosy elimination efforts. Maps generated from ArcMap© provided 'hotspots' or areas of high case density, thus providing for more focused screening. Introducing GIS technology in the elimination efforts has led to a diminution of the target number of screened clients per year, thus minimizing resource utilization. GPS technology as a health planning tool in small Pacific island countries can synergize local screening efforts and improve overall public health planning and implementation, in a way that is cost-effective and resource friendly.

Background

In 1991, the World Health Assembly passed a resolution to eliminate leprosy as a public health problem by the year 2000, where elimination was defined as a prevalence of less than 1 case per 10,000 inhabitants.[1] By the end of 2000, the goal had been largely achieved at the global level although the challenge has not yet been met by some nations, including the Federated States of Micronesia (FSM), one of the two remaining Western Pacific region countries that have not met this goal on a national level (the other being the Republic of the Marshall Islands). The World Health Organization's leprosy elimination goal has been extended to 2010 and in response the national and state leprosy programs began intensifying leprosy elimination efforts throughout the region.[2]

The prevalence of leprosy in the FSM at the beginning of 2009 was 14/10,000. Data from all four states revealed that 55% of the cases were among children under 15 years and 29% were classified as multi-bacillary (MB) cases, the transmissible form of leprosy, suggesting active transmission of the disease. Among the four FSM states, Pohnpei carries the largest burden, with a prevalence of 21/10,000 at the beginning of 2009 (Table 1). Although 70% of the cases presented voluntarily to the clinic, the average length of time from onset of lesion until detection was 2 years, a postponement conducive to the spread of the disease.

With the extension of leprosy elimination efforts in 2004, the Division of Primary Care Services (DPCS) increased annual active-case screening during summer months to increase case detection, tracking, and treatment.

Summer months (May to August) are selected mainly for staff availability purposes and to increase screening of school-age children. The number of new cases detected in 2004, 2005, and 2006 were 92, 162, and 107, respectively. The increase in numbers was largely due to increase in screening activities in the known endemic pockets of Pohnpei. The increase in newly registered cases from previous years clearly verifies the need to modify and expand existing strategies to address the challenge of leprosy elimination on Pohnpei. Strategies must be comprehensive, targeting all levels of care and focusing on active case finding, case management and tracking, stigma elimination, and capacity building towards provision of leprosy services at the community level.

In 2007, screening efforts were combined with the use of Geographic Information System (GIS; the superimposition of data, such as disease incidence, onto maps) technology as a public health planning tool to support existing strategies for leprosy elimination in Pohnpei. Initially introduced with much skepticism, it was soon realized to be a very valuable tool with potentially numerous applications even in small island countries.

Geographic Information System Technology

Medical geography is not new, in fact, epidemiologists have studied the connection between health and environment using maps for years. In the modern era, using GIS in health as a tool for health planning had become increasingly popular and offers great potential for improving health services.[a]

Table 1: FSM leprosy statistics at the end of 2008, by state

State	Population	New cases	Detection rate per 100,000	Cases under treatment	Prevalence per 10,000	Proportion among new cases			Cases cured	Relapses
						MB%	Grade 2 disability%	Age <15 yrs %		
Pohnpei	41,428	99	240	87	21	45	0	25	74	7
Chuuk	64,384	46	71	56	8.7	33	0	16	43	0
Yap	13,504	5	37	12	8.8	75	0	75	10	0
Kosrae	9,233	3	37	8	10	50	100	0	7	0
FSM	128,549	153	119	163	14	55	0	29	163	7

This table shows a state-by-state comparison of leprosy data for the year 2008 in FSM. (MB = multi-bacillary. Disability grades are as follows: 0, part not affected by leprosy; 1, part affected by leprosy but no visible changes present; 2, part affected by leprosy and visual changes present)

a. FSM Health & Social Affairs / National TB/HD Section (Data Consolidation)

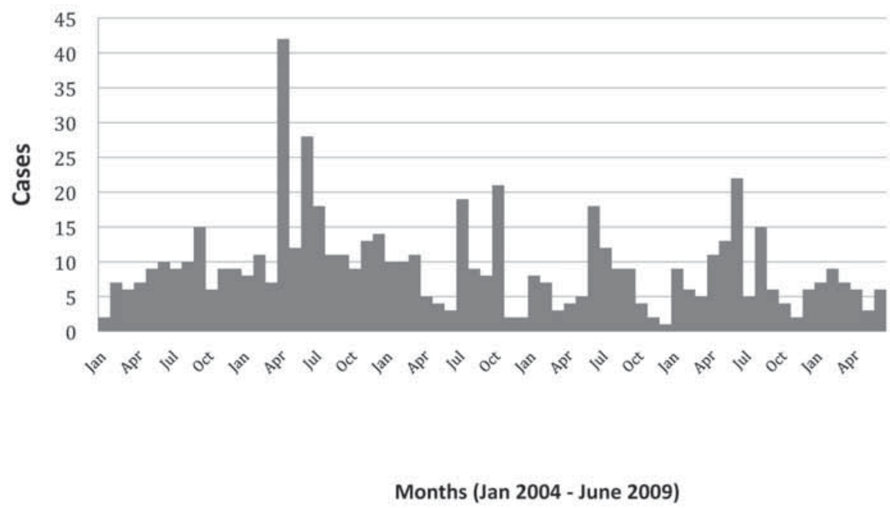
Table 2: Pohnpei state leprosy statistics, 2002-2008

	2002	2003	2004	2005	2006	2007	2008
New cases	76	65	92	162	107	87	99
Active case finding	N/A	9 (11%)	26 (28%)	54 (33%)	22 (21%)	22 (25%)	16 (16%)
Age <15 yrs	33 (43%)	24 (37%)	39 (42%)	67 (41%)	25 (23%)	28 (32%)	25 (25%)
Cases on treatment	56	41	72	104	52	-	87
Grade 2 disability %	0	0	0	2 (1.2%)	2 (1.8%)	1 (1.1%)	0 (0%)
Multi-bacillary %	-	-	29 (32%)	59 (36%)	47 (44%)	37 (43%)	45 (45%)
Completed treatment	73	79	47	111	52	51	74
Prevalence per 10,000	16	11.8	11.3	25	12	19	21

This table summarizes the characteristics of the leprosy cases in Pohnpei from 2002-2008. Note that the prevalence was highest in 2005 when active case finding activities were intensified.

Figure 1: Monthly incidence of leprosy in Pohnpei (FSM), Jan 2004-Jun2009

The number of new cases detected by month increased during the summer months where more staff members were available and extensive screening activities took place. Screening activities also took place during school summer vacation to maximize the chances of encountering children at home.



Methods

In 2007, training on the GIS software ArcMap© (ESRI, Redlands, California, USA) was conducted for health staff and surveyors from the Pohnpei State Department of Land. With the provision of ArcMap© software and a Global Positioning System (GPS) hand-held device to the DPCS, enormous interest emerged in analyzing the spatial characteristics of known leprosy cases in Pohnpei, with the intention of generating a focused margin of screening and possibly providing a cost-effective active-case screening approach, especially given meager health resources. Leprosy cases are characteristically geographically clustered, therefore it is useful to identify and study the distribution patterns of leprosy cases in Pohnpei in order to determine 'hotspots' with high endemicity, and conduct focused active case finding. The most endemic areas were determined through GIS mapping, according to the following method.

In order to generate spatial cluster data, the leprosy staff visited all of the registered patients and recorded the location of their homes using a GPS hand-held device. The coordinates were loaded into ArcMap© and spatially analyzed using point density within a 1-mile radius. The GIS software generated maps of the endemic villages showing the boundaries of the highest-density hotspots, which were divided into sections and assigned to screening teams. Coordinates for dispensaries and health facilities were added to the map to determine accessibility to services areas.

In order to ensure community involvement and cooperation, several steps were undertaken: support from village chiefs (soumas) was attained before initiating screening activities; field staff conducted a week-long awareness campaign focusing on clinical signs and stigma avoidance, which included radio announcements, posters, and fliers; and radio announcements were scheduled to continue throughout the month of screening.

Assigned groups of health workers travelled to the endemic hotspots identified under the GIS software and systematically screened each house in the hotspot in order to achieve as high a coverage rate as possible. It was anticipated that some household members would be absent during the screening and therefore provisions were made to visit some households more than once. Debriefings were held every morning before community outreach deployment.

This screening methodology was carried out in the years 2007, 2008, and 2009.

Results

Results from the annual endemic area and contact screening are shown in Table 3. Data showed a decreased number of people screened beginning in 2007, as a result of the more focused screening approach; it remained roughly unchanged, indicating equivalent yielding of cases by screening each year.

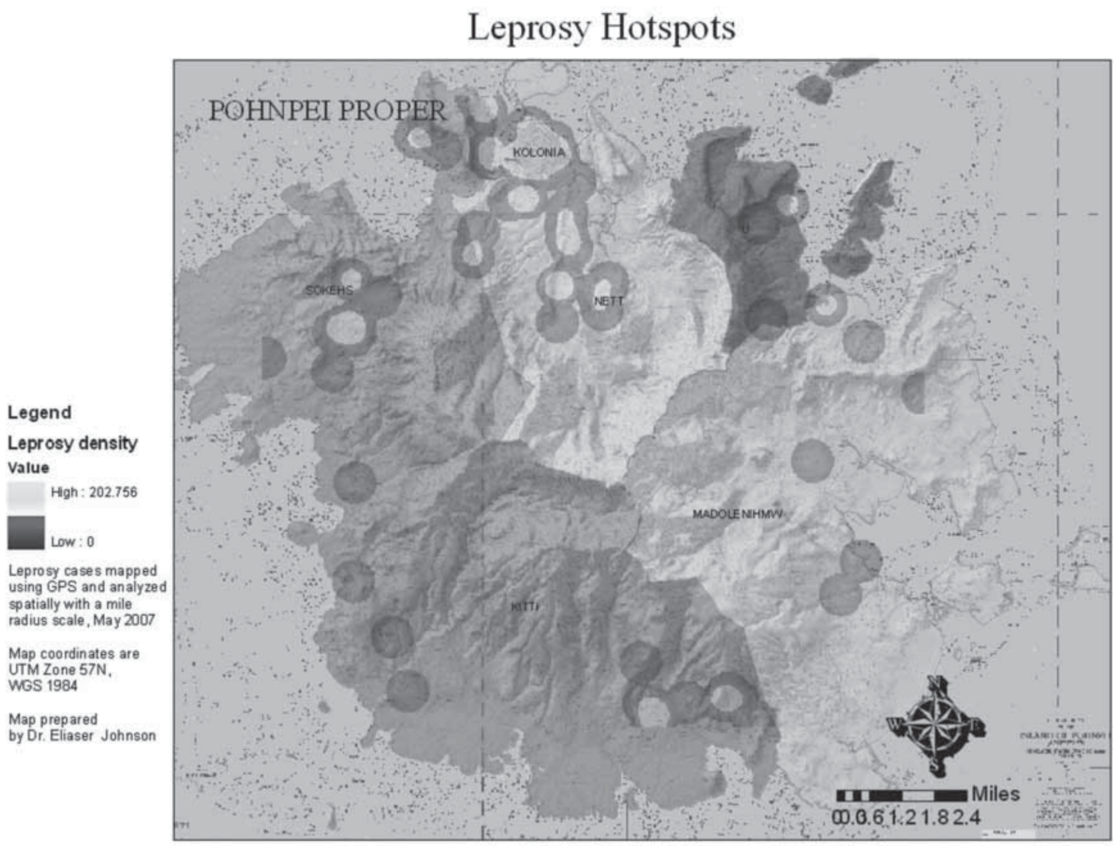
In past years, we identified major leprosy clusters indicative of high prevalence areas on the island. The results of the GIS processing confirms these areas (map not shown for patient confidentiality). Case density breakdown by municipality showed that the majority of leprosy cases in Pohnpei are situated in Kolonia, mainly clustered around the Kapingamarangi (a Polynesian ethnic minority population from the Pohnpei outer island of the same name) village in the southwest end of town. The majority of cases are near public health facilities (except for some small scattered hotspots in the eastern part of Sokehs and Kitti as well as some areas in western part of Madolenihmw and Uh).

Table 2: Screening data after GIS utilization

	Number screened	Total pop	Percentage screened	New cases detected
Summer 2007	5,853	7,065	83%	21
Summer 2008	3764	5697	66%	19
Summer 2009	735	878	84%	7

GIS utilization allowed for more focused screening, resulting in fewer persons screened.

Figure 2: Leprosy hotspots on Pohnpei Island, 2007



The circles represent the boundaries of highest-yield leprosy hotspots, which were the areas visited for targeted screening. Most cases are located in Kolonia town, and most cases are located relatively close to healthcare facilities.

Discussion

Since 2007, GIS has made a valuable contribution to leprosy elimination efforts in Pohnpei. Perhaps the most significant advantage of the GIS technology is the ability to delineate the boundaries of the highest-yield screening zones using data rather than guesswork, resulting in the ability to maximize the efficiency of screening. As a result of targeting made possible by GIS, there was a nearly eight-fold decrease in the number of households screened between 2007 and 2009 (Table 3), while still identifying a relatively constant number of new cases (Table 2). This is a clear indication of the improvement in efficiency of the program's scarce resources as a result of GIS implementation.

During program implementation, the GIS technology's visual representation of the problem had a definite effect on the division's effort to gain support from government ministers and community leaders, mainly because it is effortless to interpret the maps generated using GIS technology. GIS information can also be easily visualized by health workers who perform screening, ensuring that they understand both the scope of the problem in relation to space and their role in the solution. The graphical displays can also be easily modified to presentations for general health workers, politicians, and the general public, greatly improving disease awareness and promoting advocacy.

The GIS software required minimum training for computer literate individuals and allowed clear and rapid processing of epidemiological data to pinpoint diseases around Pohnpei. The use of the GIS technology to enhance epidemiology and direct the activities of public health programs proved valuable in this exercise and offers potential for its use in other public health arenas. This technology offers the potential to study spatial trends and distribution of diseases, especially communicable disease; the quick analysis and processing of health data by GIS provides an enormous advantage for quick decision-making during disease outbreaks. Potential circumstances may arise where GIS technology could play a valuable role in the planning and implementation of a variety of other public health programs.

Future uses of GIS in small Pacific Island nations

The World Health Organization's Public Health Mapping and GIS program has listed some of the major uses of GIS in public health: determining geographic distribution of diseases; analyzing spatial and temporal trends; mapping populations at risk; stratifying risk factors; assessing resource allocation; planning and targeting interventions; and monitoring diseases and interventions over time.[4] Although the potential of GIS for public health is beginning to be realized worldwide, the key to its success is its availability and its practical application.

Pohnpei's experience during this leprosy elimination effort has been an eye-opener for public health planners. Our experience has demonstrated that the basics of GIS can easily be learned, and that operationally useful results can be quickly realized. Because it is applicable to a variety of different health disciplines, because it is inexpensive, and because geographic differences in health are a reality in many Pacific island settings, GIS should be actively promoted for its vast potential in other Pacific island countries.

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