Should healthcare professionals care about space and time?

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GIS has a useful supplementary role in planning and decision processes of rural health systems development and delivery. This article includes two real-world examples of the use of a GIS to supplement an already well established rural health programme in the Kaniyambadi Block of Vellore District, India. The Community Health And Development (CHAD) unit of the Christian Medical College, Vellore, implemented and used a GIS system in programmatic and training situations. This article describes the efforts of health care professionals-in-training to incorporate spatial and temporal thinking into identifying and solving problems on the ground.

Background

The Christian Medical College and Hospital (CMC) is a leading health care, teaching and research institution in the southern state of Tamil Nadu, India. The institute was created in 1900 to train women medical personnel to serve in socially and culturally acceptable ways in India.

To provide medical care to rural communities, the Rural Health Unit, later known as Community Health And Development (CHAD) Hospital was started in 1955. CHAD initially provided outreach services to five villages (total population of about 5000). Over the years, it has expanded its services in the geographic/ administrative region of Kaniyambadi block. By 1980, the services had expanded to the entire 1,06,000 population with a model primary health care programme which included training of community health volunteers, traditional birth attendants and provision of preventive, promotive, rehabilitative and curative services at the village level.

The CHAD programme is now a WHO Collaborating Centre for Community Based Health Professions Education and is used as a model for training medical, nursing and allied health students from India, South East Asian regions of the WHO, Scandinavian countries of Denmark and Sweden, other European countries and the USA.

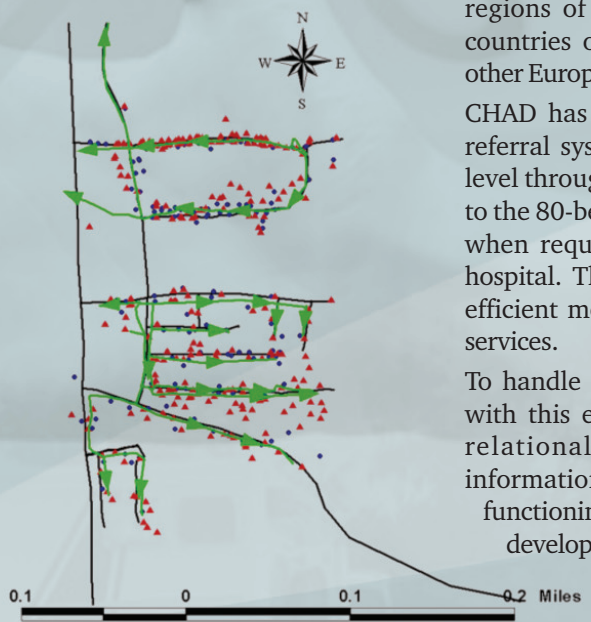

Figure 1. shows the streets (black lines), houses (red triangles), water tanks (blue squares) and pipes supplying the main village and colony. (PVC pipes with direction of water flow shown as green lines). The main village is north of the colony.

CHAD has developed a functioning referral system from the grass roots level through a monthly mobile clinic to the 80-bed secondary hospital and when required, to the tertiary care hospital. This system has served as an efficient model for rural health care services.

To handle all of the data associated with this effort, an enterprise level relational database powered information system coupled with a functioning referral system has been developed in house. To supplement these data and information, a Geographic Information Systems (GIS) overlay was deployed in 2001.

The pre-conditions for success of such a deployment were:

1. Long institutional history of pioneering, grass-roots, community needs based approach to health care delivery and consequent reputation as an institution of excellence nationally and internationally.
2. Long and successful history of the rural health model of disease control at the village level.
3. The existence of networked, relational database systems for the numbers and figures generated from the field, with detailed residence level data from over 106,000 people from one administrative block.
4. Leadership and grass-roots personnel who saw the GIS concept as being complementary technology, adding value to the business processes already in place.

The GIS system infrastructure consists of GPS derived street centerlines vector basemaps in addition to various polygon feature datasets. Additionally, every one of the 25,000 houses have been incorporated into a point feature dataset and coupled uniquely to all of the clinical and socio-demographic data for these houses. Raster data from the Indian Space Research Organisation were used to create a comprehensive spatial database that includes soil, agriculture and drainage features – all of which impact the health of a community. This extensive and comprehensive spatial data infrastructure made it possible for CHAD to work comprehensively on real world problems in the villages as described in the two examples below.

I. Dengue in Pennathur

Muniamma* (47), living in Pennathur Colony, had been lying in bed with high fever and chills for three days and unable to even cook for her family. Her husband Saravanan* (52), had been ill prior to that and had just recovered from fever and was still unsteady on his feed and was reconciled to drinking what ever koolzhu (rice porridge) was given by his neighbours. His son Karthik* (27), had started bleeding from his nose the previous night and he had been having fever with chills for a week. Saravanan and Muniamma knew that Karthik needed immediate medical attention but were in no position to help. They asked their neighbours, if they could take Karthik to the Community Health And Development (CHAD) hospital at Bagayam that was 10 km away. Karthik was seen in CHAD and his blood counts showed a lowered platelet count that had given rise to his bleeding from his nostril. He was admitted for further investigations and treatment. Karthik said many others in his village were down with fever.

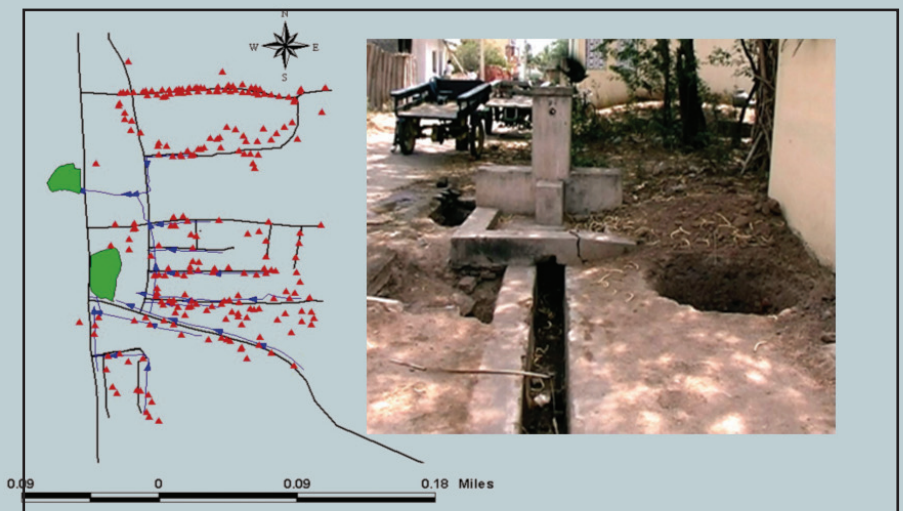

Figure 2 *shows open sewage channels (south of the village in the colony, as blue lines) and areas where it drains (green polygons). Water pipes and sewage channel crisscross each other. This is illustrated in the picture showing proximity of water pipe to sewage channel.*

A preliminary investigation team was dispatched to Pennathur village and they reported there were hundreds of persons with fever though there had been no fatalities. An outbreak investigation team consisting of a nurse, physician and two masters' level trainees were dispatched to investigate. The team was provided an initial briefing and a questionnaire. One of us (JD) with considerable experience in the use of GPS units and desktop and pocket PC based GIS software, provided basic training in the use of this technology (*http://esri.com/library/reprints/pdfs/arcuser_dengue-outbreak.pdf*).

Preliminary results from the blood samples suggested that the fever was caused by dengue. Help from the district entomology team was sought. They identified extensive breeding of Aedes mosquitoes that are vectors for the spread of this infection. Fogging with pyrethrum (a botanical insecticide produced primarily in the flowers of Tanacetum cinerariaefolium, a species of the chrysanthemum plant family) was undertaken by the entomology team to kill adult mosquitoes. CHAD sent its health educators to mobilise the community, including the local high school to search in the undergrowth for water containers where the mosquitoes could be breeding and the community emptied out all breeding sites and the outbreak of dengue fever contained, with no fatalities. Karthik and others, who had been severely ill, recovered without any need for blood transfusion.

This episode gave the trainee students an opportunity to use the GPS unit, transfer the data to GIS software, map the street centerlines, plot the houses, add data to the tables of those with and without fever, calculate attack rates and plot the illness spread in the

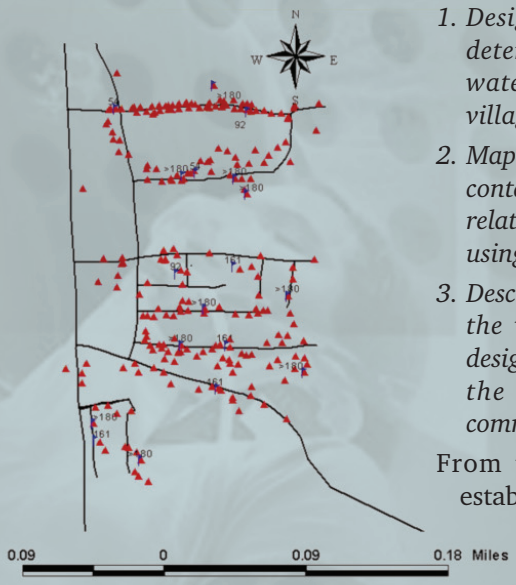

Figure 3 shows the village with the streets and houses and the results of water tests (coliform counts shown from points of collection). All samples show faecal contamination of water

community every successive week and how disease was clustered (**Figure 1**). The students also published their experience in a peer reviewed scientific journal (Nisha V et al, J. Commun Dis 2005;37(1):39)

The community health department has since, used GIS tools to train postgraduate students of medicine and epidemiology, to investigate two more outbreaks of dengue fever, and an outbreak of cholera, all in the rural areas.

What follows next is a natural progression of furthering science in an academic department.

II. Water and sanitation exercise

Third year MBBS students spend a two-week period in the community health department, CMC Vellore, learning to apply community health research methods taught to them. They are asked to carry out a finite piece of work which addresses a public health problem. They sign up for one of six such problems that are given to them. Lack of water and sanitation is a national problem. A group of 10 students signed up for the following set of tasks related to this problem:

1. *Design and carry out a study to determine the safety of drinking water in a typical Kaniyambadi village*
2. *Map the causes/sources of possible contamination and their location in relation to the drinking water source using GIS tools.*
3. *Describe the defecation practices in the village, with the objective of designing an intervention to make the environment safer for the community.*

From this task list, the students established the following aims.

1. Assess the safety of drinking water in a village of their choice
2. Look for an association between defecation practices and contamination of water
3. Understand the beliefs, knowledge and practices of the community with respect to defecation and water contamination
4. Design intervention strategies for these issues.

After conducting a thorough literature search and a briefing by the faculty, the students underwent practical training in the use of commercial, off-the-shelf GPS units, downloading the resulting data and converting this data to information in standard commercial off-the-shelf (COTS) GIS software.

The students designed data collection forms and carried out a survey, over six working days, of every household in the selected village and the surrounding environment, with a focus on water and sanitation.

All water, sewage, garbage, animal tethering sites, faecal contamination of top soil and fields that the residents used for defecation were mapped as a mixture of point, line and polygon features. Individual members of each household were interviewed and quantitative data was collected on water source, usage, storage, defecation and ablution practices, use of soap and attitudes about the use of toilets and open places for defecation. Focus group discussions were led by students, among men and women separately. The resulting qualitative data and information were collated. The topics were:

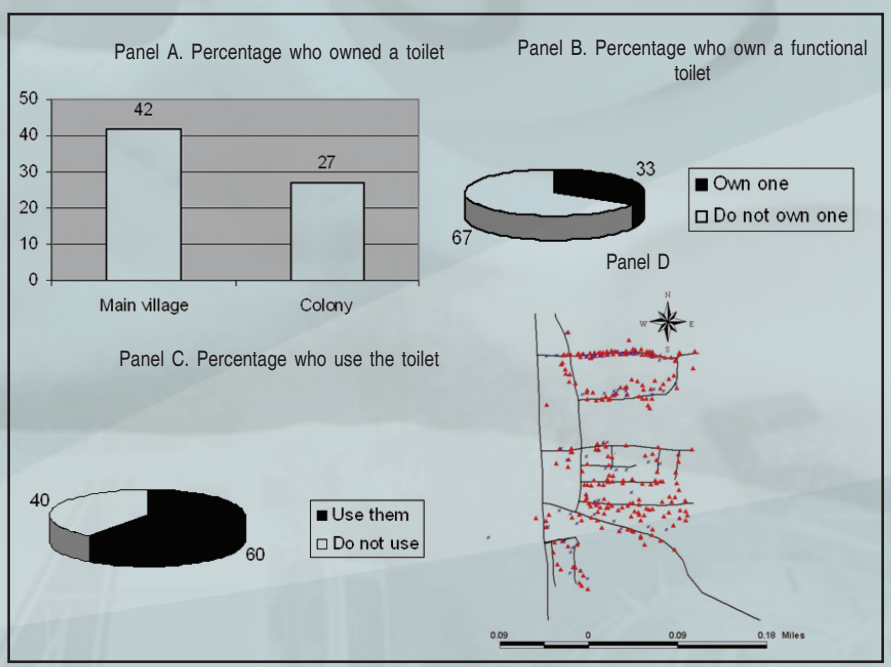

Figure 4 Panels A, B, C and D show availability of toilets, their spatial location (pink x marks) their functionality and usage.

1. water – quality, availability, disposal
2. defecation practices
3. handling of animal waste.

Shown below are illustrations of student generated 'issue maps' and salient findings that they subsequently presented to their fellow students and peers.

Findings

There is extensive contamination of water used for drinking in this village. The causes could be:

1. Proximity to sewage points
2. Inappropriate animal tethering practices
3. Not washing hands with soap
4. Underground water supply systems sited adjacent to sewage carrying channels
5. Indiscriminate defecation around the village, improper storage and sanitation of drinking water.

Recommendations/ interventions

1. All drinking water should be boiled
2. Water in the tanks should be chlorinated adequately and every day
3. Washing hands with soap should be encouraged through health education
4. Long handled utensils should be used to take drinking water out of pots and not dip a tumbler/glass directly into the water
5. Re-engineer the water supply/sewage system (proximity of water lines to sewage is hazardous),
6. Repair toilets that are not working,
7. Distance areas of defecation from bore wells

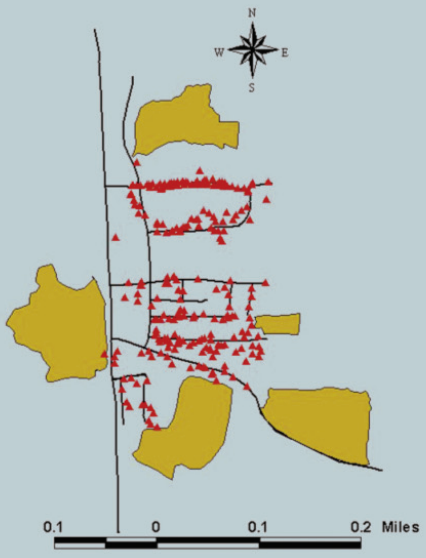

Figure 5 *shows a map of the fields where the residents defecate (polygons). These fields surround the village. During heavy rain, the village is liable to flooding from the surrounding areas.*

Conclusion

A GIS data system can enhance the decision and planning cycle in rural community health programmes. The use of GIS and issue maps is invaluable in the analysis and understanding of a set of problems and in formulating mitigating solutions. The use of visually compelling maps in attempts to change long ingrained social belief systems is yet another benefit of using a GIS to enhance the already well established rural health effort. Young students are especially drawn to these methods and processes and they must be encouraged to participate at all levels of a GIS based data system.

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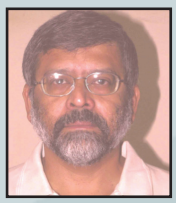

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