

## Mapping of cholera risks using Geographical Information System in Ilala District, Tanzania

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**Abstract:** Geographical Information System (GIS) was used to map cholera-epidemic prone areas and determine the predisposing factors of the disease in Ilala district, Tanzania. A database was developed to store all data (spatial and non-spatial) showing the source and spread of cholera. The results of this study indicate that Vingunguti, Kiwalani, Mchikichini, Kipawa and Buguruni areas had the highest cholera incidences. Few cases of cholera were reported in Kitunda, Kinyerezi and Ukonga. The disease is likely to spread at high rate in areas along the Msimbazi River Valley. Areas like Segerea and Tabata are likely to be more affected in future. Poor water supply, poor sanitation, and high population density were identified as cholera spatial elements within the district. The findings demonstrate the potential of GIS in monitoring sources and spread of a communicable disease such as cholera. Some of the reasons for the frequent cholera outbreaks in Ilala and other districts in Tanzania are discussed in relation to disease surveillance and control.

### Introduction

Communicable diseases continue to cause most of the mortality and morbidity in Tanzania. The commonest diseases include HIV/AIDS, malaria, respiratory tract infections and diarrhoeal diseases. Diarrhoeal diseases such as cholera and bacillary dysentery are very common in Tanzania (Rumisha *et al.*, 2003).

Cholera is a common persistent infectious disease in Tanzania with a considerable socio-economic cost to affected populations. The disease may occur in epidemic forms and spreading faster from one community to another. The first outbreak of cholera in Tanzania was reported at Twasalie village, Rufiji District in October 1977 (Mandara & Mhalu, 1981). Between 1977 and 1979, in Tanzania, the disease has affected Dar es Salaam, Coast, Morogoro, Dodoma, Mbeya, Iringa, Kigoma and Kilimanjaro Regions.

Transmission of cholera is through consumption of food or water, contaminated with human waste (Mhalu, 1991). The cholera organism is also transmitted through direct person-to-person contact among individuals living in overcrowded and unhygienic conditions. The disease can thus, spread rapidly in areas with inadequate treatment of sewage and drinking water.

There have been some efforts to contain the disease in the country but several sporadic epidemics in different parts of the country continue to occur. With the frequent and persistent epidemics, there is need to determine factors associated with the outbreaks and strengthen our disease surveillance and response strategies.

One of the best tools in disease surveillance is the Geographical Information System (GIS). In Tanzania, GIS has been applied in the mapping of various human diseases including lymphatic filariasis (M. Malecela-Lazaro *et al.*, unpublished); malaria in the Western Usambara Mountains (Bodker *et al.*, 2000) and trachoma in Central Tanzania (P. Kilima *et al.*, unpublished). Maps are excellent tools because the geographical distribution of the disease is readily visible compared to statistical tables and figures. District health teams can use maps produced by GIS as a monitoring and evaluation tool showing spatial distribution of the disease, indicating where the disease starts and how it spreads. Such information will help district teams to respond as quickly as possible to outbreaks, set priorities, plan interventions, mobilise and allocate resources. The objectives of this study were (i) to develop a database of cholera that will show the disease situation in Ilala district; (ii) to map areas of past cholera epidemics with regard to time and place; and, (iii) to examine the distribution of cholera in terms of water sources and sanitation.

### Materials and methods

The study was carried out in Ilala District, in the south-western part of the City of Dar es Salaam. It is located at latitudes 6.76°S and 7.8°S, longitudes 39.02°E and 39.34°E. The district is made up of 22 wards; Buguruni, Chanika, Gerezani, Ilala, Jangwani, Kariakoo, Kinyerezi, Kipawa, Kitunda, Kisutu, Kivukoni, Kiwalani, Mchafukoge, Mchikichini,

Msongola, Pugu, Segerea, Tabata, Ukonga, Upanga East, Upanga West, and Vingunguti.

The existing digital map for Ilala District that included ward boundaries, main roads and rivers was obtained from the Geo-Information Centre (GIC) at the University College of Lands and Architectural Studies, Dar es Salaam. Statistical data showing population distribution and cholera cases per each ward from 1997- 2002 were obtained from the Dar es Salaam City Medical Officer of Health. The attribute data for water distribution per each ward were obtained from Dar es Salaam Water and Sewerage Authority. These data included (i) water supply sources (i.e. piped water connections, deep wells, and shallow wells) and (ii) the water volume available and demand volume per day. Physical examination of the existing state and the performance of pit latrines, septic tanks, disposal sites, drainage systems, solid waste management and restaurants and food kiosks was also carried out.

Field observations were done by locating the positions of the health facilities in the area using a hand held global positioning system (GPS) receiver with precision of 10 to 20 meters (according to manufacturer’s specifications). The list of positional co-ordinates of the health facilities was compiled using Microsoft Excel spreadsheet for easy import into the GIS database. Using ArcView GIS functions the imported list of coordinates of health facility locations was later converted into point map.

A database was designed based on the attribute and spatial data collected. The entities identified from the existing information included: the district, wards, health facilities, cholera cases and water sources. Attributes for each entity in the database were identified. The attribute and spatial data were exported from MS Access in Dbase IV format in order to be accepted by ArcView GIS. The exported data formed a separate theme in ArcView. The imported themes were then added to the View window in ArcView GIS for display.

**Results**

During recent years, cholera has been a common health problem in Ilala District. In 1997, a total number of 3,220 cases and 128 deaths due to cholera were reported in Ilala district alone (DEHP, 1998). Of the 22 wards in the district, nine were frequently affected by cholera outbreaks. The most affected areas included Buguruni, Mchikichini, Vingunguti, Kiwalani, Msimbazi, Mburahati and Kigogo. Most of the reported outbreaks started from one of these wards

and then spread to the neighbouring areas. Interestingly, in recent years no cholera outbreak was reported in Pugu, Chanika and Msongola Wards.

There was a decreasing trend in the number of affected individuals from 1997 to 2000 (Figure 1a-e). Recently, the trend showed an increasing spread of the disease in areas like Kiwalani and Kipawa where more cases were reported than from Buguruni, Mchikichini and Vingunguti (Figure 1f). Cholera outbreaks were reported for consecutive years from 1997-2001 in Kitunda. A dramatic reduction of total number of cases in the district was observed in 2000 and 2001 (Figure 2).

It was observed that the low lying areas of the Buguruni, Mchikichini and Vingunguti wards, which are usually flooded during the rainy season, were more frequently affected and had more cases than other areas (Figure 3). A large number of cases were observed in areas with shallow wells including Kiwalani, Vingunguti, Buguruni and Kipawa (Figure 4).

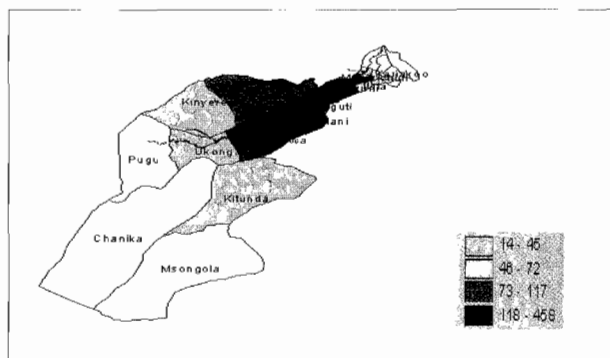


Figure 1a: Number of cases and distribution of cholera in Ilala in 1997

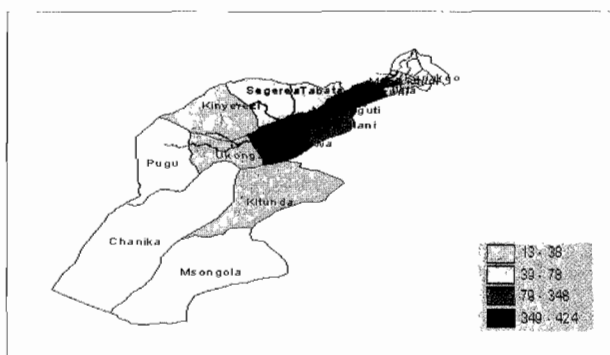


Figure 1b: Number of cases and distribution of cholera in Ilala in 1998

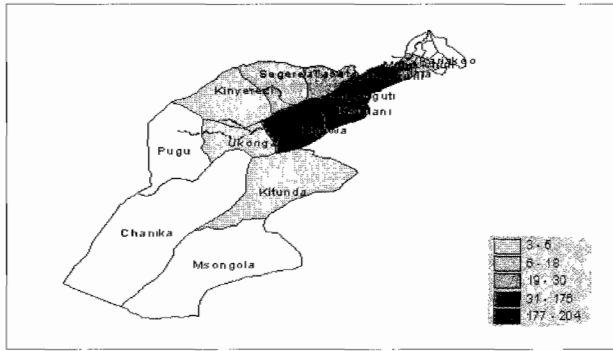


Figure 1c: Number of cases and distribution of cholera in Ilala in 1999

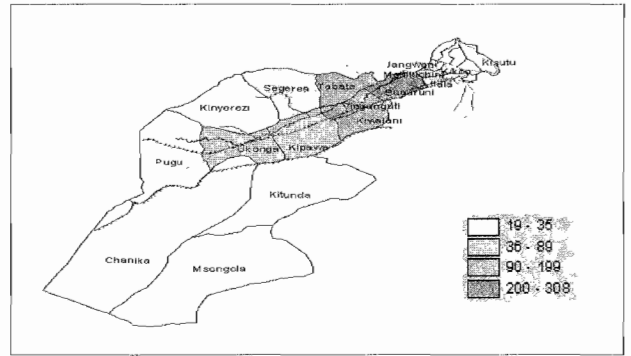


Figure 1f: Number of cases and distribution of cholera in Ilala in 2002

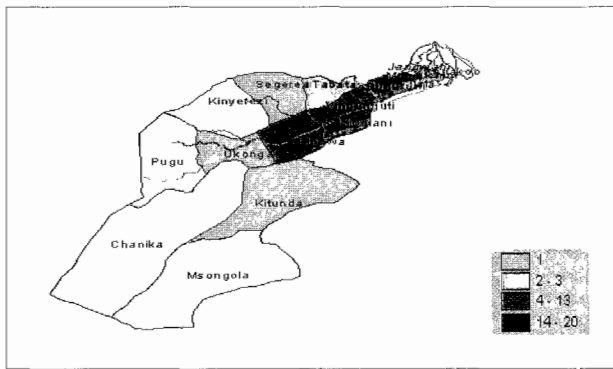


Figure 1d: Number of cases and distribution of cholera in Ilala in 2000

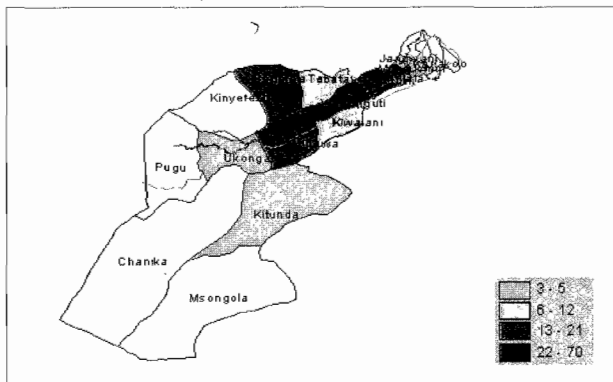


Figure 1e: Number of cases and distribution of cholera in Ilala in 2001

**Discussion**

Our findings indicate that cholera cases have been consistently reported in Ilala District since 1997. The burden of the disease however, varies from place to place. In recent years, cholera has continued to be an important cause of morbidity and mortality in various districts of the country. Cholera has now become endemic to Tanzania with small outbreaks being reported every year and a much larger outbreak occurring every 4-5 years (WHO, 2002). The large epidemics were reported in 1977, 1983, 1988, 1993, 1997 and 2002. In both 2001 and 2002, 75% of the regions in Tanzania reported outbreaks of cholera. In the year 2001, Kigoma, Arusha, Shinyanga and Dodoma were the most affected regions. During this period, the total number of cases reported was 2205 with 89 deaths. The case fatality rate (CFR) was 4.0%, which is unacceptably high, exceeding the WHO recommended rate of below 1%. The higher CFRs indicate poor clinical management of cases. In 2002, there was 5-fold increase in the number of cases (11915) a 3-fold increase in the number of deaths (293) and the disease was reported in 15 of the 20 regions of the country. The case fatality rate in 2002 was 2.5%. (Ministry of Health, unpublished report).

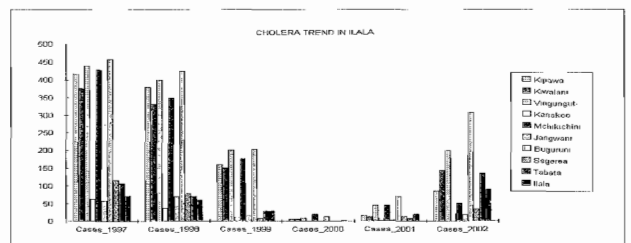


Figure 2: Annual cholera trends in Ilala District (1997-2002)



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