customer stories

Spatial Analysis Optimizes Malaria Prevention Measures

Customer

Centers for Disease Control and Prevention, Atlanta, Georgia

Project

Insecticide-treated bed net study in Kenya, Africa

Project Date

1998-2005

PROJECT HIGHLIGHTS

- **Mapping project determines effectiveness of bed nets in preventing malaria in villages in Kenya**
- **Mapping teams logged the location of every house in 200 villages where more than 125,000 people resided**
- **Houses with nets and health conditions of residents were also included in GIS**
- **Clinical malaria attack rates in bed net villages were reduced by 75% while mosquito biting rates were reduced by more than 90%**

Organizations that provide aid to poor, sick, and vulnerable people in underdeveloped nations often struggle with a serious ethical question: when resources are insufficient to help everyone, will assistance given to one group negatively impact other groups?

This was the dilemma faced by researchers working in Africa during the late 1990s. A major program had been proposed to test the effectiveness of insecticide-treated bed nets in reducing malaria, especially among children.

Although the impetus for the program was developing strategies for efficient distribution of the limited bed net supplies, the chief concern of researchers was whether people who didn't receive the nets would suffer because their neighbors did receive bed nets.

Epidemiologists hypothesized that malaria-carrying mosquitoes, unable to feed on people protected by the nets, might swarm in greater numbers at nearby homes lacking nets. Ultimately, this question was answered—with surprising results—through spatial analysis of bed net distribution patterns and malaria infection rates in Kenya.

Malaria kills between one and two million children under the age of five every year in Africa. Nearly all of the infectious bites come from three mosquito species that feed on blood between 11 p.m. and 3 a.m. In equatorial Africa, most houses have open doors and windows. People asleep in their beds are easy prey.

Permethrin is an insecticide that is harmful to mosquitoes but safe for humans. Draping permethrin-treated nets around beds was a practical solution. But before the nets could be distributed, international aid organizations wanted evidence that bed nets were effective in reducing malarial infection, mortality, and morbidity and that neighboring areas without nets would not experience corresponding increases in these effects.

The Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, believed this type of statistical and spatial analysis could only be conducted using Geographic Information System (GIS) and spearheaded the effort to track and map the results of a pilot bed net study in Kenya. The study covered roughly 500 square kilometers and included 125,000 people living in 200 villages.

In 1998, CDC initiated the study at a field station in the village of Kisian. Here, ArcView was used to build a GIS of the study areas, which would have to be mapped on foot using GPS receivers. The accuracy of this field mapping was crucial because the analysis of bed net distribution and human infection rates would be conducted at the individual house level.

CDC personnel and participating researchers trained mapping teams, mostly composed of Kenyans with no background in GPS or mapping, in the use of GPS receivers and handheld data collection devices. CDC purchased four Trimble GPS Pathfinder® Pro XRS GPS receivers with Trimble TDC1™ dataloggers, or handheld computers. Trimble GPS Pathfinder Office software was loaded onto a desktop PC at the Kisian station, and feature collection dictionaries and menus were created and uploaded to the TDC1 handhelds for field use. They have since updated their hardware to include Trimble GeoExplorer handheld GPS receivers—a lightweight but rugged computer with a GPS receiver built in.

The teams mapped one village per day, focusing on the collection of location and attribute data for features relating to malaria and other health studies—things like houses, roads, water sources, livestock pens, and medical facilities. Mapping teams used pull-down menus on the handheld computers to enter attributes of features, including the number and ages of each house's occupants and the codes used to identify occupants by their positions in the family.

House mapping was accelerated by an Advantage GPS mapping laser from Laser Atlanta of Norcross, Georgia. The laser was linked to the GPS receiver and the handheld computer, enabling a field crew member to stand in the middle of a compound and remotely record the location of each house by firing the laser. The laser calculated the offset distance from the crew to the house, which was then automatically corrected by the GPS to determine the precise coordinates of the structure.

Trimble®

At the end of each day in the field, the crews returned to Kisian and uploaded the location and attribute data into GPS Pathfinder Office. Although the GPS equipment was capable of real-time differential correction, this was not done because it would have required radio broadcasting of the correction signals from the base station, and broadcast licenses are difficult for foreigners to obtain.

Instead, GPS Pathfinder Office used the base station GPS data to perform differential postprocessing to correct the accuracy of the feature location measurements collected in the field. The attribute data was edited, cleaned up and added, along with feature points, to the GIS.

With the initial basemap and data collection completed, CDC began distributing bed nets to half of the villages in the study area. Houses in villages with the nets were noted in the GIS. From that point, crews kept careful records of those who became infected with malaria, those who became ill, and those who died. Field teams counted mosquito larvae found in stagnant water as well as live mosquitoes captured in traps, all of which was recorded in the GIS.

After several years, clear trends began emerging, and the study confirmed that bed nets generated significant results in all statistical categories in the villages that received them. In children less than two years old, mortality was reduced by 17 percent, clinical malaria attack rates were reduced 75 percent and mosquito-biting rates were reduced by more than 90 percent.

The real surprise was that infection, sickness, and mortality also dropped in areas where no nets were used. Spatial analysis revealed that houses within 300 meters of a bed net village enjoyed protective benefits. Approximately 22 percent of households without bed nets benefited from this community effect. Because people without nets were benefiting from their neighbors' nets, bed nets were more effective than researchers first surmised.

This project continues, but the focus has shifted to determine the ideal pattern of distribution for insecticide-treated bed nets so the limited supply can be used to benefit the greatest number of people. The most important result of this study was proof that the nets, even in limited numbers, were effective. Millions of children in Africa and around the world are now sleeping more safely beneath bed nets donated by international aid organizations.

The equipment used on this project includes:

- ArcView software
- Trimble GPS Pathfinder Pro XRS receiver
- Trimble TDC1 dataloggers
- Trimble GPS Pathfinder Office
- Trimble GeoXM handhelds

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

www.trimble.com

NORTH & SOUTH AMERICA
Trimble Navigation Limited
7401 Church Ranch Blvd
Westminster, CO 80021
USA
+1-720-887-4374 Phone
+1-720-887-8019 Fax

EUROPE, AFRICA & MIDDLE EAST
Trimble GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY
+49-6142-2100-0 Phone
+49-6142-2100-550 Fax

ASIA-PACIFIC
Trimble Navigation Australia PTY Limited
Level 1/123 Gotha Street
Fortitude Valley, QLD 4006
AUSTRALIA
+61-7-3216-0044 Phone
+61-7-3216-0088 Fax

Trimble