Technical Note

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Use of Geographic Information Systems in Control Programs for Onchocerciasis in Guatemala[1]

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Periodic ivermectin (Mectizan®,[3] Merck) treatment of persons with *Onchocerca volvulus* infections reduces their risk of developing blinding ocular lesions (*1*). The drug, given once or twice a year as a single oral dose, is safe enough to administer (with a few exceptions) to entire populations of affected communities. Major distribution programs are currently delivering thousands of doses of ivermectin in endemic communities of Mexico, Guatemala, and Ecuador.

Epidemiologists involved in onchocerciasis control need to classify communities by their disease risk and priority for ivermectin treatment (*2*). Geographic information systems (GIS), which combine data base and digital mapping functions, have an enormous potential for assisting with this task (*3*). Powerful and relatively inexpensive GIS software—most notably MapInfo (MapInfo Corporation), GisPlus (Caliper Corporation), AtlasGIS (Strategic Mapping), and ARC/INFO for PCs (ESRI)—is available for microcomputers (*4*).

In Guatemala, transmission of onchocerciasis is known to occur in three circumscribed zones designated "western," "central," and "eastern" (*5, 6*). The blackfly vectors (primarily *Simulium ochraceum*) in these zones breed in pristine streams that arise in the Sierra Madre and Sierra Los Cuchumatanes mountain ranges. Below an elevation of 500 meters, temperatures are too hot to support high vector densities; while above 1 500 meters, cooler temperatures retard both the fly's biting frequency and the microfilaria's development to the infectious (L3) stage (*6, 7*). Therefore, concentrated transmission, high prevalence, and ocular disease occur almost exclusively in communities lying between 500 and 1 500 meters (*8*).

We used AtlasGIS to identify the communities at risk in and around the known

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[3]Use of trade names is for identification only and does not imply endorsement by the U.S. Public Health Service or the U.S. Department of Health and Human Services.

onchocerciasis-endemic zones in Guatemala. First, using large-scale (1:50 000) maps, we systematically entered the names, elevations, and latitude/longitude coordinates of 2 939 communities located in or near those zones. We then stratified them by elevation and produced an electronic pin map of the 1 288 communities (44% of the data base) lying between 500 and 1 500 meters (Figure 1A). After that, using functions available in the program, we were able to dynamically "zoom in" on parts of the country map, such as the portion of the central endemic area shown in Figure 1B.

The software that we used permits identification of each community by name, by a unique ID number, by political subdivision, and by elevation. Figures in the data base files may be accessed and changed without exiting the mapping program. Overlay functions (up to 250) allow collation of other variables—such as demographic variables, epidemiologic indices (nodule rates, microfilaria rates, and microfilaria intensities), road conditions (all weather or seasonal), rivers and streams (shown in Figure 1B), and areas served by primary health care outposts.

Systematized targeting and evaluation constitute important activities in all ivermectin treatment programs in the hemisphere. The effectiveness and dispatch with which these activities are performed can be expected to play a significant role in moving toward the Pan American Health Organization's goal of eliminating new ocular onchocercal lesions from the Americas by the year 2000 (*9*). Toward this goal, GIS permits rapid assessment of drug coverage, analysis of impact indicators, and scheduling of community retreatment in the Guatemalan ivermectin distribution campaign.

Within this context, certain problems should be noted that limit the immediate use of GIS by national control programs. First, good boundary files (i.e., digitized maps) are not readily available in the endemic countries (Brazil, Colombia, Ecuador, Guatemala, Mexico, and Venezuela). Commercially produced computer maps usually lack the precision needed for epidemiologic planning. Therefore, we found that the best approach was to digitize our own maps—a relatively labor-intensive task.

Second, many governments (including that of Guatemala) restrict large-scale maps for security reasons. Large-scale maps or gazetteers are used to identify the coordinates of small villages, where the most severe onchocerciasis occurs (*8*). In the absence of these, relatively inexpensive (US$ 1 500) hand-held instruments are available that can establish village coordinates using the satellite global positioning system.

Third, successful GIS application requires an epidemiologist who has time, above-average computer literacy, and enthusiasm for the subject.

And fourth, a GIS system costs money. Software prices typically run between US$ 1 000 and US$ 3 500 (*4*), and their export may be limited to Europe, Canada, and the United States. Minimum computer hardware requirements (for IBM-compatible systems) include an 80286 CPU, a 40 megabyte hard disk, a battery backup system ("UPS"), and an EGA monitor. A digitizing pad is almost essential. If a high-resolution printer or a plotter is added, the total cost easily reaches US$ 6 000–7 000.

Yet despite the fact that these problems cannot be ignored, none appear insurmountable. Indeed, it seems very likely that GIS will soon be an important tool for health professionals planning or directing field-based control programs of the sort described here.

Editorial note: From 1987 to 1992, Dr. Richards worked in Guatemala at the Medical Entomology Research and Train-

Figure 1A. A total of 1 288 triangles are plotted on the map of Guatemala, these representing communities located between 500 and 1 500 meters elevation, most of them within or bordering the western (W), central (C), and eastern (E) zones of endemic onchocerciasis in Guatemala.

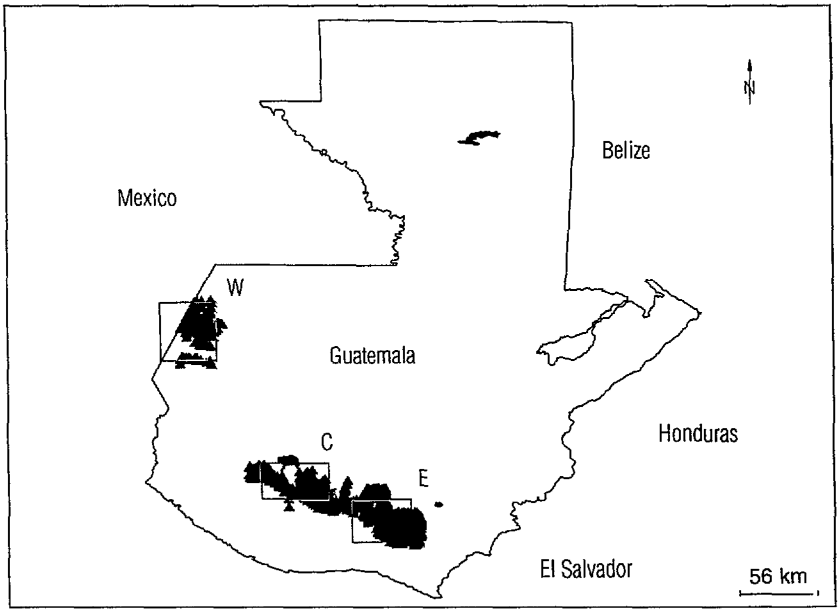
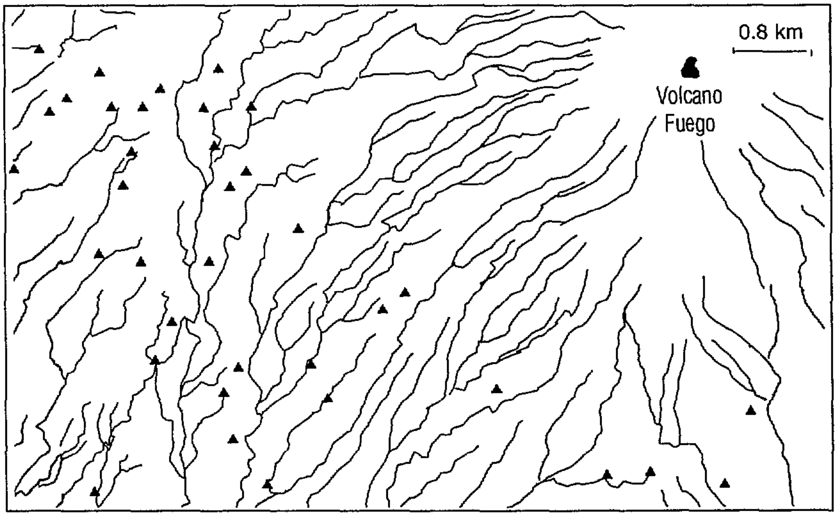


Figure 1B. This more detailed map provides zoom magnification of a portion of Figure 1A. That portion, considerably smaller than any of the rectangles in Figure 1A, comes from a part of the central (C) zone on the slopes of the volcano Fuego. The communities targeted for potential treatment are again represented by triangles, and the thin lines show rivers and streams. These thin lines terminate near the western and eastern edges of the chart, where map digitization has not yet been completed. The crater of the volcano Fuego is shown in the upper right corner of the map.



ing Unit (MERTU), a field station operated by the United States Centers for Disease Control. During that time, he worked closely with numerous national institutions involved in the ivermectin delivery program in that country, including the Ministry of Public Health and Social Welfare, the Universidad del Valle de Guatemala, and the National Committee for the Blind and Deaf. Financial support for the ivermectin delivery program has been provided by several international sources, among them the International Eye Foundation, the United States Agency for International Development, and the UNDP/World Bank/WHO Special Program for Research and Training in Tropical Diseases. Other institutions collaborating in the delivery program include PAHO, the University of Arizona, Tulane University, and the Mectizan Expert Committee. The GIS project was funded by the River Blindness Foundation.

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