Research on Rapid Geographical Assessment of Bancroftian Filariasis

prepared during a protocol development workshop
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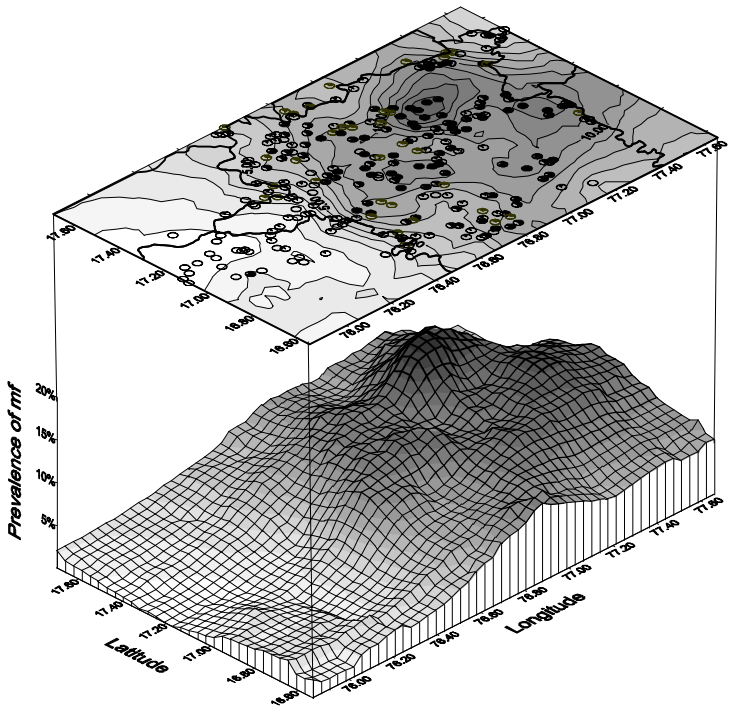
in James Cook University, Townsville, Australia



UNDP/World Bank/WHO Special Programme
for Research and Training in Tropical Diseases (TDR)

and

WHO/UNICEF Joint Programme for Health Mapping (HealthMap)
WHO Division of Control of Tropical Diseases (CTD)

CONTENT

1 Introduction

Lymphatic filariasis is a major public health problem in tropical countries. Recent estimates suggest that some 120 million persons are infected world-wide; 107 million with *Wuchereria bancrofti* and 13 million with *Brugia malayi*. The number of people with physical disabilities due either to lymphoedema and hydrocele or the newly recognised sub-clinical abnormalities of lymphatic and renal function are currently estimated at 43 million, with Bancroftian filariasis accounting for almost 40 million of these cases (Michael 1996).

The International Task Force on disease eradication identified lymphatic filariasis as one of six potentially eradicable disease since there are now good enough tools to combat the disease (CDC, 1993). The World Health Assembly at its meeting in May 1997, passed a resolution on the elimination of the disease as a public health problem through mass treatment of affected populations and appropriate management of clinical cases.

In order to initiate any disease control programme based on mass drug distribution, one needs to understand the geographical distribution of the disease in the affected countries in order to know where to target mass treatment. Unfortunately, data on the distribution of lymphatic filariasis are not widely available primarily because the standard procedures for determining which communities are affected are cumbersome, time-consuming, expensive and very intrusive. In areas where the parasite exhibits a nocturnal periodicity, parasitological examinations need to be done at night. This becomes logistically cumbersome to organize, and communities often refuse to co-operate.

Recent epidemiological studies in Ghana suggested that clinical filarial disease is a good proxy measure of the levels of endemicity of filariasis.(Gyapong et al, 1996). This findings has since been validated in a WHO coordinated multi-country study (WHO 1998a). On the basis of the results, the study participants recommended the use of clinical examinations of a sample of adults as a rapid method to assess the community burden of the disease.

Even with these new rapid assessment methods, it would be very time-consuming and expensive to do filariasis surveys in all potentially endemic communities in order to determine the geographical distribution of lymphatic filariasis. However, given the clustered distribution of filariasis in most parts of the world, it may be possible to develop methods which allow the estimation of the distribution of filariasis on the basis of surveys in a limited spatial sample of communities. Such a method has already proven very valuable for onchocerciasis control in Africa (Ngoumou et al 1994, WHO 1998b).

Building on this idea, the participants in the workshop reviewed spatial patterns of lymphatic filariasis, designed different methods for rapid geographical assessment of Bancroftian filariasis, and formulated a plan for field-testing of the proposed methods.

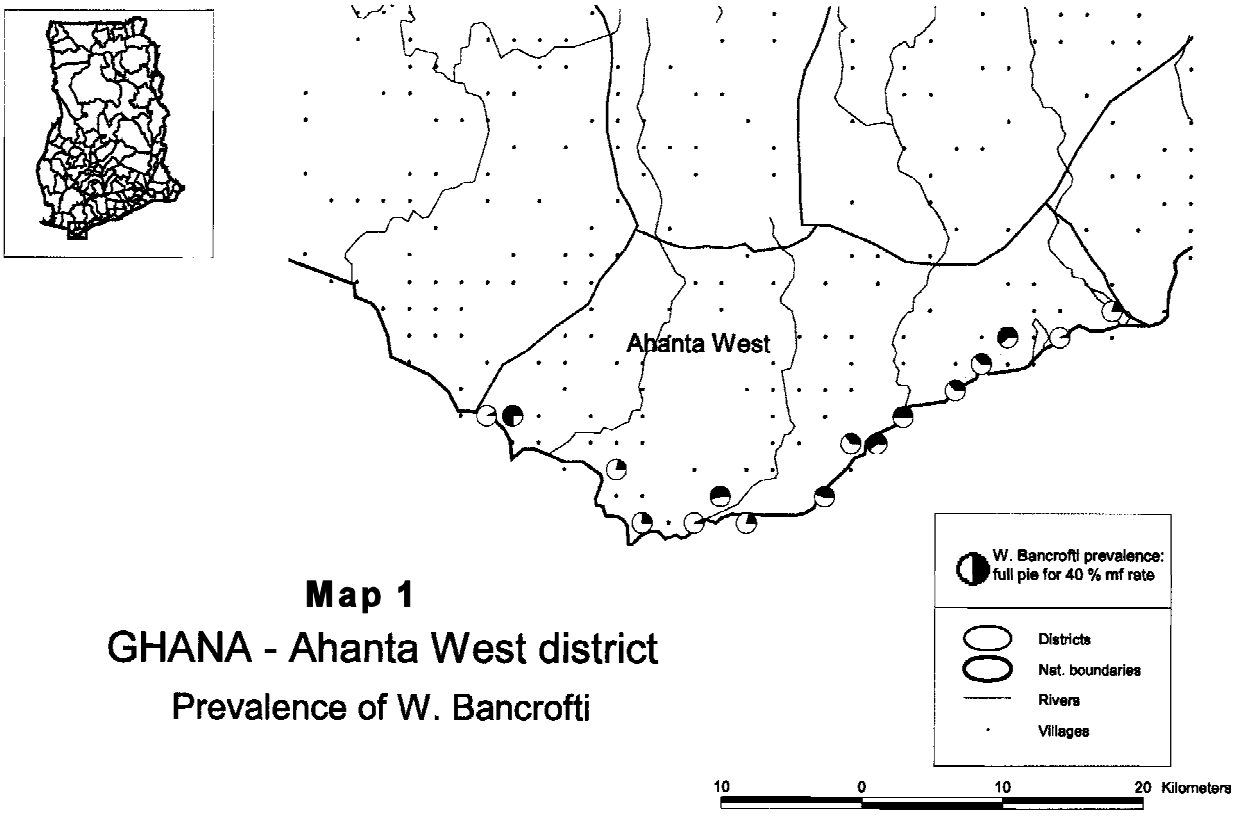
2 Geographical distribution patterns of filariasis

2.1 Size of filariasis foci

Data on the prevalence of filariasis infection from selected areas in three countries (Ghana, India and Myanmar) were analysed geographically in an attempt to better understand the spatial patterns of Bancroftian filariasis infection.

2.1.1 Ghana

The prevalence of microfilariae for 17 communities from Ahanta West District was visualised on a map. Initially, night blood surveys were done in two communities following reports that there were cases of lymphatic filariasis. The surveys confirmed that the two communities were endemic for lymphatic filariasis. Subsequently, surveys were done in sample communities selected at regular intervals along the coast to the East and West in order to determine the extent of the distribution of the disease. All 17 surveyed communities were shown to be endemic, suggesting that this area contains a homogeneous filariasis focus with a East-West diameter of at least 50 km (Map 1). As all the sample communities were from coastal areas, it is not known how far the focus extends inland.

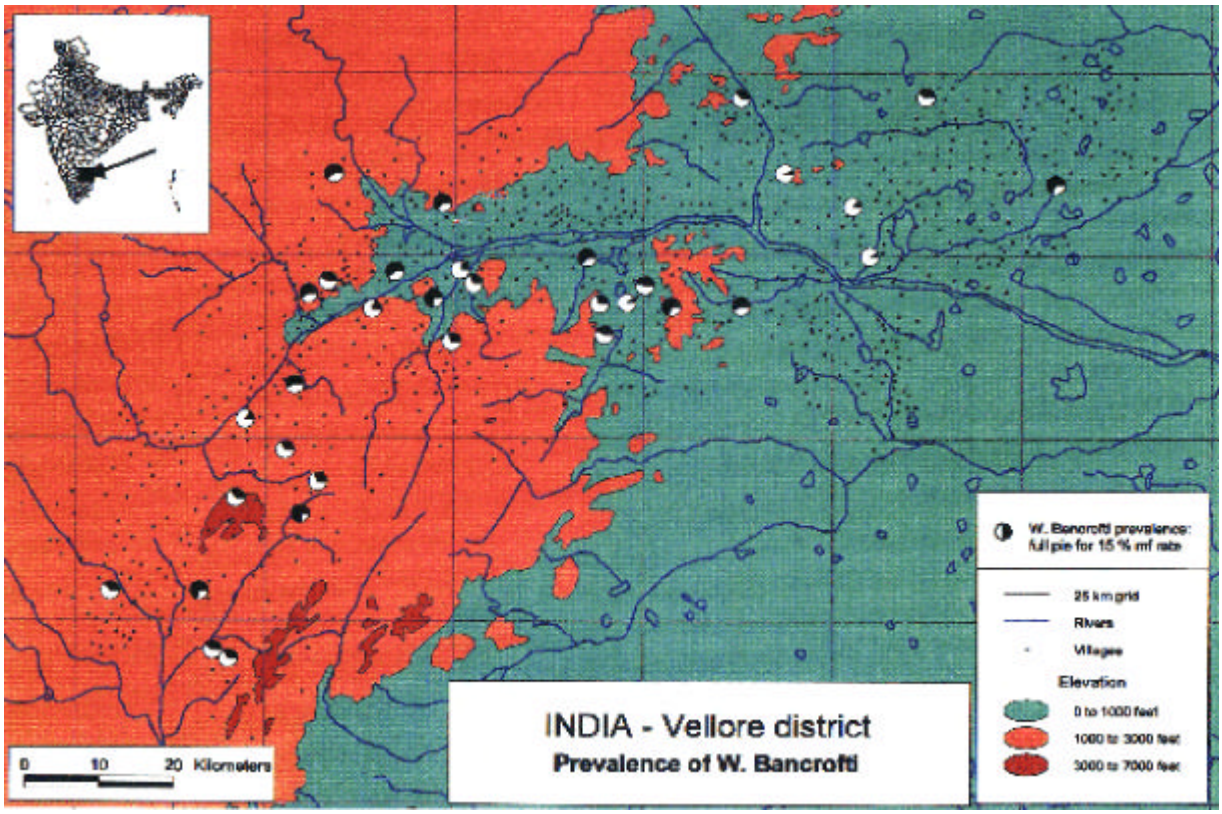


Map 1
GHANA - Ahanta West district
Prevalence of W. Bancrofti

2.1.2 Vellore district in India

Data on the prevalence of microfilariae for 33 communities from Vellore district of Tamil Nadu State were examined to assess the spatial pattern of filariasis in this district. All 33 communities were endemic for filariasis and the results suggest that these communities are part of a large filariasis focus with a size of at least 50 km x 150 km (Map 2). In the absence of non-endemic sample villages it was not possible to determine the boundary of the focus. It was noted that the surveys had been done by the district health office and that it was not known to the workshop participants how the sample communities had been selected. It is possible that the data had been biased towards communities which were suspected to be endemic.

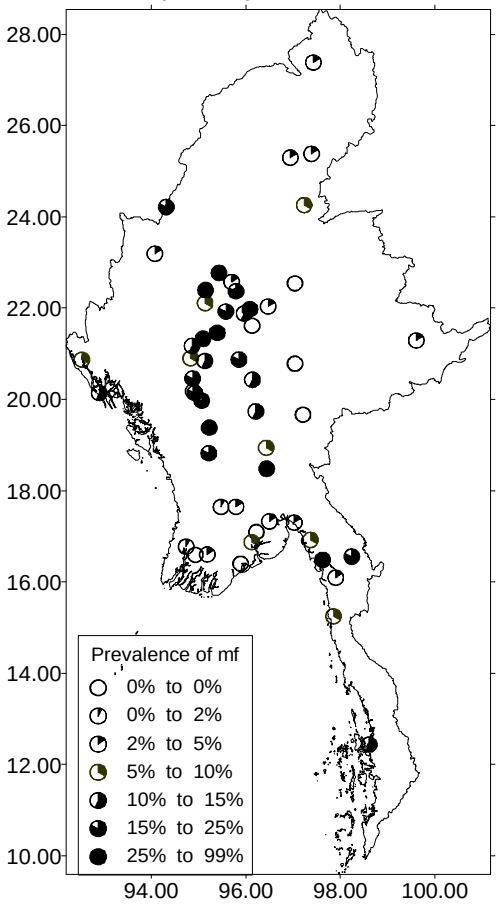
Map2: Prevalence of microfilaraemia in sample villages in Vellore district, India



2.1.3 Myanmar

Filarial antigen prevalence data from 70 randomly selected Townships spread over the 14 Districts of the country were analysed. The prevalence of antigenaemia was determined using the ICT filarial antigen detection kit on blood samples from 100 blood donors from each site. The majority of the blood donors were residents of the main towns in the selected Townships. The map of the prevalence data suggests that the central dry zone is highly endemic (20-30 %) and that the northern, eastern and southern areas are less endemic or free from filariasis. (Map 3)

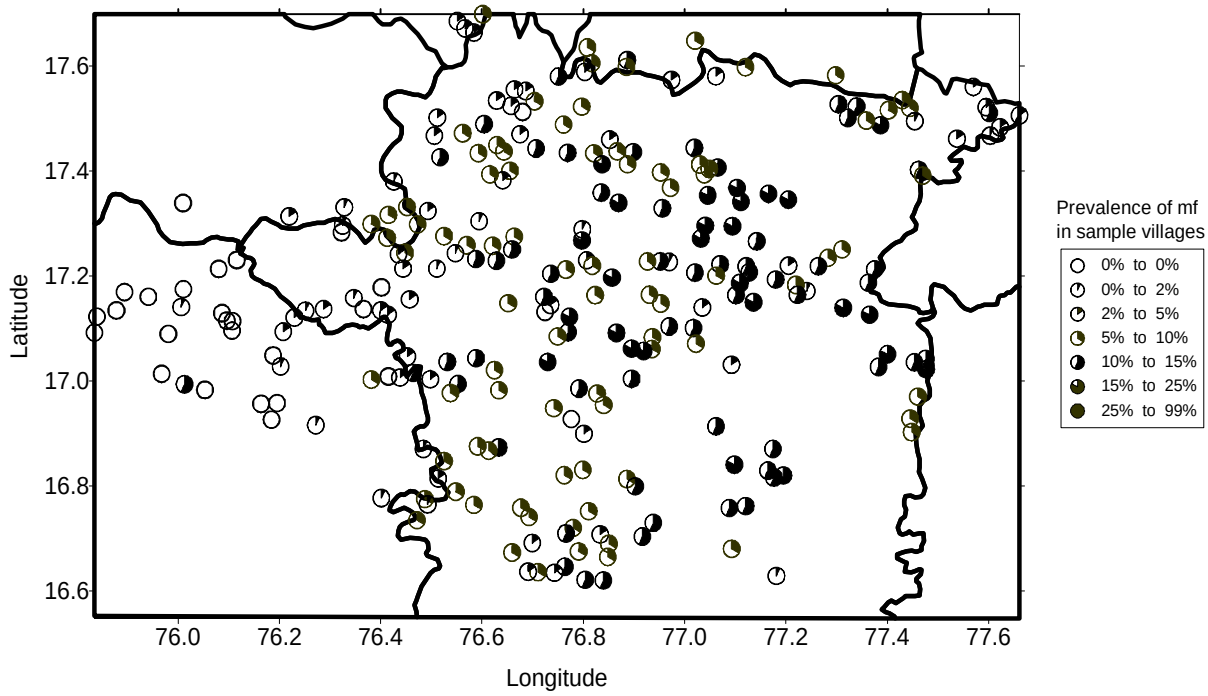
Map 3: Prevalence of filarial antigen in sample townships in Myanmar



2.1.4 Gulbarga district in India

After the workshop, an analysis was done of microfilarial prevalence data for the district of Gulbarga in Karnataka State in India. These data were the result of a night blood filariasis survey undertaken in Gulbarga district between 1985 and 1988. The sampling was done following the guidelines of the National Filariasis Control Programme (NFCP). Of the villages sampled, 262 villages whose geographical coordinates were available were plotted on a map using GIS. The results are given in Map 4. They show that filariasis in endemic throughout the study area except in the West where there the prevalence of microfilaraemia was zero in most sample villages.

Map 4: prevalence of microfilaraemia in sample villages in Gulbarga district in India



2.2 Preliminary spatial analysis

2.2.1 Myanmar

A preliminary spatial analysis of the Myanmar data indicates that there exists a spatial autocorrelation between the prevalence data, with the semivariance being smallest for villages which are located closest to each other (see Figure 1). An exponential model was fitted to the semivariance data and this model was used in so-called kriging to estimate the prevalence of antigen for each point of a grid overlaying the country. In kriging, the prevalence at a grid point is estimated by a weighted average of the observed prevalences, with the weighting factor depending on distance and spatial autocorrelation as defined by the semivariance model. The results of this estimation are given in Map 5 which shows the contour lines for the estimated prevalence of antigen.

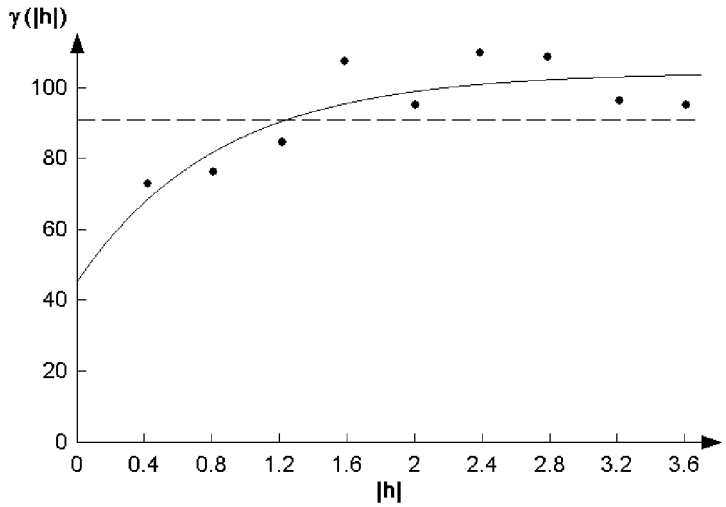
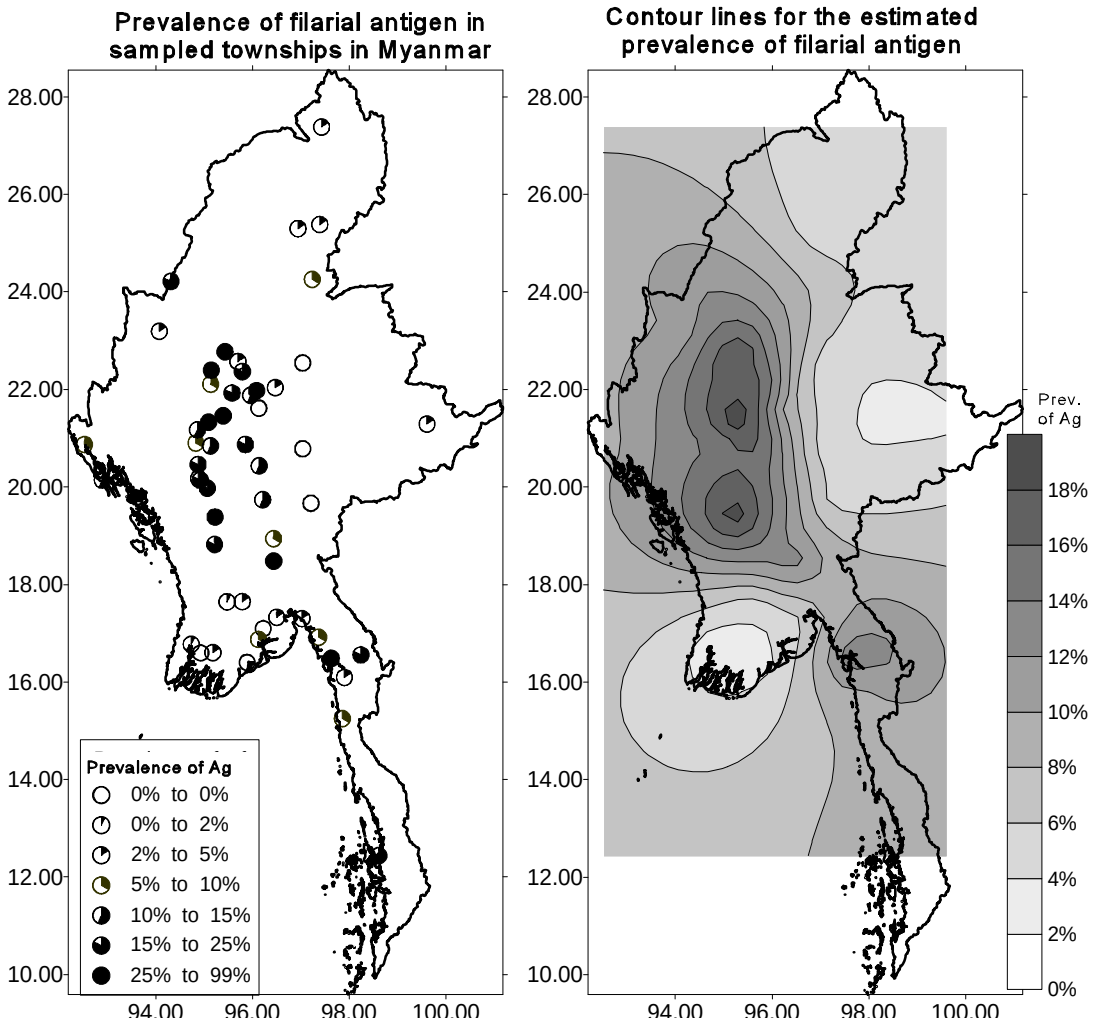


Figure 1: An omnidirectional semivariogram showing increasing semivariance, (, of antigen prevalence with distance till a distance of 2 when (levels off. (the units of distance, h, are in degrees; 50 km is approximately 0.48 degrees). The fitted curve represents an exponential model with nugget 45, range 2.5 and sill 59.

Map 5: estimated prevalence of filarial antigen in Myanmar



The contour map shows the existence of a major filariasis focus in the centre of the country, and an area which is virtually filariasis free in the South-West. In the remaining part of the country, the sample townships were widely dispersed with some isolated townships being located at more than 250 km from the nearest sample township. With such distances between the samples, interpolation becomes questionable and there appears to be a need to extend the sample coverage of the country before a complete map of the distribution of filariasis in Myanmar can be made.

2.2.2 Gulbarga district in India

The detailed data for Gulbarga district enabled a full spatial analysis of the endemicity pattern of Bancroftian filariasis. The semivariogram analysis showed a strong spatial autocorrelation of the prevalence of microfilaraemia (see Figure 2). The fitted linear variogram model was subsequently used in kriging and contour analysis. The results are shown in Map 6 which combines a two-dimensional plot of the observed prevalence of mf and a countour plot for the estimated prevalence with a three-dimensional surface plot of the estimated prevalence of microfilaraemia.

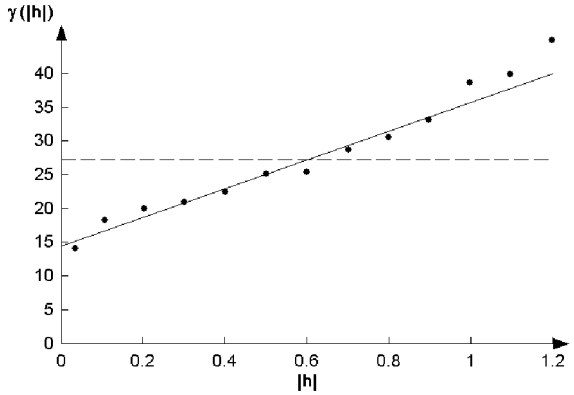
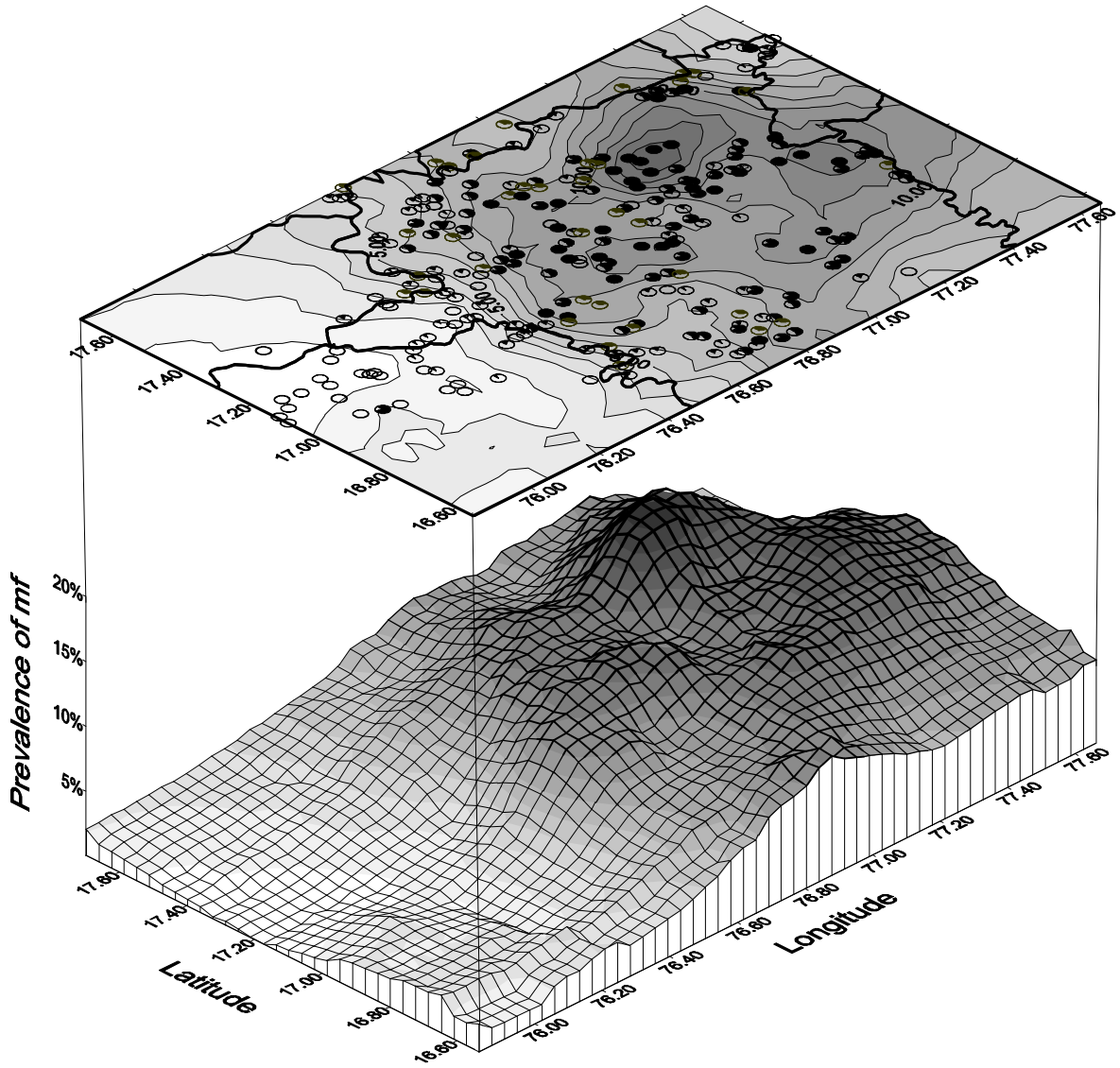


Figure 2: An omnidirectional semivariogram for Gulbarga district showing an increasing semivariance, (, between village MF prevalence with distance, h. This pattern indicates a strong spatial autocorrelation between the prevalence data. The fitted linear model has a nugget of 14.56 and a slope of 21.336

Map 6: Distribution of Bancroftian filariasis in Gulbarga district, India



The pattern for this district is very clear, with high endemicity in the centre and the East, a peak prevalence around 77.2° E and 17.3° N, and a gradually declining prevalence of microfilaraemia to the West. Large scale treatment appears indicated for most of the district. These prevalence contour

maps should be very useful to control managers by clearly indicating priority areas for control and by facilitating objective decision making on the boundaries of treatment areas.

3 Proposed methods for Rapid Geographical Assessment of Bancroftian Filariasis

Although the available data from the above countries was limited, it was noted that in all cases the filariasis foci were fairly homogeneous and quite large with a diameter of at least 50 km. This preliminary finding was used in the design of proposed methods for Rapid Geographical Assessment of Bancroftian Filariasis (RAGFIL). These methods and the steps involved are described below.

3.1 Exclusion of areas

The first step is to evaluate regions of endemic countries, defined by ecological or other features, in order to identify areas where there is no filariasis or where there are only sporadic infections which are unlikely to be significant for control. Such regions will be excluded from further rapid assessments. Although it is important not to exclude endemic areas for which control is appropriate, criteria should be specified for each country to exclude regions where the chance of significant lymphatic filariasis is acceptably low. Criteria for exclusion may include negative results in prior screening, and demographic and ecological features that are incompatible with the parasite, vector, and disease (e.g. uninhabited areas, deserts, national parks, very high mountain ranges etc).

Historical survey data may be sufficient for inclusion of an area. Such data may include either published literature or data from national programme activities. The latter may be obtained from national health documents, reports from international sources (eg, sources from WHO; TDR documents currently under review; South Pacific Commission Reports in New Caledonia, and relevant published literature, such as Sasa's *Human Filariasis*). Older sources (eg, before 1950) should be sufficient for classifying regions as possibly endemic, and recent epidemiological data from proper studies may be acceptable as community survey data.

3.2 Mapping of distribution of filariasis in remaining areas

In known endemic or possibly endemic regions (ie, those not excluded), Rapid Geographical Assessment of Bancroftian Filariasis (RAGFIL) will be done. Two different RAGFIL methods are proposed:

(i) a method in which a large sample of villages will be surveyed indirectly using questionnaires directed at key informants, and

(ii) a method based on surveys using rapid assessment techniques (viz, health worker examination for hydrocele and lymphoedema, or possibly antigen screening with the ICT card) in a small sample of communities selected on the basis of a geographical grid (grid spacing 50 km, subject to validation).

3.2.1 Indirect questionnaire

With this method, questionnaires will be sent to specified local key informants. The questionnaires are based on the instruments developed for rapid assessment and which were evaluated at the RAP workshop in July 1997 (WHO 1998a). An example of the questionnaire is given in Annex II.

In the study districts or townships, initial contact will be made with district (or block/ township)-level authorities (eg, district medical officer, DMO, or other district leaders, as appropriate for that setting). At this meeting, an effort will be made to identify villages and their geographical coordinates on a map. A random sample of communities will be taken to which questionnaires will be send. For this sampling, a grid with grid distance of 50 km will be used, and a random sample of not more than 25 communities will be taken for each cell of 50x50 km on the grid. Only those villages for which map coordinates can be assigned, either from a 1:250,000 or better map or from other sources, will be included.

Key informants from the selected communities and means of contacting them will be ascertained from these meetings with district-level authorities. Key informants may include village heads, teachers, health system personnel, or other leaders in the community capable of responding to the questionnaire.

The questionnaires will be sent to these key informants through the post or some other existing means suggested by the district-level authorities. The research team will decide whether the completed questionnaires should be returned directly to the investigators by post, or sent to the district headquarters for retrieval by the investigators. If the questionnaires have not been received within a specified period of time (eg, 1 month), then one reminder will be sent. If the questionnaires are not received after that, then no further efforts to recover them will be made.

The questionnaires will be evaluated according to the analytic framework developed at the RAP workshop in July 1998 (eg, presence or absence of LF, number of cases, prominence as a health problem). A spatial analysis of the results should then be undertaken using the techniques described in chapter 2.

3.2.2 RAP survey in a sample of communities

An area-stratified random sampling design is to be carried out for the mapping. Considering experience and available data, mapping will be based on rapid assessment for villages located on a 50 km x 50 km grid, subject to validation in the current study. Steps for the proposed mapping are as follows:

- Overlay a grid of 50 km X 50 km on the map of the country.

- Calculate the geographical coordinates at each intersection of the X and Y lines. Identify the community nearest to each of the identified intersection points of the grid falling within the country to identify the spatial random sample of communities for rapid assessment (clinical survey by a health worker, and possible antigen testing after validation of the test). The name and coordinates of the communities will be entered on a spreadsheet with

population, area, and other relevant variables, set up with field names for a uniform database.

- Exclude regions declared as non-endemic in the initial screening from further evaluation.

- Train health workers to screen a random sample of 50-100 adult males for hydrocele and lymphoedema. If there are less than 50 adult males in the selected community, the screening should be extended to include males from the nearest community till a total of at least 50 adult males has been examined. Only males who have been at least 10 years resident in the community should be included in the examination. Only obvious lymphoedema and hydroceles greater than a tennis ball should be recorded as positive. The examination should use the principle of "*if in doubt, leave it out*". (Once the technique is validated, clinical examination could be supplemented or replaced by antigen screening with the ICT card.)

- Years of residency in the community, age, and clinical findings will be entered for each subject.

- The prevalence of filarial disease (hydrocele or lymphoedema) in adult males should be plotted for each sample community on a map using GIS software.

- Each surveyed community will be classified as endemic or non-endemic based on the findings of the examination. For the purpose of the testing of the method (see section 4) the presence of a single adult male with filarial disease will be regarded sufficient for classifying a community as endemic. This criterion may need to be revised later.

- The region bounded by endemic communities is considered endemic. The region bounded by non-endemic communities is considered non-endemic. The region bounded by both endemic and non-endemic communities is considered a fuzzy zone. To better define the boundary between a endemic and non-endemic zone, a further sample will be taken from the fuzzy zone using a more refined grid of 25x25 km.

- RAP surveys will be done in the sampled villages in the fuzzy zones and the results will be plotted on the same epidemiological map.

Alternatively, and based on local policy, all communities in fuzzy zones could be included in a mass treatment programme for lymphatic filariasis.

4 Field testing of the different methods

4.1 Study objectives

C To test the feasibility and effectiveness of a RAGFIL method based on the use of indirect questionnaires, which will be completed by key informants in a large sample of potentially endemic communities for which coordinates from district level officials are available.

C To test the feasibility and effectiveness of a RAGFIL method based on rapid clinical assessment of lymphatic filariasis by health workers in a sample of communities selected using a 50 km grid sampling strategy. Antigen screening may also be included among the assessment methods.

C Compare the feasibility and effectiveness of the two methods..

4.2 Study design

The RAGFIL methods will be tested in areas known to have both endemic filariasis foci and non-endemic zones. In each study site, a rectangular testing area with a size of 200 x 200 km will be selected. All communities in the testing area should be accessible during the study period.

Questionnaires will be sent to a large sample of communities in the study area for which coordinates can be identified at the district level. A total of 25 communities will be selected for every 50 km^2. Time required for assigning map coordinates and a subjective assessment of the process at the district level will be recorded in the study data base

The study area of 200x200 km with a grid of 25x25 km will have 81 communities to be surveyed. RAP surveys will be carried out in all the 81 communities which also includes the 25 communities obtained from the 50x50 km grid classification of the study area, thus allowing a comparison of the two types of grid sampling strategies.

In each of the 81 selected villages, both a clinical RAP survey and ICT testing will be done according to the methodology described in section 3.2.2.

To ensure reliable results, the clinical examination should be done by clinicians from the survey team. Standardization and quality control of the clinical classification should be ensured through special training per site and assessment of intra-observer variation.

4.3 Spatial analysis of endemicity patterns

The endemicity patterns of the study area will first be classified using the results of the 50x50 km grid sample (including the 25x25 km sub-sample in fuzzy zones) and, as a completely separate exercise, using the results of the indirect questionnaire. For this classification the spatial analysis techniques mentioned in chapter 2.2 will be used in order to ensure an objective and reproducible interpretation of the results. Other classification methods, such as classification by a panel of experts

with a good understanding of the geographical and socio-demographic characteristics of the study area, will also be tried.

The identified patterns based on the 50x50 grid will then be compared with the epidemiological map based on the 25x25 sample and on the results of previous surveys. Two maps will be drawn: one based on the clinical data and one on the results of the antigen detection test. On the basis of this comparison, the adequacy of the 50x50km sampling strategy will be assessed.

The analysis should also involve an evaluation of the spatial sample of villages collected on a 50 km x 50 km on the basis of the sample of villages produced on the grid of 25 km x 25 km. At least three important comparisons can be made, 1) descriptive statistics of the two samples, 2) the shape of the sample distributions and 3) their spatial autocorrelative structure. If the first two comparisons show the fine and coarse grid samples to be similar, a third comparison using a semivariogram may be attempted.

The semivariogram "tool" is a graphical representation of spatial autocorrelation, i.e. the degree to which a variable is related to itself over space.

Semivariance, (, is defined as

$$(_h = \frac{1}{2N} \sum (z_h - z_{h+1})^2$$

h lag distance between two villages
z_h the mf prevalence at a village
z_{h+1} the mf prevalence at a second village some distance from the first

A comparison of every possible pair of villages is undertaken, i.e. if there are 100 villages then 4950 village pairs are generated using the following relationship,

$$\text{village pairs} = [n \times (n-1)]/2,$$

where n is the number of villages. There is a sizeable literature on the variogram tool and its use in spatial estimation using the kriging interpolator (e.g. Isaaks and Srivastava 1989, Cressie 1991). A number of software packages are available for the calculation of the semivariogram, including GeoEas and VarioWin (both are available on the Internet). Software packages for kriging and contour mapping include GeoEas and SURFER.

4.4 Analysis of costs and other resource requirements

A cost analysis of the resource requirements necessary to undertake each of these methods is essential in determining the affordability and feasibility of these approaches in different endemic settings.

The direct costs of each approach to the provider, including opportunity costs (costs for diverting existing resources, such as personnel) will be assessed. The cost analysis will provide information

on:

- the total financial costs of the approach, which can give an indication of affordability.
- the distribution of costs with respect to input items, which can indicate those inputs which constitute a disproportionately large proportion of costs and thus those in which there is a large potential for savings if only small reductions in these resource items can be made.
- predictions on the cost of the approaches at scale, and in different endemic settings.

The requirement for other resources, such as trained personnel (such as geographers) and equipment (GIS hardware and software), are also important in exploring the feasibility of each strategy.

The cost analysis will be undertaken by constructing itemized cost frameworks which include all variables explicitly. The first step is to identify all resource inputs for each each activity of the approach. These are usually categorised under Personnel, Materials & Supplies, Operating & Maintenance and Capital inputs, and by activities which for the questionnaires and grid sampling methods may be as follows.

Questionnaires:

- Setting up and meeting with DMO to locate villages and key informants
- Producing and delivering questionnaires to key informants in selected villages
- Recovery of questionnaires
- Databasing and creation of digital maps using the questionnaire results

Grid sampling

- Grid creation and village selection at national centre
- Sensitize DMOs
- Training of Health worker teams
- Data collection by health worker physical examination from selected villages
- Data collection by ICT cards
- Databasing and creation of digital maps

The resource inputs for costing under the various categories for each approach (and activity) will be listed as follows.

Personnel
(All full-time and part-time personnel connected with the programme, including all clerical and maintenance staff, volunteers and consultants)

- The amount of time that each person spends on the programme.
- The compensation paid to each worker. Gross earnings should include all overheads including special incentives, overtime or hardship bonus, holiday and sick pay, uniform, housing and travel allowances.

Materials and supplies
(All materials used up in the course of a year as direct inputs into the principle activities of the project)

- The amounts of materials used (quantities consumed, not amounts ordered or budgeted). These figures should also include waste due to spoilage, breakage, theft and misuse since these costs are directly attributable to the programme.
- The full cost of supplies should include the cost of transportation to the point of use (i.e. including any freight charges as a result of importing materials and any internal distribution costs).

Operating and maintenance
(All those items used in operating, maintaining and repairing capital inputs)
e.g. For vehicles, these will include fuel, lubricants, insurance and registration fees, tyres, batteries and spare parts. If the capital inputs are used for more than one programme, the operating and maintenance costs should be apportioned according to use.

Capital inputs
Capital inputs include buildings, vehicles and equipment. Many of these inputs will already exist, and will only be used part-time in the programme. If the capital inputs are to be shared amongst a number of projects, only the time used in the programme should be costed.

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Annex II: Interview of Key Informants

Rapid Assessment of Community Burden of Disease

1. Name of District _____Name of Village_____

Village Latitude _____ Longitude _____ Population_____

2. Name of interviewee _____ Age_____ Sex____

Occupation_____

3a. What are the six commonest diseases of adults in this village (rank).

a._____b._____c._____

d._____e._____f._____

3b. If there was enough money to control only THREE of these diseases, list in order of preference, the ones you would choose.

a._____b._____c._____

4. Specific Disease Information

4.1 Do you know of people in this village with goitre? Yes____ No____

How many people in the village have goitre _____

4.2 Do you know people in this village with elephantiasis of the leg? Yes____ No___

How many people in the village have elephantiasis _____

4.3 Do you know of people in this village with hydrocele? Yes____ No____

How many people in the village have hydrocele _____

4.4 Do you know of people in this village with guinea worm? Yes____ No____

How many people in the village have guinea worm _____

4.5 Do you know of people in this village with leprosy? Yes____ No____

How many people in the village have leprosy _____

4.6 Do you know of people in this village with tuberculosis? Yes____ No____

How many people in the village have tuberculosis _____