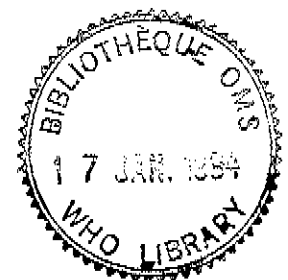
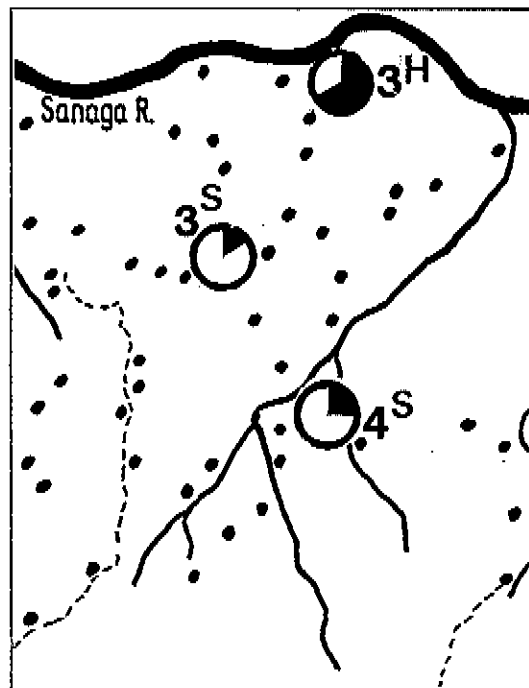




A Manual for Rapid Epidemiological Mapping of Onchocerciasis

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UNDP/World Bank/WHO
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1. Introduction

Onchocerciasis is a parasitic disease caused by the nematode *Onchocerca volvulus*. It is transmitted by the bite of a female blackfly of the Family Simuliidae which breeds in fast-flowing rivers, hence the common name river blindness. The habitat of the blackfly determines the distribution of onchocerciasis in river basins, in communities at the end of the road, usually with little or no national health services, and with problems often unknown to governments. Onchocerciasis is found in 27 countries in Africa and in isolated foci in Latin America and in Yemen in the Arabian peninsula. It is estimated that over 80 million people are at risk of infection, some 18 million infected and one million people visually impaired, of whom some 340 000 are blind (WHO 1987). An unknown but large number suffer from severe skin disease.

Onchocerciasis is a serious public health problem and an obstacle to socio-economic development in focal areas where it is endemic. The public health importance of onchocerciasis, both in terms of skin and eye lesions, is directly related to the degree of endemicity of infection in the community. Studies have shown that communities with a prevalence of 55% or more and a Community Microfilarial Load (CMFL, Remme et al 1989) of 10 or more, account for 80% of onchocercal blindness. If communities with a prevalence of 40-54% and a CMFL of 5-9 are included, then the two groups account for nearly all the blindness due to onchocerciasis (Dadzie et al, 1991). The priority for onchocerciasis control, therefore, is to bring control first to the most endemic communities in the most affected foci where the disease is a significant public health and socio-economic problem

Until recently, the control of onchocerciasis has been limited to *Simulium* larviciding, which has been remarkably effective and successful in the Onchocerciasis Control Programme (OCP) area in West Africa. However the cost and the sophisticated technology involved have left governments in endemic countries outside OCP incapable of tackling the problem. The advent of ivermectin, an effective microfilaricide and microfilarial suppressant suitable for large-scale treatment with little adverse reaction, and its availability, free of charge, from the pharmaceutical firm, Merck & Co. Inc., to endemic countries which can distribute it, has opened up new possibilities. This has encouraged several governments to consider developing National Onchocerciasis Control Programmes. It has also kindled the interest of many agencies and blindness prevention related NGOs to the possibility of becoming actively involved in large-scale treatment of affected communities. However, in the absence of a simple, affordable technique for

identifying and mapping out high risk communities, governments have been unable to put to best use their scarce resources and the assistance offered by the NGOs for national control programmes.

The OCP, for its own purposes, initially in laying down the basis for evaluation of the impact of vector control and later in selecting communities for routine control of onchocerciasis with ivermectin, developed an epidemiological mapping method for onchocerciasis (De Sole et al., 1991). This method, however, relied heavily on detailed knowledge of the river systems, gained from helicopter surveys and from extensive studies of the vector members of the *S. damnosum* complex. Furthermore, the assessment of each zone for onchocerciasis was based on skin-snipping a dense network of communities which makes this method relatively slow. Besides, this method was applied only to savanna areas, and to the very largely deforested area of Sierra Leone. Thus the OCP method, apart from not being technically feasible in extensive rain-forest areas, cannot be applied in most countries where both knowledge of onchocerciasis and financial resources are limited. There is therefore a need for a rapid, cheap and rational method for assessing the distribution of endemicity of onchocerciasis and one that can be applied to different geoclimatic regions.

In this manual, a method of Rapid Epidemiological Mapping of Onchocerciasis (REMO) is described which is based on the selection of a very small sample of villages to be surveyed and which allows the extrapolation of the results to a large number of other villages. The mapping exercise requires a general understanding of the ecology and behaviour of the vector, the epidemiology of onchocerciasis and knowledge of the geography of the area. Provided accurate topographical maps are available, no prior knowledge of the onchocerciasis situation in the areas to be surveyed is necessary.

The methods described were developed and field tested in Cameroon early in 1993 and the experience gained there is freely referred to in this manual. It is believed that the method described could be applied wherever the main vectors of onchocerciasis are members of the *S. damnosum* complex. Outside the OCP area members of this complex are the primary vectors in 14 African countries, and in Yemen. In these countries over 11 million people are infected with onchocerciasis (WHO, 1987).

2. Rapid Epidemiological Mapping: The Method

The distribution of onchocerciasis and the endemicity levels attained are largely determined by the ecology and behaviour of the *Simulium* vectors. Of particular importance is the vector's requirement for breeding sites in fast-flowing, relatively unpolluted rivers and streams. In addition, the vector has an effective flight range, when seeking a blood-meal, which is very unlikely to exceed 15 km, and is usually much less. This means that severely affected communities are almost invariably located within 10 km of a vector breeding site.

Given these facts, random choice of communities to be surveyed is ineffective and inappropriate. Unless resources are substantial, and many communities are examined, randomization of survey effort will lead to an inadequate description of the distribution pattern of the disease. In the REMO method selection of communities to be surveyed is **optimally biased towards those at highest risk** with due regard being given to adequate geographical coverage. As this approach is rooted in the fact that the vectors have highly specific breeding site requirements and limited flight range, it is possible solely with the aid of topographical maps to make a choice of representative villages most likely to be seriously affected by onchocerciasis. This is so even when the persons making the choice are unfamiliar with the particular area to be surveyed, and have no prior knowledge of the onchocerciasis situation there.

The method of rapid epidemiological mapping consists of the following three stages:

1. the division of the country into zones;
2. the selection of communities to be surveyed per zone;
3. rapid epidemiological assessment of endemicity in the selected communities

It is recommended that the planning of these three phases is carried out by a group of two to four people with as much relevant knowledge as possible. Ideally the group should include an entomologist with experience of the *Simulium* vectors, an epidemiologist with a good quantitative understanding of onchocerciasis and a geographer with a good knowledge of the region.

The group should work with a regional atlas or assorted maps which provide hydrological, geological, climatological, vegetational and demographical information as well as with standard topographical maps.

2.1 DIVISION OF THE COUNTRY INTO ZONES

The density, spatial distribution and host-seeking behaviour of the vector, and the physiology of the parasite *Onchocerca volvulus*, which determines the manifestations of the disease, are known to vary in different biogeographical areas. As a consequence, prior to planning the field surveys, it is necessary to divide the region to be studied into biogeographical zones, each having a reasonable degree of uniformity with regard to its potential for onchocerciasis.

(a) Bio-geographical divisions of the country

The first part of the exercise is to determine whether the region under study falls into one or more bioclimatic/biogeographical zones. In many cases this information is available in detailed country atlases. If not, it can be deduced from standard ecological and climatological texts (White, 1983; Sayer et al., 1992; Thompson, 1965). A professional geographer will usually be aware of any relevant published work. For areas north of the Equator, the standard vegetation zones, Sahelian, Sudan Savanna, Guinea Savanna, Transition Zone and Forest can be used (Keay 1953) and the boundaries adjusted in line with White (1983).

In the Cameroon pilot study, the country was eventually divided into six biogeographical divisions based on climatic and phytological information available on the maps in the Cameroon Atlas (Laclavère, 1980), and consideration of the limits of the watersheds of the major drainage systems. Initially seven divisions, based primarily on vegetational cover, were chosen. However, the boundary separating Guinea Savanna Woodland and Transition Zones was very imprecise; it cut through major tributaries of the Sanaga river basin, and seemed unlikely to result in major differences in vector ecology. The Guinea Savanna Woodland and Transition Zones were, therefore, combined as Division III with the boundaries defined by the watershed of the Sanaga river basin. As an example, a description of the Divisions applied to Cameroon are given in Table 1 and are shown on Figure 1.

Figure 1: Bio-geographical divisions of Cameroon

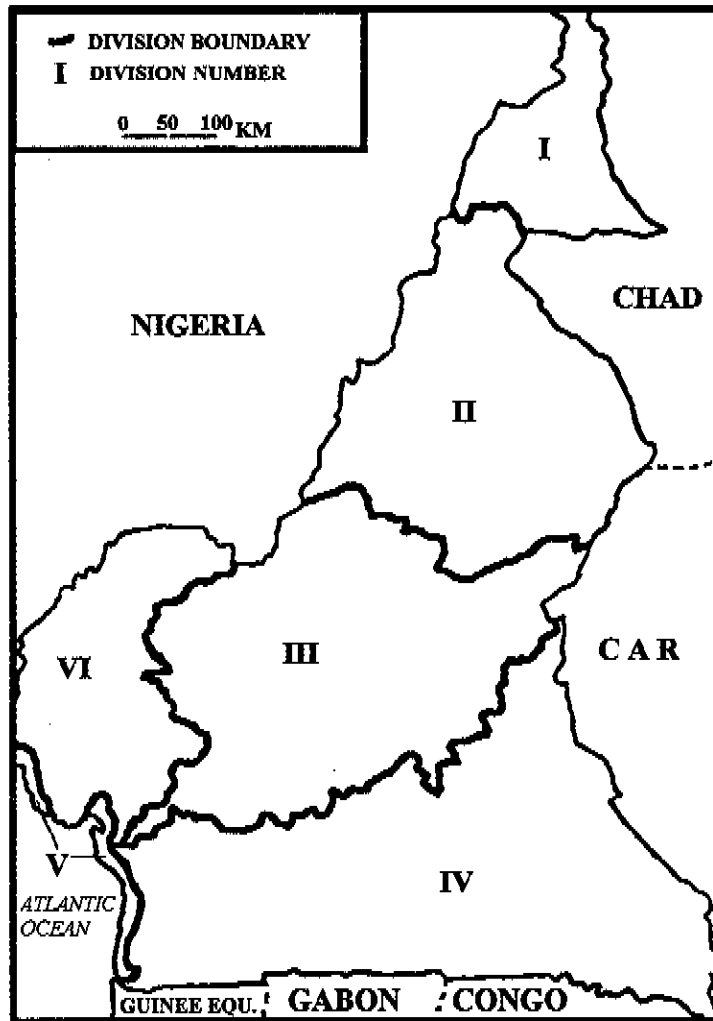


Table 1. Biogeographical Division of Cameroon

Cameroon was divided into six Divisions which reflected the biogeographical situation, in particular the climax vegetation cover. The precise boundaries of the Divisions took into account watersheds and major geological features. Division III encompassed the drainage basin of the Sanaga River system, which covered more than one principal vegetation type.

Division I

This, the far north of the country lying between 10° and 13°N, is comprised of the Sahelian Zone and the Sudan Savanna Zone at higher elevations bordering the Mandara Mountains of Nigeria. It drains predominantly into the Logone River. Much of the area is densely populated and onchocerciasis is probably restricted to the Sudan Savanna.

Division II

This consists of the Northern Guinea Savanna Zone from approximately 8° to 10°N, the southern boundary being the escarpment of Ngaoundere and the northern watershed of the Sanaga basin. This area is highly wooded savanna at lower elevation, except for the massif of Kogou. It is largely drained by the Benue river system. The population density is low.

Division III

This Division is defined by the watershed of the Sanaga river basin. It extends from 4° to 7° 30'N. In the north the vegetation is of mixed Northern and Southern Guinea Savanna (Savane soudano-guineenne), corresponding to the Adamawa Province, and the Transition Zone of mixed forest and savanna (mosaïque forêt-savane). It includes a large, virtually uninhabited region, north of the Sanaga River.

Division IV

This Division is characterized by tropical rain forest, which although extensively logged, entirely covers the area south of 3°N as well as the whole area east of 12° 15'E. The northern boundary is the watershed between the Sanaga and Nyong rivers and the southern boundary is the frontier between Cameroon and the Congo, Gabon and Equatorial Guinea. Most of it is drained by the rivers Boumba, Dja, Lokoundje, Ntem and Nyong. Only the basin of the Nyong is deforested. The western half of the Division is lightly populated and the eastern half almost unpopulated.

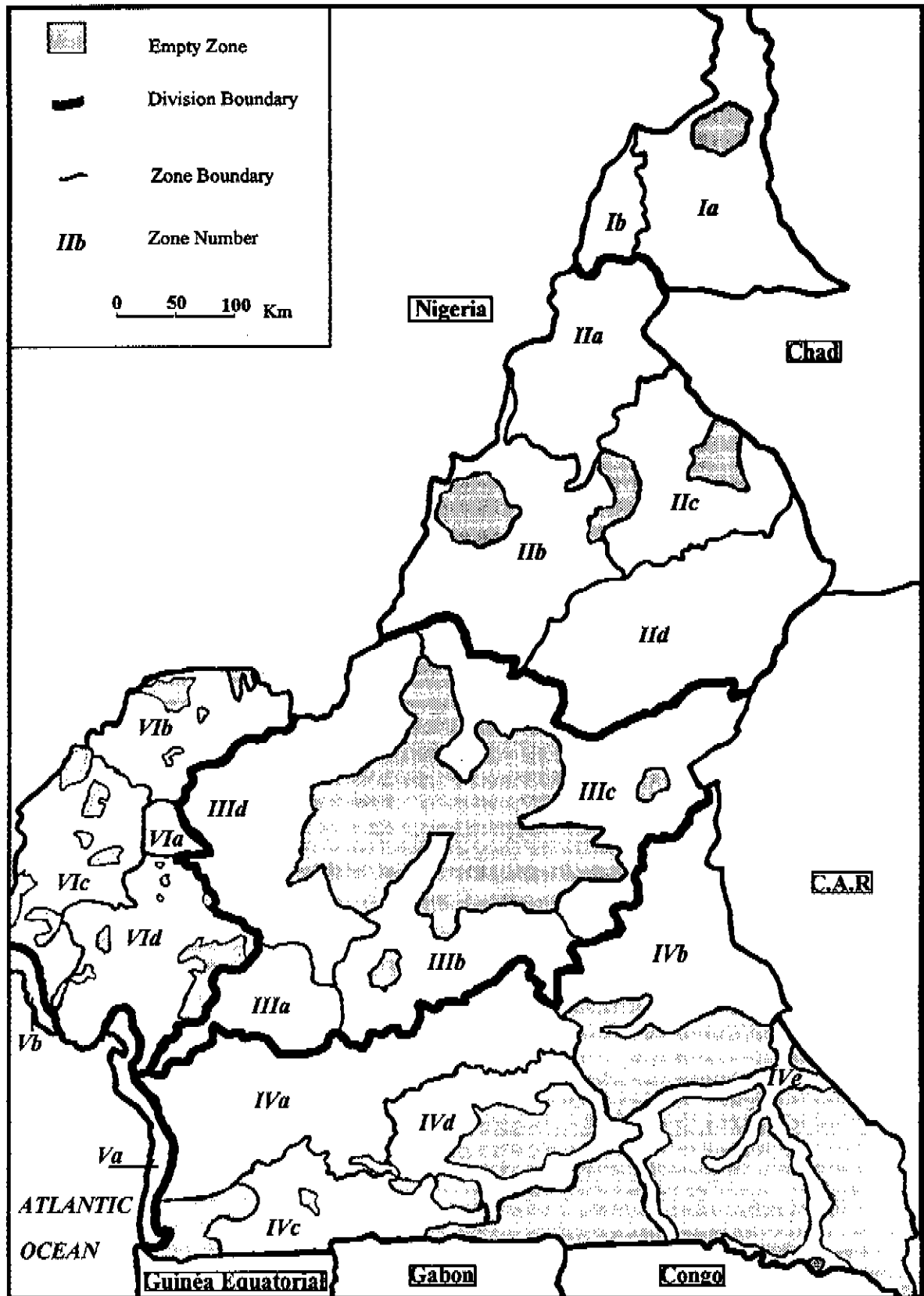
Division V

This, the littoral, is the coastal plain, approximately 20 km wide. It is split into two parts by the lower slopes of Mount Cameroon. There are extensive areas of mangroves in the Douala and Rio del Rey areas. It is mostly unsuitable for the vectors of onchocerciasis.

Division VI

This Division, which has large areas of land above 2,000 m high, is roughly equivalent to English speaking West Cameroon. It is characterized by a very wet equatorial climate, with rainfall exceeding 2,000 mm, and without a significant dry season. The southern half of the Division is naturally covered in rain forest though many areas have been deforested. The northern half includes high grassland areas. There are important areas of montane forest. Much of the Division is drained by rivers which flow westwards into Nigeria. The Central area is densely populated and the western area generally lightly so.

Figure 2: Subdivision of Cameroon into zones



(b) Subdivisions into zones

In most countries divisions based on biogeographical criteria will probably be too large to provide an adequate degree of uniformity and will need further subdivision. The most appropriate and objective method of subdivision is to use the watersheds of the major drainage systems as the sub-division or zonal boundaries. In addition, the main rivers themselves may have sections with markedly different flow characteristics which will have direct implications for their suitability as vector breeding sites. As far as possible, zones which are to be the basic areas for an assessment of the onchocerciasis situation should have a degree of hydrological uniformity. In Cameroon the original six Divisions were further sub-divided to give a total of 21 zones, only 3 of which are likely to be entirely free of onchocerciasis (Figure 2). The average size of the zones was 23,000 km² (not taking into account the empty areas). The large Sanaga basin was divided into four zones, the lower, middle and upper reaches of the Sanaga itself and the main tributary, the Mbam, with the addition of a large depopulated area to the north of the Sanaga river.

(c) Exclusion of empty and unsuitable areas

Once zoning, essentially on the basis of hydrological information, is complete, consideration can be given to incorporating data on substantial areas which are likely to be onchocerciasis-free either because they are without significant human population or are totally unsuitable for the vector (see Figure 2). In many African countries, including Cameroon, the human population is distributed in a highly non-random manner with some areas entirely uninhabited, or with extremely low human population density (Laclavère 1980). Many of these areas are National Parks or game reserves, or areas of high forest. However, in Cameroon one of the most important empty areas lies in the Mbam District and is the result of population displacement following wars in the 19th Century.

2.2. SELECTION OF COMMUNITIES TO BE SURVEYED IN EACH ZONE

The objectives at this stage of the mapping exercise are to select villages to be surveyed which will show:

- whether onchocerciasis is present or not; and
- if present, give a rough indication of distribution and severity.

The mapping group should work with the best available topographical maps, which for this purpose must give a portrayal of the rivers and relief of the country and of the disposition of villages. Maps at the scale of 1:200,000 are probably best for this purpose and such maps are available for most, if not all, francophone countries in Africa. In African anglophone countries 1:50,000 maps which convey all the necessary information are usually available. However, they are less convenient to use than the 1:200,000 scale maps. Unfortunately, the 1:250,000 maps available in some anglophone countries tend to be unsuitable for the present purpose, with relief (contour) details not adequately portrayed.

(a) Selection of high risk communities

The main objective of this first step is to verify whether, in the selected zone, onchocerciasis is present or not. This requires the selection of a strictly limited number of communities to be surveyed. These high risk communities should be situated in the likely worst areas, with due regard to adequate coverage of major potential vector breeding sites, as revealed on the available map sheets.

The choice of high risk communities is made by the team of three or four experts, using the following criteria.

Selection criteria for high risk communities:

- The selected community should be located close to river banks
- Preference to be given to communities close to rapids marked on the maps.
- The selected community should be a "first line" community (i.e. villages/communities without other human settlements between them and the river/rapids)
- Preference to be given to isolated communities;

- At least one high risk community to be selected in each distinct stretch of river (i.e a section of river providing vector breeding sites of a similar nature);
- On the main river, at least one high risk community to be selected every 30-50 km
- At least one high risk community to be selected in the valley of every major tributary.

It is recommended that each member of the mapping group independently chooses 6-8 communities to be surveyed, which (s)he believes would be adequate to verify the presence of onchocerciasis in the zone under consideration. These choices are then discussed in detail among the team members. All villages unanimously chosen are plotted on the map. Other villages which have been selected by only one or two members of the team are included on the map if the other member(s) can be persuaded of their value.

The exercise of choosing villages starts at the lowest stretch of the main river and works upstream; takes account of rapids marked on the map and of bridges (often built at rocky sites); and considers the distribution of, and access to, villages. In each case, the likely worst villages are chosen, provided that they are more than 30 km apart. The overriding consideration in selecting villages is their location in relation to potential vector breeding sites. Initially, account is not taken of the size of the village, although the need to have a sample of 30-50 adult males (see section 2.3), implies that the community is about 250 strong.

The group then chooses an alternative village for each of the high risk villages. The alternatives should have similar characteristics to the original choices and be likely to suffer the same challenge of onchocerciasis transmission. In each case, the alternative will be surveyed if the original choice cannot be located, cannot be reached, has an uncooperative population, or is too small (or too large). When the high risk village is too small both it and the alternative will be assessed to ensure an adequate sample, and where the two villages are truly similar they will be considered as one entity, if they are less than 5 km apart. It is important that small villages should not be deleted from the survey as it is often in such communities that onchocerciasis is at its worst.

In some cases there will not be an adequate alternative for a high risk village, i.e., one that appears to be in the same situation as regards onchocerciasis. In such cases no alternative may be chosen. However, should this be likely to leave a serious gap in the geographical coverage it may be worthwhile to choose an

alternative, even though it is substantially less suitable than the original choice.

Where a village is over 800 strong, a sub-sample will be taken from that part of the village considered to be most at risk of onchocerciasis. If sub-sampling is not feasible the original choice will be replaced by a smaller village.

In areas where villages consisting of a group of closely contiguous households do not exist, scattered households are assessed until the required sample size is reached. The choice of households is made using information obtained from the community regarding its limits, and taking account of their locations and the objectives of the sampling plans.

The proportion of the total number of communities in the area which shall be surveyed is not of principal concern in the sampling procedure.

(b) Selection of secondary communities

The objective of this second step is to obtain some indication of the distribution and overall severity of the disease. *It will only be proceeded to if at least some of the high risk communities have proved to be meso- or hyperendemic for onchocerciasis.*

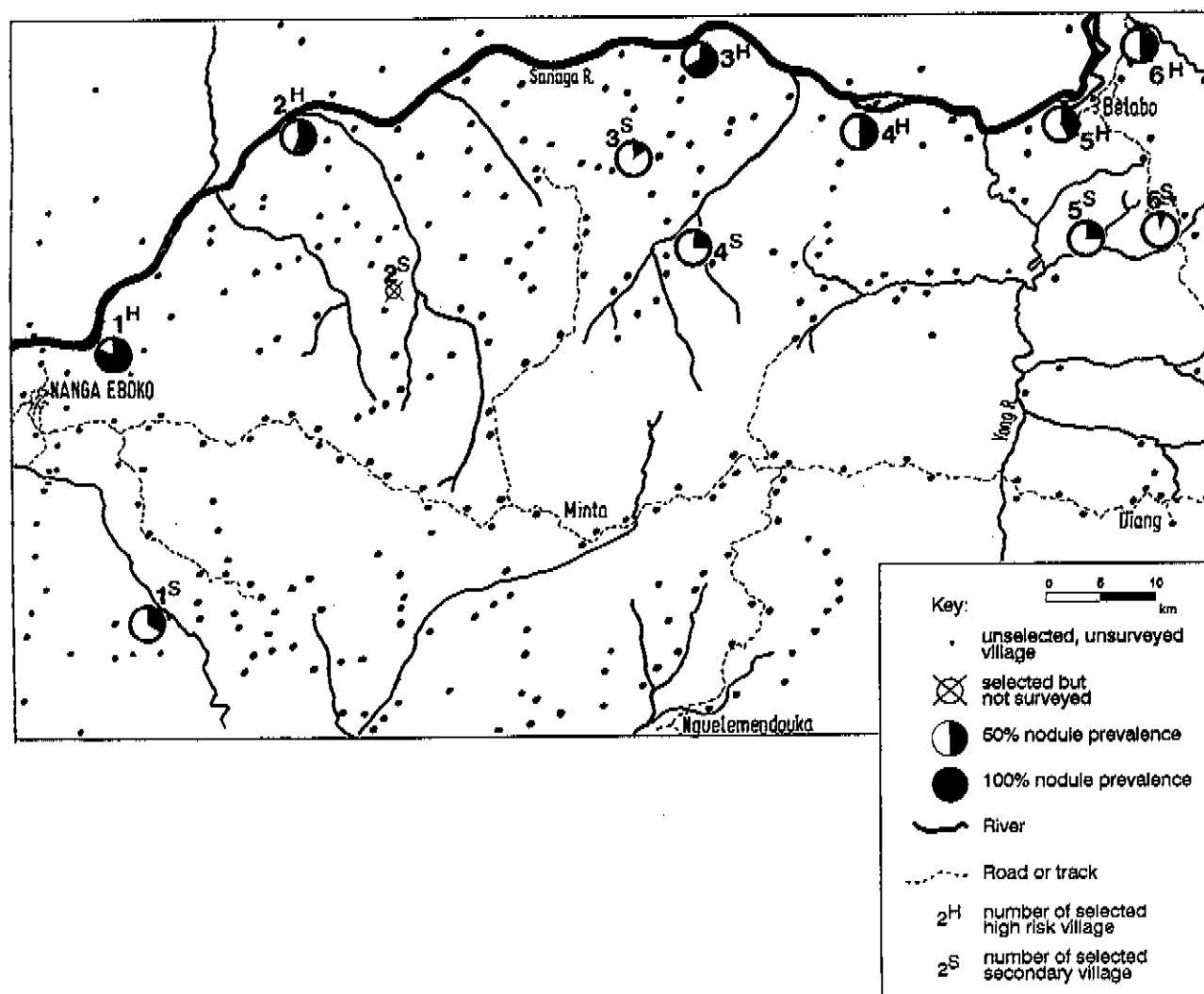
For each high risk village or its alternative, the mapping group should choose a related secondary village, which should be located at least 10 km farther away from the likely main source of vectors.

The assessment of secondary villages can be carried out once all high risk villages have been surveyed. However, often it may be more cost effective to carry out the assessment of a secondary village immediately after its 'parent' high risk village has proved to be at least mesoendemic. In a few cases, where a high risk village cannot be assessed for one of the reasons given in Section 2.2(a), and where there was no alternative village, it may still be worthwhile to assess the secondary village.

An example of the layout of high risk and secondary villages to be assessed is given in Figure 3 for the middle reaches of the Sanaga River. It should be noted, however, that this example does not strictly follow the selection criteria on page 9 (for instance, the average distance between high risk villages is less than 30 km). This reason is that the selection was made during the development of the REMO method when all criteria had not yet been fully defined. Furthermore, the selection of secondary villages was done while the team was in the field when considerations of accessibility were of great concern. At that time the principle of alternative villages had not yet been introduced. As a result, no alternative was selected for one secondary village (2⁵) which was not accessible, leaving an uncomfortable gap

in the epidemiological information on the map. Nevertheless, the results of the REMO in this zone are clear: the zone is endemic for onchocerciasis and shows the classical savanna pattern with high endemicity along the main river and a declining endemicity with increasing distance from the main river.

Figure 3: Results of Rapid Epidemiological Mapping of the middle Sanaga basin (zone IIIb).



2.3. RAPID EPIDEMIOLOGICAL ASSESSMENT OF ENDEMICITY IN SELECTED COMMUNITIES

The objective of the Rapid Epidemiological Assessment (REA) is to ascertain by a rapid, non-invasive, technique applied to those most at risk, whether onchocerciasis is present in the community and, if so, to obtain a measure of its endemicity level.

(a) Selection of persons to be examined.

In each community, a sample of 30-50 males aged 20 years and over should be examined for presence of nodules. All persons in the sample should be engaged in rural occupations and should have been resident in the community for at least 10 years. Males are preferred because they are generally more likely to be heavily infected than females and they are more amenable to examination by palpation. However, if women desire to be included in the examination, there is no objection to doing so. However, this should be in addition to the sample of the male population.

It is necessary to visit each community on a day shortly before that fixed for examination in order to arrange for the people to be present for examination. In practice this limits the examination to one or at most two villages per working day. There will thus usually be time to examine all persons who present for examination. This will be helpful in public relations and will provide valuable additional data at marginal extra cost. The assessment can also include the collection of other information if desired (see Section 2.3.c).

(b) Search for Nodules.

Procedure

- i. The search for nodules will be carried out in a good light and the patient/subject (P/S) should be stripped down to a loin cloth or shorts.
- ii. The P/S should be asked whether he has nodules and, if so, to indicate them.
- iii. Nodules will be sought by both visual inspection and careful palpation.
- iv. Nodules should be looked for systematically, the P/S should be palpated with special attention given to the commonest sites as follows:

- iliac crests (hip) and neighbouring areas;
- over and behind the greater trochanters;
- coccyx and natal cleft;
- around the knees;
- around the ankles;
- ribs (front and rear), chest wall, and over the spine;
- scapulae and shoulders;
- elbows, wrists and arms;
- over the head, especially the brow, occiput and around the ears.

Note : it is not necessary to be excessively intrusive, or to examine the genital and anal regions, unless the patient draws attention to those regions himself.

To achieve the objectives, all patients (i.e., 30-50 males aged between 20 and 60 years) should be examined. Each examination may be discontinued after the finding of the first nodule (but see Section 2.3.c below).

The differential diagnosis of *Onchocerca volvulus* nodules is not difficult, and with experience it is expected that less than 5% of nodules will be mistaken. The main sources of confusion are likely to be the following:

lymph node (typical locations - groins*, axillae, neck);
 lipoma (usually soft);
 Sebaceous cyst (within the skin);
 ganglion (attached to tendon sheaths at wrist or hand, or ankle or foot);
 juxta-articular nodule of jaws.

* It is best to ignore the groin region when searching for nodules since the lymph nodes there are very often enlarged, whereas *O. volvulus* nodules in that area are rare).

The main source of error in carrying out REAs is not under-recording of nodules but rather over-recording, owing to over-enthusiastic inclusion of assorted lumps and bumps as nodules. *The guiding principle of the field teams carrying out REAs should be "if in doubt leave it out".*

(c) Other information which may be collected

If time permits, additional data concerning the prevalence and severity of onchocerciasis can be collected. These may include:

- i. carrying out nodule palpation on all males over 20 years of age who attend;
- ii. extending the survey to include women, if this is their wish;
- iii. counting the number of nodules carried by each positive subject;
- iv. recording the presence of leopard skin (a mottled depigmentation of the shins seen with onchocerciasis; and which has to be distinguished from other causes of depigmentation, especially those associated with old scars, vitiligo, leprosy and yaws;
- v. noting anecdotal evidence regarding the severity of the disease, especially the amount of blindness in the community.

3. Rapid Epidemiological Mapping: Execution

It is important to plan carefully the execution of the REMO. The overall planning is the responsibility of the officer in charge (Coordinator) of Onchocerciasis Control at the national, state or regional level. S(he) will be responsible for the collection of the available information on the distribution and endemicity levels of onchocerciasis from reports, previous studies and surveys, and from accounts of health personnel. The Coordinator will select the members of the mapping group (see page 3), and supervise the division of the country into zones and the selection of communities to be surveyed per zone as described in section 2.1 and 2.2.

3.1. ORGANIZATION OF SURVEYS

The Coordinator will decide on the order in which the zones will be assessed, the time required to survey each selected zone, and on the size and the composition of the survey teams. Areas from which there are few or no data available should be given priority, if they appear to be suitable for onchocerciasis.

(a) Recruitment and Training of Survey Team

The Coordinator will select and train the survey teams since he is unlikely to spend all the time in the field during the survey. Basically, each survey team will comprise of 3 - 4 members; a driver, a nurse (team leader) and an assistant nurse. The fourth member who should have knowledge of local languages and customs, will be recruited from the local public health staff or administration.

Training will be given to the team leader, the nurse and the assistant nurse who will carry out the survey. The training will include the theory and practice of carrying out REAs, give an account of REMO and explain the reasons for the choice of particular villages and discuss any special problems which may arise.

The theoretical training will explain the procedures to be followed in the field and describe each task. Team members will be made familiar with the record forms to be used. A checklist of materials, including maps required for the survey will be reviewed. In particular problems likely to be encountered will be discussed. The following points which determine the outcome of the REA will be stressed:

Normally REA is to be carried out first in selected high risk villages and then in secondary villages. However alternative villages to high risk villages have been selected in advance for the following reasons:

- Selected high risk villages may not be accessible (however, the most severely affected villages tend to be isolated and poorly accessible. Serious attempts should therefore be made to reach all selected high risk villages).
- The population may be unwilling to cooperate, or may not be available at the time of the survey team's visit.
- Villages to be surveyed may not be found because of inaccuracies of the maps.
- Names of villages may have changed or villages may be known by different names locally.
- Villages may have disappeared if the map is not recent.

During the practical training the Coordinator will demonstrate to the field teams nodule palpation in one or two selected villages and ensure that the technique has been correctly learned. At the same time an attempt will be made to obtain some information on observer variation with a view to its reduction prior to the field teams embarking on their surveys. Ideally, the practical training session will be conducted in the first few villages as part of the survey. The teams will then be allowed to work on their own when the coordinator has assured himself on the competence of the teams.

(b) Preparation and Execution of the Field Surveys

A time-table should be drawn up to show surveys and related activities and indicate the order in which each activity will be undertaken. The planning of these activities must take account of climatic and seasonal factors, as these may affect access to survey areas, and the participation of the population. The surveys should, as much as possible, be conducted during the dry season. In the rainy season, the rural population is busy in the fields and only a few people may be available for examination. Moreover, some villages are inaccessible at that time of the year. Information should be collected on the state of the roads and tracks so that travel times can be estimated realistically.

Immediately prior to the survey the field team leader will receive, check, and sign for the materials required for the survey. These will include the maps, preferably at a scale of 1:200,000 (original sheets, not photocopies) on which the villages to

be surveyed have been marked in such a way as to distinguish the three categories of village (high risk, alternative and secondary villages).

To ensure maximum cooperation by the population, administrative authorities and village leaders should be informed beforehand of the impending survey and if possible of the precise date and time of the team's arrival. At this stage, cooperation will be sought in getting the adult male population aged 20 years and above to attend the examination.

In the course of conducting the survey, the survey team should aim to arrive at the village in the late afternoon of one day in order to mobilize the populace. Upon arrival of the survey team, the village leaders should be contacted, together with any other persons who can be of help (teacher, health assistant, etc). The purpose of the survey will be explained to them and it should be mentioned that the examination of only the adult male population does not discriminate against other population groups, particularly women. People should also be informed that there are plans to control onchocerciasis by ivermectin distribution and that if the drug ivermectin is introduced in the area for that purpose, all women, men and children, who are eligible, will be treated.

The REA will be carried out the following morning and the team will move on to the next village in the afternoon. Sometimes two villages may be assessed in one day, but on other occasions it may be possible to carry out only one REA every second day. It is advisable that the survey team carries along some aspirin and chloroquine tablets which may be used in treating fever or which may be left behind with a local health worker as a public relations gesture.

While in the zone, the survey team may be provided with anecdotal information which indicates that a certain community, not among the villages selected for REA, is very severely affected by onchocerciasis. Such information should be carefully recorded but should not normally be a reason for additional action. However, in case the REA's in the sample villages indicate that the endemicity is very low throughout the zone, it might be wise to undertake an REA in such a special community where onchocerciasis is said to be very severe. This will help to reduce the possibility that small but severe onchocerciasis foci are overlooked in the REMO and, hence, in the planning of control.

(c) Recording of REA results

A careful record should be kept for all persons selected for examination, including information on sex (in case both males and females are included in the examination), age, whether the selected person was examined or not, the results of the nodule palpation and of optional signs such as leopard skin. There should be a record form for each REA village, similar to the example given below.

Sample Village Record Form for REA

No.	Name	Sex	Age	Examined Y/N	Palpable nodules		Leopard skin* Y/N
					Y/N	Number*	

* optional

For each zone, the results of the REA's in the selected communities should be summarized on a record form which should contain as a minimum the information given in the sample form below. The village number in the first column should also be clearly indicated on the working maps, as it is common in many parts of Africa to find several villages with the same name within the same region. It might be even better to keep right from the beginning a record of the exact longitude and latitude of the selected villages, and to include this information in the zonal record form.

Summary of REA results per Zone

Vill. No.	Village Name	Type of village H/AH/S*	Estimated census population	No. of (fe)males selected	No. of (fe)males examined	Males with palpable nodules	
						No.	% (of exam.)

* H: High Risk Community; AH: Alternative High Risk Community; S: Secondary community

The type of village should be clearly indicated, whether it concerns a "high risk" village, an alternative choice for a high risk village, or a secondary village.

During the field visit, or from recent census data where these exist, an estimate of the census population of the selected villages should be made. Only an approximate figure will be needed and it is not necessary to do a detailed census.

In case males and females have been examined, separate summary forms should be filled for each of the sexes. Otherwise, only one form - for adult males - will be needed per zone.

(d) Cartography

Results of the REMO surveys need to be expressed cartographically to be fully appreciated. Probably the simplest method is to illustrate the percentage prevalences in the form of segmented pie-charts on the zone maps, with empty pies indicating zero nodule prevalence and full pies 100% nodule prevalence among the adults examined in the REA.

At the simplest level, and best for purposes of planning exercises, computer generated, or hand drawn, pie-charts can be stuck directly on to the available topographical maps. For internal reports and speedy dissemination, a photocopy of the original topographical map reduced to report size (A4) can be made; pre-made pie-charts (see Annex II for examples) stuck to this and the whole re-photocopied. However, such a photocopy may be hard to read, the roads tend to show up much better than the rivers and the locations of unsurveyed villages are hard to see. For this reason, it is suggested that a tracing be made of the original topographical map showing the rivers, roads and settlements, and perhaps indicating something of the relief. The tracing should then be subject to photocopy reduction and the pie-charts added and re-photocopied. This procedure does not require any professional skill. A presentable map can be made in one day providing there is access to a photocopier with a reducing function. Figures 3 to 7 are of this type with stencilled lettering.

(e) Costs and Logistics

The following are guidelines on estimates of costs in time and in money which need to be considered with regard to the planning of the different phases of REMO starting from its design through to the carrying out of the actual surveys involved.

The classification of a country into Divisions and Zones, as outlined in Section 2.1, should be achieved in 2-3 hours if an experienced geographer, with a good knowledge of the country, works with an entomologist and epidemiologist.

The selection of villages to be surveyed in each zone; initially the selection of high risk, alternative, and secondary villages will probably take 2-4 hours per zone, but as the exercise is continued for several zones, and as the group gains experience, the time taken should be substantially reduced, with up to 4 zones being dealt with in one day.

The rationale behind selecting communities is laid out in Sections 2.2. In assessing likely costs and logistical needs, and in recording actual expenditure, consideration will have to be given to the condition of the roads, travelling times and the pattern of dispersion of the human population. In most zones it should be possible to carry out REAs of 10-12 villages in fourteen days.

Very little is required in the way of equipment and supplies. Maps and stationery will have to be purchased and REA record forms printed. The survey team will be in the field for several weeks. They will, therefore, have to be paid an allowance for food and lodging.

Provision for transport will be essential and will have to be carefully considered. A 4-wheel drive vehicle will be required to allow easy movements of the survey team from village to village. Extra time should be allowed for possible mishaps. In areas not readily accessible, provision should be made to use motor cycles. Running costs for vehicle and motor cycles, i.e., maintenance and gasoline should be budgeted for.

3.2. POSSIBLE PATTERNS TO BE EXPECTED

(a) Classical savanna pattern

In savanna areas of West Africa, the distribution of onchocerciasis is closely related to the configuration of the rivers that provide suitable breeding sites for the vectors. Thus the communities most at risk are those which are located beside fast-flowing rivers. As one moves away from the river, prevalence of infection, CMFL and the manifestations of the disease tend to decrease. It has also been demonstrated that the nearest village to a breeding site, even if at several kilometres, is likely to be more severely affected than one which is at the same distance from a breeding site but is shielded by another community located closer to the breeding site. The shielded village is classed as a second-line village. (Rolland and Balay, 1969). In Figure 3, this classical pattern of distribution is well shown for the Sanaga River valley.

(b) Diffuse pattern of the forest

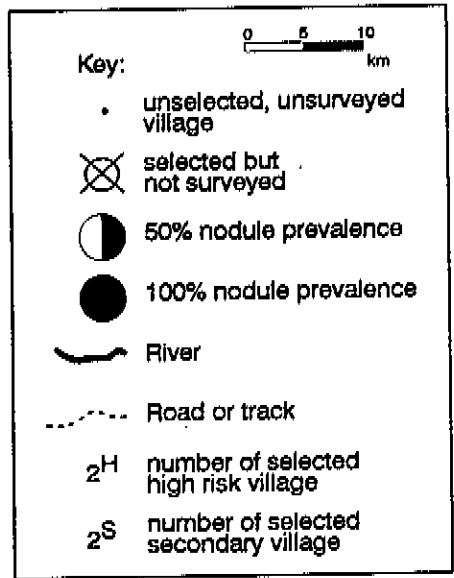
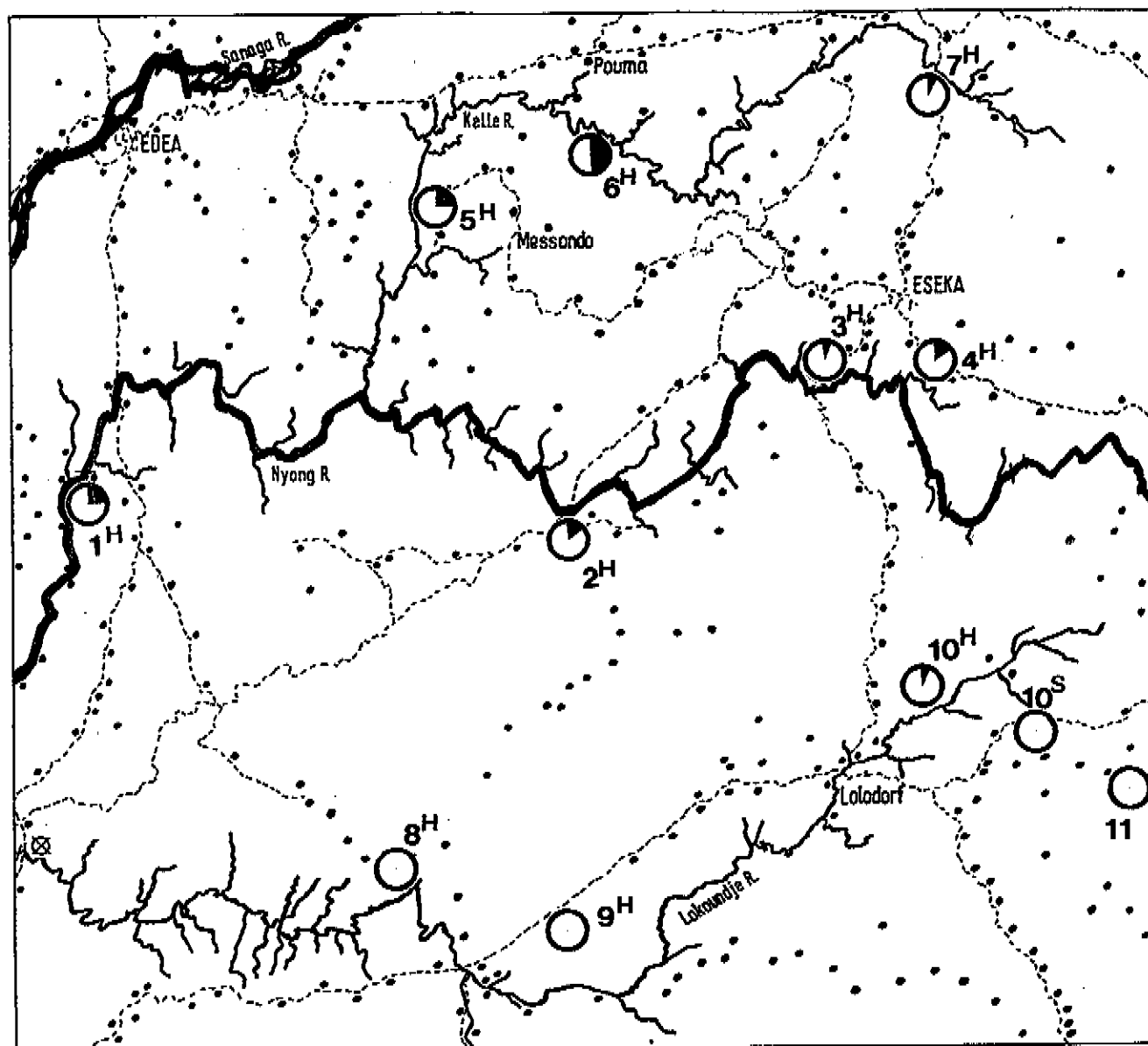
In some areas, mainly forested, there is likely to be a more diffuse pattern of onchocerciasis distribution. The reason is probably that the main vectors breed in quite small streams, which are virtually innumerable. This results in each community being located close to a breeding site (ie., within 1 or 2 km), and without another community between it and the breeding site. Thus, each community has a fairly high onchocerciasis prevalence rate, though the intensity of transmission and hence the CMFL may not always be very high.

In Cameroon, it was known from earlier investigations in the Kumba area, that onchocerciasis was widespread and probably of the diffuse type; and this was confirmed by REMO (results not reported here). A diffuse type of distribution was also found in the Mamfe area of the Cross River valley, even though a classical pattern might have been expected (see section 3.3).

(c) Unexpected results

REMO may provide results which are unexpected. This proved to be so in the Nyong river valley in the Eseka area (Figure 4), where a classical pattern of severe onchocerciasis was expected to occur in riverine communities. Despite the apparent suitability of the river for vector breeding (large rapids, rocky ground) the little onchocerciasis found was virtually confined to the Kele tributary in the north while there is probably no onchocerciasis transmission at all in the southern part of the zone. This finding is of course of great significance for the planning of control.

Figure 4: Results of rapid epidemiological mapping of the Nyong river valley (zone IVa)

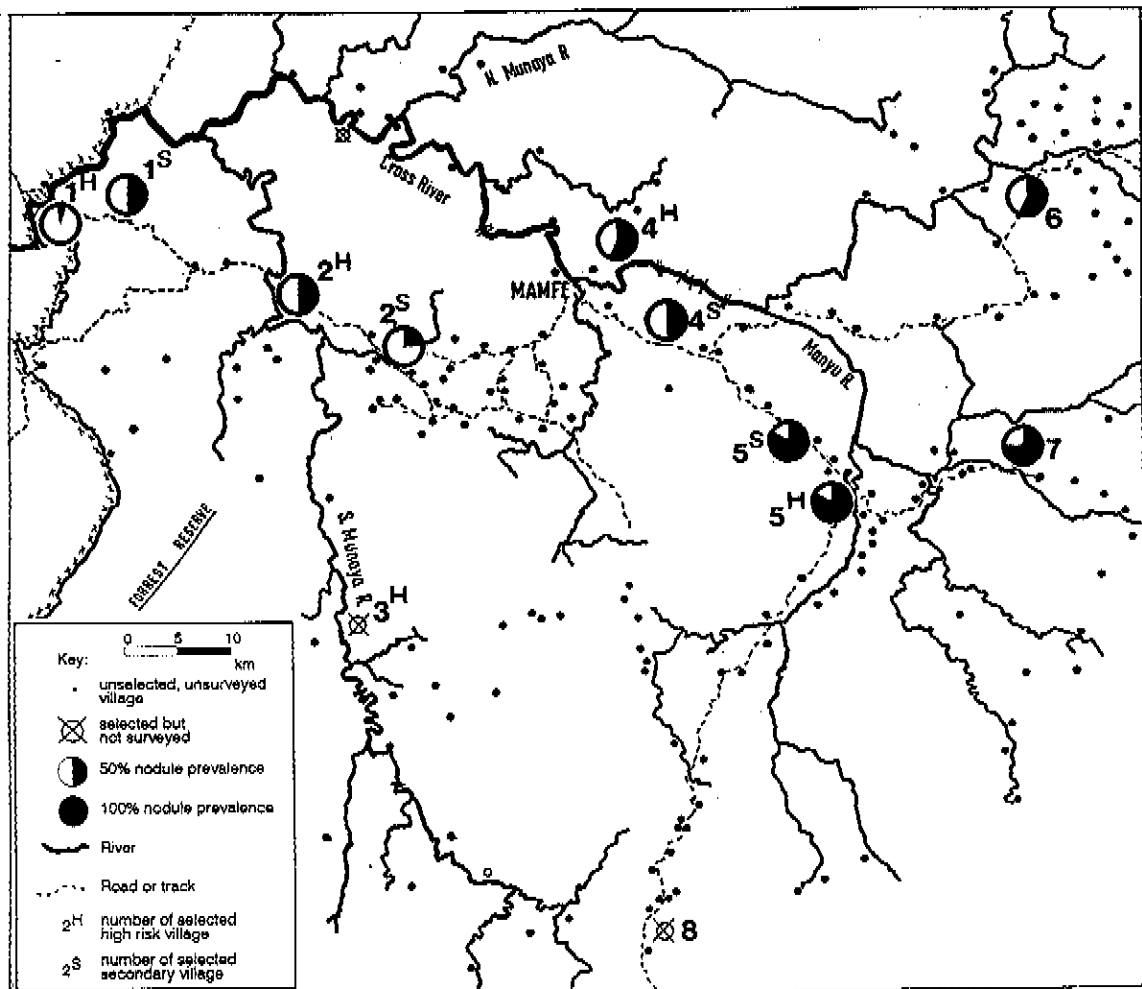


3.3. ADEQUACY OR OTHERWISE OF SURVEY RESULTS

The distribution patterns and endemicity levels shown by the REMO surveys will determine the necessity or otherwise for further survey work. Where the distribution is diffuse and endemicity levels high, there may be little need to carry out additional surveys. This proved to be the case for the Mamfe zone in Cameroon.

Figure 5 shows the results of the REMO survey as originally planned. Thirteen villages were chosen. These included six high risk villages located close to rivers which appeared likely to be suitable for vector breeding. Of these, two were not accessible at the time of the REA survey. For each of the remaining four villages, a secondary village, located at least 10 km from a likely important breeding site was also chosen. Furthermore, three villages were selected which were located in the headwaters of a tributary (villages 6, 7 and 8).

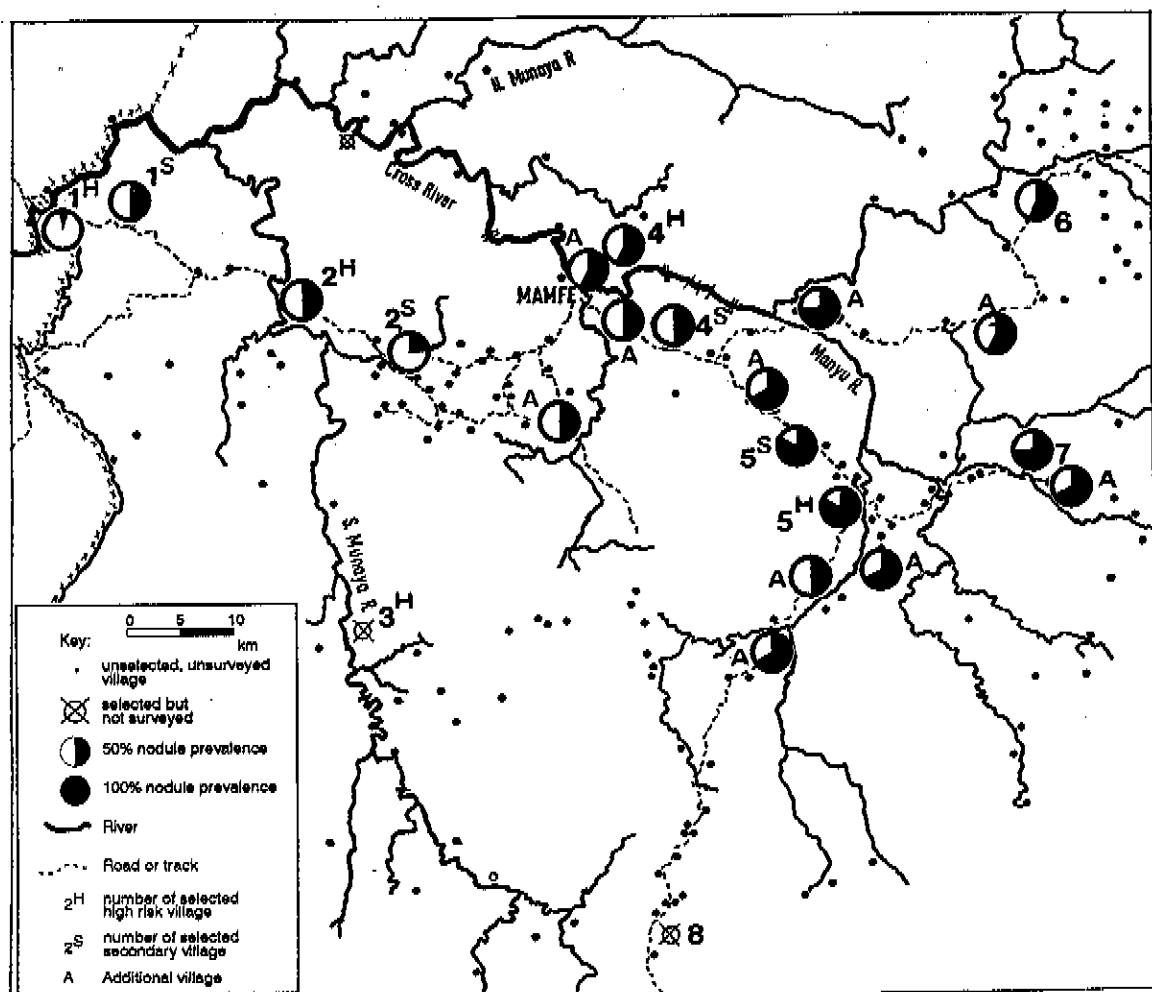
Figure 5: Results of rapid epidemiological mapping of the Mamfe zone (zone VIc)



The results from the 10 villages examined clearly show that onchocerciasis was diffuse in this zone and that the endemicity level was very high. Only in one village (1H) was the nodule prevalence very low. However, this particular village turned out to be a community of highly mobile traders on the border with Nigeria, who were not involved in rural activities and probably little exposed to the vector. The results for this village, therefore, are not representative for the epidemiological situation in this part of the zone. More relevant are the REA results for the corresponding secondary village (1S) which had a nodule prevalence of 48%.

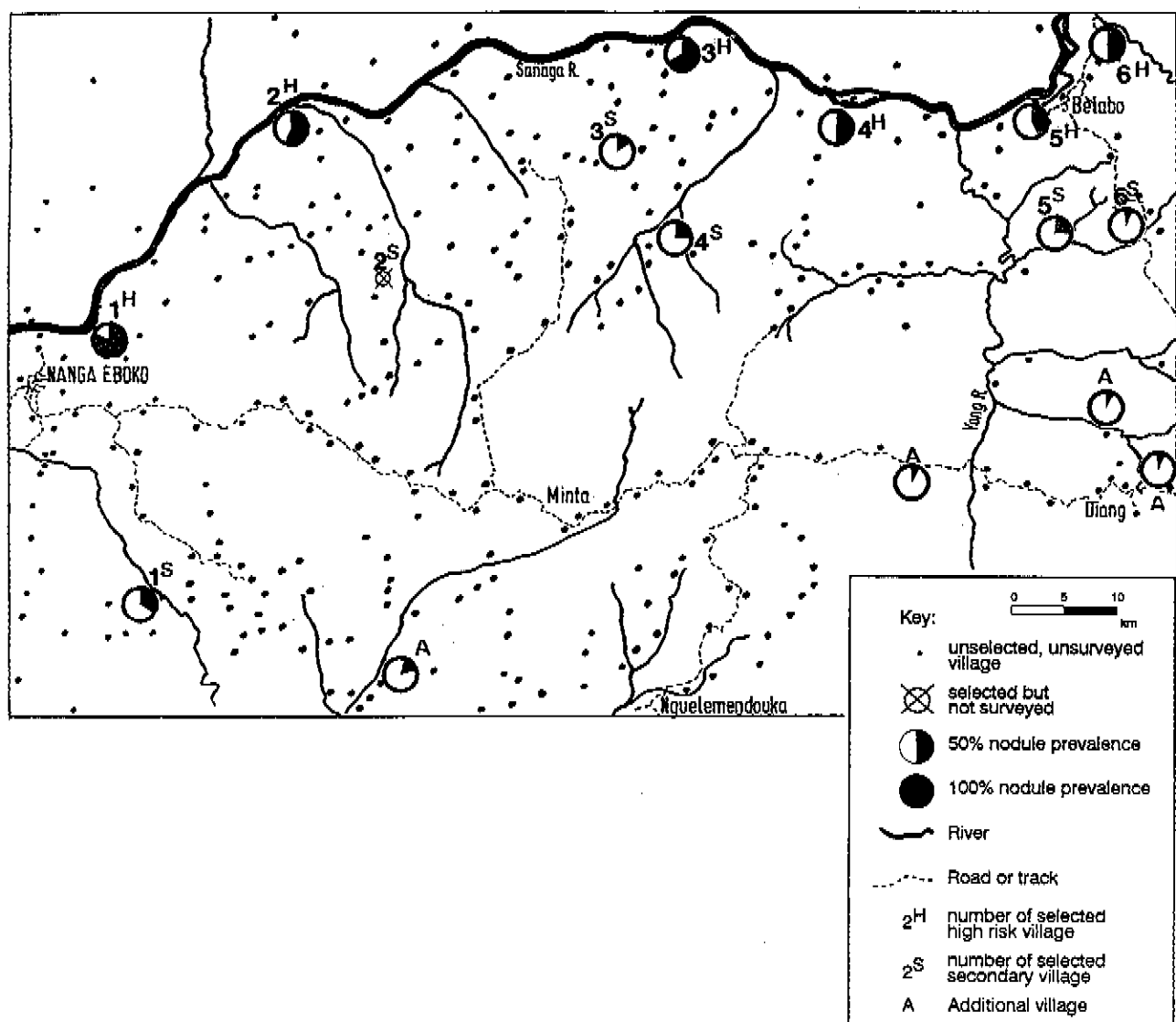
As part of the validation of the REMO method, REAs were carried out in 10 additional villages in the section of the zone upstream of Mamfe. The results (shown in Figure 6) confirmed the original findings and did not materially alter the conclusions already reached. Therefore, these additional surveys were unnecessary.

Figure 6: Results of all REA surveys done in the Mamfe zone (zone VIc).



In the Belabo area of the Sanaga valley, the original survey, of ten villages, showed the classical pattern with a clear decline in prevalence rates for secondary communities (Figure 3). Nevertheless, these communities still showed substantial onchocerciasis prevalences. Survey of an additional four villages at greater distances, and shielded from breeding sites by other communities, gave valuable additional data showing that onchocerciasis was of very low endemicity at a distance of 30 km or more from the main river (figure 7). These type of results should materially improve the detailed planning of control activities.

Figure 7: Results of all REA surveys done in the middle Sanaga River Basin (zone IIIb)



Where the REMO survey results prove unexpected, additional surveys may be needed to try to clarify the distribution pattern. The aim of the REMO surveys is to provide information about the distribution and severity of the disease, not to explain why the distribution pattern arose. Thus, in the Eseka area of the Nyong valley, results from 12 surveyed villages surprised the investigators. In the south of the area onchocerciasis was virtually absent. Near the Nyong river itself onchocercal prevalences were low although, on the basis of the information on the map, the river looked suitable for the vector. Only to the north of the basin, and especially in the valley of the Kele tributary, was mesoendemic onchocerciasis found. These results, though unexpected, were adequate at least for the south of the area, and enabled, on the basis of a few REA's only, a decision to be made not to start large scale ivermectin treatment in this part of the zone.

3.4. ESTIMATION OF POPULATION BY ENDEMICITY LEVEL

Once the percentage prevalences in the form of pie-charts are plotted on the original unreduced topographical maps, an attempt should be made to delimit areas in which all the communities are likely to be at similar endemicity levels. This will not be easy when only a very limited number of REAs has been done, but it is, nevertheless, worthwhile. It is an exercise in which the collaboration of the original group of entomologist, epidemiologist and geographer might again be useful. Once the different endemic areas have been delimited for each such zone or sub-zone the communities must be listed and population figures obtained from the latest available census. Where there is no recent census, it may be possible to apply a correction factor, if the annual rate of increase in the rural populations has been calculated. Substantial urban centres should be excluded from the figures, as their populations will have a relatively low risk of contracting onchocerciasis. Probably small, essentially rural, towns will also be excluded from the total population which should be included in the mass treatment campaign, though they should be covered by clinic-based treatment centres.

For each area the number of communities with an endemicity level above a given threshold and the total population involved can be estimated. In addition there will be data on the number of non-endemic communities and on the total population in low endemic areas which should be covered by clinic-based treatment centres.

4. Implications for the Planning of Ivermectin Treatment Programmes

Once REA has been carried out in all zones and the results plotted on topographical maps the REMO is complete. The distribution patterns for each zone will be apparent (see section 3.2.) and the need for any additional surveys will become obvious. If there are substantial gaps in the coverage which preclude sound estimation of onchocerciasis distribution, it may be necessary to carry out additional surveys immediately. However, it is expected that the need for most additional surveys will not be crucial for sound planning or for meeting the requirements of the Mectizan Expert Committee. Thus additional REAs can be deferred until control actions are being initiated.

In addition to the entry of the survey data on to maps, areas with communities of broadly similar endemicity levels will have been delineated and the numbers of communities and population sizes at each endemicity level will be available (3.4) for each zone and nationally. With these tabulated and cartographically expressed data a national approach to the planning of control measures becomes possible.

4.1. PRIORITIZATION IN LARGE-SCALE TREATMENT

The REMO data should be sufficient to enable the Coordinator to make rational use of scarce resources with a view to optimizing the benefits of onchocerciasis control activities. Nevertheless, in addition to the REMO study, use should be made of all available survey data which is not out of date. In particular any properly conducted skin snipping surveys should be given full consideration.

Using all data, the Coordinator will be in a position to rank the zones in order of need for control measures. (S)he will also be in a position to provide objective predictions of the numbers of communities and population sizes which will require coverage by an active treatment campaign, for any chosen level of endemicity.

Given the likely availability of resources, it will be possible to ascertain the threshold of endemicity at which a community becomes eligible for active mass treatment, so that the eligible population can be catered for with available resources (see also Annex I). If resources are few, active ivermectin distribution may have to be restricted to communities with relatively high endemicity levels, other communities being covered by a clinic-based system or having the treatment deferred. However, such an exercise in planning will have to take other factors into account, such as the fixed costs of reaching and establishing the treatment team in a particular zone, liaising with local authorities, etc., and the marginal costs

(thanks largely to the free availability of the drug) of treating additional, lower endemicity communities in the immediate vicinity.

Should resources be inadequate to cover all zones in which there are hyperendemic communities, choices will have to be made as to which zones require priority treatment. The prioritization exercise can be objectively carried out using the data available from the REMO.

The preliminary findings from Cameroon provide a good example of how REMO results can be used for prioritization in the planning of onchocerciasis control. Among the three zones in Cameroon where REMO has been done so far, the first priorities for large scale ivermectin treatment are clear, viz.: (i) virtually all communities in the Mamfe zone and (ii) the communities located within a band of 10 km from the main Sanaga river need to be treated urgently. On the other hand, it appears that large scale treatment is not indicated in the southern half of the Nyong zone and in communities at a distance of more than 30 km from the main river in the Sanaga zone.

The REMO data will place the Coordinator in a strong position in his/her approach to the Mectizan Expert Committee and in obtaining the maximum benefit from any NGO prepared to offer help. (S)he can steer the NGO to a priority zone, or subzone, and by rational choice of treatment threshold levels can ensure that resources are used to benefit the communities in greatest need.

4.2. REFINING THE EPIDEMIOLOGICAL MAP IN PREPARATION FOR LARGE-SCALE TREATMENT

For any given zone it will probably be necessary to carry out additional REAs prior to undertaking a mass treatment campaign. Such surveys should be executed in the same manner as the original ones and should if possible, immediately precede the treatment campaign. Communities to be surveyed should be chosen using the same criteria as before. The primary aim will be to ensure that all relevant parts of the zone have been adequately assessed. Where the onchocerciasis distribution pattern is diffuse, these additional REAs will be expected to confirm that onchocerciasis occurs throughout the zone; where the classical pattern occurs, additional surveys will ensure that the width of the areas covering communities needing treatment are accurately delimited; where the initial results were surprising, the additional REAs should provide confidence in the interpretation of the data and help to ensure that the endemic areas are properly mapped.

It is important that the additional REAs should not be so numerous as to result in the overall effort being virtually undistinguishable from carrying out REA surveys

in most villages. Whilst it is impossible to provide a lower guideline figure for the proportion of communities to be surveyed, it seems likely that the upper proportion should not exceed 10%. For the Mamfe zone, 10 surveys seem to have provided adequate data for planning treatment of 184 named communities.

4.3. USE AND LIMITATIONS OF THE METHOD IN DIFFERENT AREAS

The method described in this Manual arose from a consideration of the ecology of members of the *S. damnosum* complex and of the distribution of onchocerciasis in terms of first and second line villages (Rolland and Balay, 1969) in West Africa. The study carried out in Cameroon clearly demonstrated that REMO is a satisfactory method of describing the distribution of onchocerciasis in both forest and savanna mosaic country, whether it be the classical or the more diffuse pattern typically found in forested country.

It is thought likely that REMO surveys will prove of value in all areas, including SW Arabia, where the vectors of onchocerciasis are members of the *S. damnosum* complex. However, in countries such as Tanzania, over reliance on examination of maps could lead to field work being carried out in onchocerciasis free areas. This is because some parts of Central and East Africa are inhabited by non-man-biting, hence non-vector, forms of the *S. damnosum* complex, to the exclusion of man-biting/vector forms. The reasons for this are not understood, and examination of maps alone offers no evidence of whether the members of the *S. damnosum* complex likely to be present are potential vectors or not.

In areas where the main vectors are members of the *S. neavei* group (especially in parts of Zaire and Uganda), the present approach needs modification. This is because members of the *S. neavei* group can only thrive in forested areas, and these are not adequately represented on standard topographical maps. Where accurate detailed maps of vegetation cover are available, these could be used in conjunction with the methods covered herein, to give a basis for planning REA surveys in lowland areas. Unfortunately, in the mountainous country of the frontier zone of Rwanda, Zaire and Uganda, available topographical maps do not adequately portray human population distribution. Without the survey teams being equipped with Global Positioning Systems fruitful surveys could not be conducted. In such mountainous areas the villages to be assessed could not be effectively chosen prior to the survey team's arrival in the field. Therefore surveys would have to be conducted by staff capable of designing a rational network of survey points on the spot. On balance it does not seem worthwhile to expend scarce resources on such a dubious effort.

Finally, despite the above limitations, the methods are likely to prove of use in most if not all countries where the predominant vectors are members of the *S. damnosum* complex, and outside the OCP countries of West Africa this includes some 11 million people infected with onchocerciasis (WHO, 1987) who reside in areas which might be assessed and mapped in this way.

5. References

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Annex I.

Criteria for large scale ivermectin treatment.

The public health importance of onchocerciasis, both in terms of skin lesions and eye lesions, is directly related to the degree of endemicity of infection in the community. In the West African savanna, communities with a prevalence of 55% or more account for 80% of onchocercal blindness. If communities with a prevalence of 40-59%, are included, then the two groups will account for nearly all the blindness due to onchocerciasis (Dadzie et al, 1991).

Although, in a perfect state, it would be desirable to undertake active mass treatment with ivermectin in all communities where the risk of onchocercal blindness or other severe complications is not negligible, in most countries, at least at the outset of ivermectin distribution campaigns, financial and logistic considerations are likely to make it necessary to confine active distribution initially to the worst affected communities. Control programmes will therefore need to define a threshold for the level of endemicity above which they will provide active mass treatment of the total eligible population in a community, and a threshold below which they will confine themselves to making ivermectin treatment available through the regular health care system only.

Guidelines to aid in this decision were provided by an international meeting on "Strategies for ivermectin distribution through primary health care systems" (WHO 1991) and these were later refined (WHO 1992). According to those guidelines, large scale ivermectin treatment is a 'must' when the prevalence of mf in skin snips (all age groups combined) is greater than 60%, and 'highly desirable' when the mf prevalence is between 40% and 60%. No attempt was made to define a lower threshold below which mass treatment with ivermectin is not indicated, as such a lower limit depends in the first place on the locally available resources.

Skin snip surveys are time-consuming and costly to undertake and this limits the practical value of thresholds defined in terms of mf prevalence. However, it has been shown that there exists a good relationship between the classification of onchocerciasis endemicity based on skin snip data and the classification by rapid assessment methods, especially nodule palpation in a sample of adult males (Taylor et al 1992, WHO 1992; see also section 2.3). It has therefore been possible to define for each of the above mf prevalence thresholds, the equivalent value for rapid assessment methods based on nodule palpation and visual inspection for leopard skin. The results are given in the table on the next page. It should be stressed that this table gives only guidelines and that the ultimate decision on thresholds to be used is the responsibility of each individual control programme or the general policy in the country concerned.

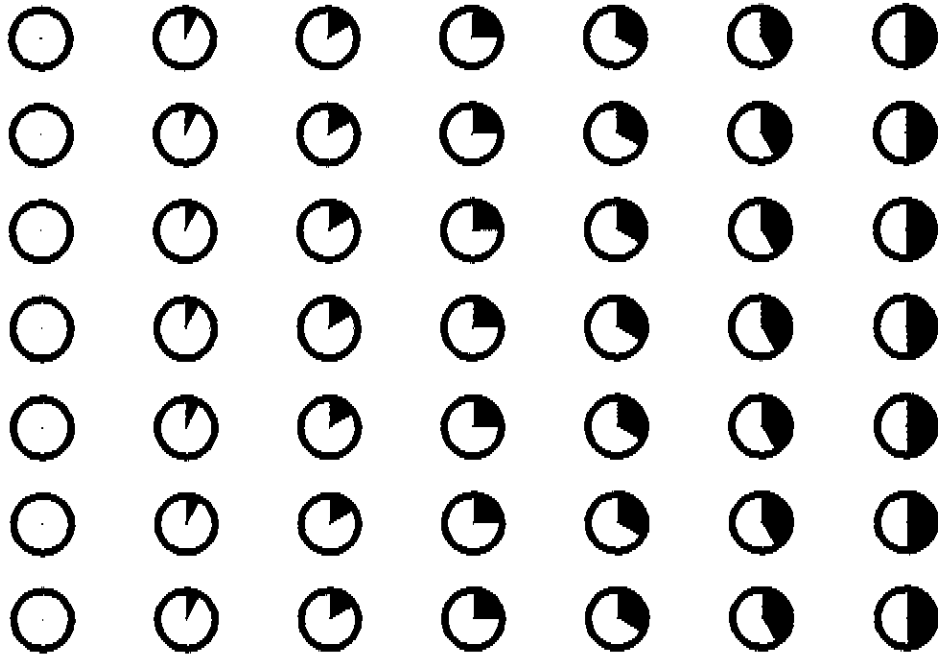
Suggested criteria for large scale ivermectin treatment.
(adapted from WHO 1992)

Assessment method	Large scale treatment	
	Urgent (must)	Highly desirable
1. PARASITOLOGICAL ASSESSMENT		
<u>Prevalence of mf in skin snip</u> Males and females of all ages Males over 20 years	60% and over 90% and over	40% - 59% 70% - 89%
2. RAPID ASSESSMENT METHODS		
<u>Prevalence of nodules</u> Males over 20 years	40% and over	20% - 39%
<u>Leopard skin</u> Males over 20 years	20% and over	not useful

Annex II.

Prevalence pies for making epidemiological maps

Prevalence: 0%	8.3%	16.7%	25%	33.3%	41.7%	50%
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Prevalence: 58.3%	66.7%	75%	83.3%	92.7%	100%
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