ecology of malaria in urban squatters of greater Khartoum hai gamier in omdurman
The Ecology of Malaria in the Squatter Settlements of Urban Sudan: Hai Gameir in Omdurman

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Malaria has a serious impact upon health and development in Tropical Africa. Currently, it is becoming an increasingly serious matter in many urban areas. This stems from a rapid increase in population, springing especially from rural to urban migration, and the resultant overwhelming of urban services. The result has been the creation, in Africa’s major cities, of urban settlements characterized by inadequate housing, abject poverty, and high incidence of disease. This paper addresses the problem in the Greater Khartoum urban area and is concerned particularly with Gameir in Omdurman, one of its poorest areas. In particular, the interaction of physical and human environmental factors is examined in relation to malaria. This investigation was carried out by a series of field investigations in 1995 and 1998. The evidence shows that there is a strong correlation between the incidence of malaria in Gameir and levels of poverty and poor housing in a physical environment conducive to the spread of malaria, unless firm counter-measures are in place. The conclusion is that these are not in place and that there seems little likelihood of improvement in the near future, not because there are no solutions, but because, under the present political and economic circumstances, the necessary financial inputs are not available. Nevertheless, some simple improvements could be instituted.

Key words: malaria, squatter settlements, nutrition, migration, flooding, Sudan, Omdurman

La malaria a un impact considérable sur la santé et le développement en Afrique tropicale. Elle est en train de devenir une affaire sérieuse dans de nombreux quartiers urbains. Ceci découle de l’augmentation rapide de la population, issue surtout de l’exode rural et du débordement consécutif des services urbains. La conséquence en a été la création, dans les villes principales africaines, de quartiers marqués par des contraintes adaptées, la pauvreté abjecte et la forte fréquence de maladies. Ce travail analyse le problème dans la région urbaine du Grand Khartoum, en examinant plus particulièrement le cas de Gameir à Omdurman, une des régions les plus pauvres de la ville. Notamment, l’interaction entre les facteurs environnementaux physiques et humains est examinée par rapport à la présence de la malaria. Ce travail a été effectué en 1995 et en 1998 à l’aide d’enquêtes sur le terrain. Les résultats montrent qu’il y a une forte corrélation entre la présence de malaria à Gameir d’une part et les niveaux de pauvreté et les conditions de logement dans un environnement physique favorable au développement de la maladie d’autre part, à moins que des mesures énergiques soient mises en œuvre. Celles-ci ne sont pas en place et il semblerait qu’il n’y ait peu de possibilité d’amélioration, non pas par absence de solutions, mais parce que les apports financiers nécessaires ne sont pas disponibles, suite aux circonstances politiques et économiques actuelles. Cependant, quelques améliorations simples pourraient être mises en place.
Introduction

This paper sets out to describe the interrelationship between people and malaria in a typical squatter settlement in one of the three urban areas within Greater Khartoum (Khartoum, Khartoum North, and Omdurman, around the confluence of the White and Blue Niles) and to examine the relative importance of physical environmental and socio-economic factors in the incidence of the disease. It also suggests some simple developments that would improve the current health situation in such settlements.

Malaria was accurately described by Hippocrates in about 400 BCE, but there is good evidence from Egyptian papyri to suggest the existence of the disease in the Nile Valley as early as 1500 BCE (Muller and Baker 1990). However, the full process of malarial development in humans was not fully elucidated until after World War II. The disease is transmitted by the bite of the anopheles mosquito, carrying the Plasmodium parasite, which first attacks the liver before entering the bloodstream. There are many types of malarial parasite, of which the commonest in most of Tropical Africa are Plasmodium falciparum, P. malariae, P. ovale, and P. vivax. Malignant tertian malaria, caused by P. falciparum, is the most virulent and difficult variety to diagnose from other recurrent fevers and has mortality in about 10% of cases (Meade, Florin, and Gesler 1988; Muller and Baker 1990). Meade, Florin, and Gesler (1988) suggest that malaria is usually a debilitating, rather than a life-threatening, disease. Malignant tertian malaria caused by P. falciparum is becoming increasingly resistant to treatment by anti-malarial drugs (Prothero 2001). Some indication of the scale of the increasing resistance problem was given by Crompton, as far back as the 1970s (Crompton 1984). He states that, in 1958, there were 35 species of mosquito resistant to insecticides and that this figure had increased to 110 by 1971.

Large areas of the world have climatic conditions conducive to the breeding of malarial mosquitoes, and these include not only tropical lands but also many areas with warm temperate and Mediterranean-type climates (see Prothero 2001). The best conditions for the anopheles are said to lie in temperatures between 25°C and 35°C, with relative humidity at 60% and a rainy season of at least three months. Temperatures below 16°C and above 37°C and relative humidity of less than 25% are not so conducive to their survival (Learmonth 1977).

In the past malaria has been considered a disease of rural, rather than urban, areas. This is no longer the case. In Tropical Africa its spread into urban areas can be attributed to a range of factors. Greater resistance of the anopheles mosquito to insecticides and the drug resistance of the parasite have made control measures less easy to apply. Internal political instability, and the failure of preventative services to cope with the rapid areal expansion and population growth of cities, have also been important factors in the disease's spread in urban areas. In turn, these difficulties have been exacerbated by the influx of rural dwellers with the malarial parasite into an alien environment, people who, so often, have to live in very squalid and unhygienic conditions, leading to circumstances conducive to the spread of a range of other diseases and to a weakening of resistance to malaria.

Background

Malaria in Central Sudan

The whole of central and northern Sudan, as far north as Atbara on the main Nile, has climatic conditions conducive to the spread of malaria (Dutt and Dutt 1978). Much work has been done, since the publication of Dutt and Dutt’s study, on malaria in central Sudan, and...
the results have been summarized by Hamad et al. (2002). The most significant findings have been that the dominant species of malaria-carrying mosquito is *anopheles arabiensis* and the main parasite involved is *Plasmodium falciparum*, the main cause of malignant tertian malaria. Hamad concludes that 95% of the cases of malaria in central Sudan are caused by *P. falciparum*. A survey along the White and Blue Niles in Greater Khartoum found that at one site all cases of malaria were caused by *Plasmodium falciparum* and at the second surveyed site the species involved were *P. falciparum* in 84.9%, *P. ovale* 8.2%, and *P. vivax* 6.9% of cases (el-Sayed et al. 2000). An earlier survey of 1993 in the peri-urban area of Greater Khartoum, quoted by el-Sayed, found that 32% of the sampled population were infected with *Plasmodium falciparum*. In 1991 the number of reported malaria cases amounted to 20% of Greater Khartoum’s population (Alredaisy and Davies 2001). Though the figures are clearly incomplete—with many cases, especially from the poorer parts of the conurbation, unreported—published figures record more than 300,000 cases of malaria a year in Greater Khartoum (Khartoum State, Ministry of Health 1996).

The importance of malaria today, as a disease in Greater Khartoum, seems proven, with all its human and economic consequences. However, this was not always so. As far back as 1904 Khartoum was declared to be malaria free (Gleichen 1905). Doubt has been expressed by some scholars about the claim that, in Greater Khartoum, malaria is a serious health hazard. De Jong-Boon (1985) claimed that most mosquitoes found in Khartoum are *culex* mosquitoes that, unlike the *anopheles*, do not transmit malaria but, as they breed in sewage and drains, can transmit a range of undesirable fevers that are reported as malaria. In support of her claim, she quotes work done by the Sudan Ministry of Health in the 1980s, which found that most blood samples taken from “malaria” patients in a sample survey of clinics in Khartoum did not yield malaria parasites. On the other hand, these observations were made in the early 1980s, immediately after a series of very low Nile floods. The turning point seems to have been the very high Nile floods of 1988 (el-Sayed et al. 2000). The inherently unhealthy nature of the White Nile and Blue Nile confluence was frequently referred to in the 19th century, and Santoni, who visited Khartoum in 1877, reported that one-third of the European population had died from fevers during that rainy season (Santi and Hill 1980). Khartoum is still a potentially unhealthy environment, as was demonstrated in 1988. The incidence of malaria has much increased through rural to urban migration.

**Urban Growth**

Since the 1950s there has been a remarkable expansion of the urban population in many of the world’s less developed countries, with much of it concentrated into one or more large centres. In Africa in the 1950s there were only 2 cities with more than a million people. By 2000, this number had increased to 40, with the primary city frequently being several times larger than the second largest. The Sudan is no exception. In 1955 8% of the population lived in urban areas. By the 1993 Census the figure had risen to 30% (Sudan, Ministry of Finance and Economic Planning 1996). Greater Khartoum had a population of 246,000 at the time of the 1955–56 Census (Sudan, Department of Statistics 1962). By 2000 the estimate exceeded 3 million, representing a doubling since 1983. One result of this incredible expansion has been an increasing degree of urban primacy. In 1955 Greater Khartoum had 4.7 times the population of the second-largest urban centre. By the 1993 Census this had increased to 8.9 times (Davies 2001).

Such rapid rates of urban population increase in Africa cannot be accounted for by natural increase alone but imply a high degree of in-migration, with much of it rural to urban. Khartoum State, within which Greater
Khartoum lies, had a population of 3.5 million in 1993—46% were born outside the state and many of those counted as “born-in-the-state” were rural dwellers who had moved into the city (Davies 2001). For Omdurman, el-Bushra and Hijazi (1991) give a figure of 47% of the population born outside the city, of whom 41% came from outside Khartoum State. In the case of Greater Khartoum the large influx has been caused by such typical factors as urban bias in the use of resources and the consequent neglect of rural areas and their welfare. Thus, it is in Greater Khartoum that the better medical, educational, and social services (piped water, electricity, and the like) are concentrated. To these may be added a range of other factors. The Sudan’s long-running civil war has led to a massive dislocation of population, with many southern Sudanese migrating to Greater Khartoum. In 1993 there were 220,000 persons born in southern Sudan living in urban Greater Khartoum, out of a population of 2.9 million. Furthermore, the vagaries of rainfall in this desert-marginal zone, typified by the series of drought years in the early 1980s and part of the 1990s and the consequent failure of crops, on top of government neglect, has led to the abandonment of many rain-land farming areas in western Sudan, especially in Kordofan. Notably, in the Nuba Mountains political instability and crop failures have come together. The problems of rural areas along the White Nile area south of Khartoum have been explored by Alredaisy (1993). There were 750,000 people born in Kordofan living in the Greater Khartoum urban area in 1993. Such figures do not include the offspring of southerners and people from Kordofan born in Greater Khartoum. Because of the rapid movement of people into Greater Khartoum from rural areas in the 1980s, the authorities ran an extra Greater Khartoum Census in 1990. In this it was estimated that nearly half-a-million people were living in “Displaced Camps” (Davies 1991). It is now conceded that even this figure was a serious underestimate of the problem. Figure 1, based upon satellite imagery (see el-Kheir 1991) shows the extent of “unplanned settlement” in Greater Khartoum at this time. In classic fashion these unplanned areas can be seen to be peripheral to the cores of the three main urban centres. The chronic housing problem in Greater Khartoum at this time has been discussed by el-Nur (1991). The population increase has been such that the necessary growth of urban services has simply not taken place, with the result that many have to live in slum conditions in squatter settlements.

Rural to urban migrants bring their cultural traditions with them. French writers from the early 1970s, such as Sautter (1972), have described this facet of the urban migration process. Gibbal (1972), in his study of the phenomenon in Ivory Coast, refers particularly to rural attitudes and methods of thought and belief. This “ruralization” of the city is not only important culturally but also has important economic and health implications. Many studies of squatter settlements and their functions have been made, but for Greater Khartoum, an important study of the phenomenon was carried out by Norris in 1985 in Umm Badda, a squatter area of Omdurman, and this was summarized by el-Kheir (1991). The development and importance of the informal sector in Greater Khartoum, in which so many migrants have become involved, was discussed by Herbert and Ibrahim (1991). Ibrahim (2002) gives, as the latest estimate available, a figure of 60% of urban employment in 1986, based upon ILO estimates. Since 1992 the Khartoum State Ministry of Housing and Engineering claims to have regularized 80% of the squatter settlements of Greater Khartoum (Hamid 2000). However, as Hamid points out, “regularization” does not mean that water, sanitation, electricity, and other urban services have been brought to these areas: Hamid goes on to describe the “ruralization” of Greater Khartoum, in terms of cultural attitudes, and the complete lack of the standard urban amenities and services. Such has been the urban expansion through migration from the countryside, that poverty...
is now widespread in Khartoum State, with figures of perhaps 70 to 80% living below the poverty line (Hamid 2000; Ibrahim 2002).

Migration and Malaria

The importance of migration in the spread of various diseases in Tropical Africa has been well documented, not only with respect to malaria. Prothero (2000) refers to cholera, which was believed to be absent from Africa south of the Sahara for about a century but reappeared in the 1970s, when...
an epidemic broke out affecting much of Tropical Africa. The migration of people and goods was cited as the main factor leading to its widespread. There was a serious, associated outbreak of this disease at that time, among recent migrants in north Omdurman, an outbreak which posed a serious threat to the city as a whole (Sudan, Ministry of Health 1980). Various facets of the effects of migration on the spread and incidence of malaria have been examined seriously since the 1950s (e.g., May 1958; Prothero 1961; 1965; 1994; 2001; Meade 1976; Cruz-Marques 1987; Sevilla-Casas 1993; Singhanetra-Renard 1993). Much of the work in the 1950s and 1960s was concerned with WHO’s malaria-eradication program. In Africa Sudan was in the forefront of this unsuccessful campaign. One of the main reasons for failure was the degree of population movement. First of all, there has been a long tradition of movement eastwards by western Sudanese and West Africans, along the savannah grass road, which lies between the Sahara to the north and the wooded areas to the south, a movement connected with the pilgrimage to Mecca (Davies 1964; Bauomi 1972). Secondly, there was much nomadic migration with the seasons, which at that time might have involved 40% of the population of Sudan (Davies 1966). One of the authors of this paper himself saw how the malaria-eradication campaign along the Blue Nile at this time was vitiated by population movement. In more recent times the significance of the movement of Westerners and the spread of disease, particularly malaria, has been examined in Sudan’s large Gezira irrigation scheme (Elhassan 1998). This researcher concluded that 68% of the population of the area in his survey suffered from malaria during the rainy season, but that figures higher than this average were found in the settlements occupied by migrant Westerners. This seems to confirm, to some extent, the long-standing contention among the Gezira tenants that migrant Westerners were an important factor in this disease in the Gezira. Malaria, accounting for 37%, was the major cause of death in the Gezira Scheme in the late 1990s (Elhassan 1998). In 1995 malaria topped the list of disease admissions into Sudan’s hospitals (Sudan, Ministry of Health 1995).

Clearly, there is much more to the incidence of malaria than climate, rapid urban growth, and migration. Available figures for Greater Khartoum in the 1990s suggest that the number of cases has been increasing at a faster rate than that of the population. Some of these other factors include the spread of new irrigation areas in close proximity to the city, considered to be a very important factor by el-Sayed (el-Sayed et al. 2000); poor location of new settlement areas; low incomes; and low quality and congestion of housing, especially affecting recent arrivals in the city (Alredaisy and Davies 2001). The occupation of unsuitable sites was a most significant factor in the severe damage inflicted upon third-class and unofficial housing areas of Greater Khartoum in 1988 by the coincidence of high Nile floods and unusually heavy rains (Davies and Walsh 1997). In all, 36% of the population of Omdurman were seriously affected (Abu Sin and Harbi 1991). To these may be added poor maintenance of urban infrastructure even in first-class residential areas. Plate 1 shows flooding in the Riad District of Khartoum, caused by a burst water main during the dry season creating new breeding sites for the anopheles mosquito. It is significant that the problem of burst water mains peaks each year from November to January (Khartoum State, Ministry of Health 1996). The coming together of a variety of factors and their significance in relation to the spread of malaria have been noted in many other parts of less-developed-world countries (Prothero 1965; Eyles and Woods 1983; Jones and Moon 1992). Their interaction is now considered in relation to one area in Omdurman.
Hai Gameir: A Regularized Squatter Settlement

Omdurman is divided into local districts (or Hai). One of the squatter areas in north Omdurman claimed by the Khartoum State Ministry of Housing and Engineering to have been regularized since 1992 is Gameir (see Figure 1). In turn, Gameir comprises six local neighbourhoods (haras). This paper now examines the results of sample surveys, carried out in July/August of 1995 and 1998, of migrants living in two of these (Hara El Sharg and Hara Thalitha). These particular haras were chosen because of their proximity to the Nile; because in outward appearance they are typical of squatter areas in Greater Khartoum; and in the belief that results from here would be relevant to the rest of this urban conurbation. The surveys examined, particularly, any relationship between nutritional levels, economic status, and prevalence of malaria attacks as reported by the people. The methodology employed included the use of a questionnaire survey, supported by in-depth interviews with a cross-section of the sample and the weighing of food samples. The results were further tested through discussions with community leaders and government officials familiar with Hai Gameir. For malaria, data were collected to identify frequency of attack, duration, and severity. In the event, severity could not be satisfactorily tested, partly because there were no deaths from the disease reported by the chosen sample. One caveat must be entered here. It was not possible to identify how many reported attacks were of malaria rather than of some other fever. In 1995 there were approximately 400 households in these two haras (386, according to the 1993 census; Sudan, Ministry of Finance and Economic Planning 1996). Financial and other constraints limited the random sample to 40 households (10% of the total), with all those surveyed being recent migrants to the city.

Characteristics of the Sample

The 40 households were chosen at random within the two haras. There was no system of street naming or numbering and the houses are not distributed in any logical fashion. This means that any standard sampling procedure
was, in practice, difficult to implement. Furthermore, it was necessary to find households willing to co-operate in a meaningful fashion and to ensure that they were recent arrivals (i.e., within the last two years). These severe restrictions meant that the sample has its limitations, but nevertheless, it is believed to be broadly representative of squatter areas in Greater Khartoum. The surveyed population was 350. By ethnic origin, they were from northern and western Sudan and from West Africa. However, it should be realized that some of these folk had settled somewhere else first on arrival from the countryside, either in Greater Khartoum or in some other urban centre, before finding their way here, while others had been forced to occupy this area by the difficulty of finding suitable accommodation elsewhere in the city. The shortage of housing in Greater Khartoum, with the resulting high cost of purchase or renting, has been described by el-Nur (1991).

A variety of factors are involved in the spread of disease, such as the local physical environment, the socio-economic conditions, biological make-up of the population, and the existence of a transmission agent. A discussion of the situation relating to Gameir now follows.

**Malaria and the Physical Characteristics of the Gameir Area**

Gameir lies along the edge of the main Nile and is bounded to the south by the ephemeral Khor Tatay. The topography of the area is undulating, with the geology consisting of sedimentary rocks of the Nubian Series. The undulating nature of the area is emphasized by large and deep holes scattered over the site, resulting from the excavation, in the past, of surface materials for house construction in the third-class residential areas of Omdurman. So significant is this feature that Gameir has the nickname *El Hofer* (the holes).

Figure 3 shows that the Nile is at its highest at Omdurman in August and September. Omdurman’s average annual rainfall of 161 mm is confined almost exclusively to the three months of July, August, and September, with average rainfalls of 46 mm, 75 mm, and 25 mm, respectively. So there is coincidence between high Nile, ephemeral khor flow, and rainfall. The average daily temperatures at this time of the year range from a mean minimum of 25°C to a mean maximum of 38°C. Relative humidity averages 55%. In all, the importance of these features in affecting the
incidence of malaria cannot be over-emphasized, in that they provide excellent conditions for the breeding of *anopheles* mosquitoes. Not surprisingly, the incidence of malaria peaks in October and November, as there are pools of water left by the falling Nile in the bed of Khor Tatay and in the various holes left from the former quarrying; all of which provide excellent breeding grounds for mosquitoes. Seventy-five percent of those interviewed in the survey reported having bouts of malaria at this time of the year.

Clearly, there will be variation in malaria incidence from year to year, depending upon the height of the Nile flood and the amount of rain falling in this locality, with its desert-margin climate. For example, 1988 saw the Nile flood reach levels second only, in the 20th century, to those of 1946; and the 1980s saw both the driest year (1984), with less than 10 mm of rain at Omdurman, and the wettest (1988), with 372 mm (Walsh, Davies, and Musa 1994; Davies and Walsh 1997).

The rainy season is followed by a short hot period in October/November, when daily maxima often exceed 40°C and sun temperatures can exceed 50°C, which is rather too high for the *anopheles* mosquito, so that by the end of November malaria incidence tends to fall. Nevertheless, 12% of those interviewed reported suffering bouts of malaria during the dry season in January and February. This expansion of the disease into the dry season in Gameir has been brought about partly by the presence, along the Nile (on the Omdurman side and on the opposite bank near Shambat and Kadaro) and on Tuti Island, of considerable areas under irrigation. From these areas *anopheles* mosquitoes are blown across the river to Gameir at this time of the year, for there are no months when the average monthly mean temperature falls below 16°C, which is the critical low temperature for the breeding of *anopheles* mosquitoes. According to the local Ministry of Health, 86% of the agricultural population of Khartoum State suffers regularly from malaria (Khartoum State, Ministry of Health 1996). The position is not improved by the situations indicated by Figure 2. There is also a reservoir of the disease within the community, created by other human factors, which affect its intensity in both the high- and low-incidence seasons.

**Malaria and the Socio-economic Characteristics of the Gameir Population**

The Gameir community is 47.5% people from tribes of northern Sudan, 40% people from western Sudan, and 12.5% people with a West-African origin. Though these groups can be found well distributed in Gameir, there is a concentration of people with a West-African origin in the eastern part of the community, near to the Nile. An average household size of 7.8 gave Gameir a total population, at the time of the surveys, of about 3,500, with the sample composed of 350 individuals (Sudan, Ministry of Finance and Economic Planning 1996). Figure 4 shows that there were more females than males (100 females to 87 males). Table 1 gives the occupations of heads of household. This shows that half the sample household heads were employed in a variety of lowly paid labouring jobs. Of the total, 12.5% were reported as working overseas in the Gulf States and elsewhere, making their households, in effect, female-headed households. Men working away account, in part at least, for the excess of females in the population. In such circumstances female income becomes an important additional source to many households. The survey also identified a further 36 household members in employment, of which most were in lowly paid labouring jobs, giving a figure of 20% gainfully employed.

Though Gameir is one of the “regularized” communities referred to by Hamid (Hamid 2000), it is, nevertheless, characterized by an unhealthy residential environment, due to a significant lack of services. There is no electricity. Although 62% have private latrines, these are merely holes in the ground.
A further 25% have access to such facilities but do not have sole use, while the remaining 13% have to perform on any spare piece of ground in the community. Household waste and rubbish is thrown up in piles in the street, as there is no collection service. Eighty-five percent dispose of used waters by throwing out into the street. In spite of regularization, the streets are often little more than alleyways. Houses are of mud, with on average two rooms, with two, small, unglazed windows per room. Less than half the households had a proper cooking place. Residential density averages four persons per room, and houses are closely packed together, representing considerable congestion. Furthermore, some of the migrants from the Nuba Mountains have settled in the quarried hollows already referred to, as the situation here mirrors the hill country from whence they have come. Such congestion means that it is easy for the *anopheles* mosquito to pass malaria from person to person. As 57.5% of the population have to rely on donkey carts for water supply, water is easily spilled. Sites of water spillage and poorly maintained mud houses also provide hiding places for mosquitoes throughout the year (Alredaisy 1990).

Furthermore, there is a considerable disease reservoir among migrants coming from West Africa and western Sudan. This has been cited as the reason for West-African workers in the Gezira Scheme’s being located separately in their own villages (Elhassan 1998). It may, perhaps, be significant for the persistence of malaria in Gameir into the dry season, that there is a strong tendency for people of West-African origin to be located near the Nile, at the nearest point to the irrigated lands on both sides of the river. Further, among the migrants in the survey 6% had...
TABLE 2
Average Household Food Consumption in Gameir (per day in grams)

<table>
<thead>
<tr>
<th>Sorghum</th>
<th>Bread</th>
<th>Meat</th>
<th>Sugar</th>
<th>Milk</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>170</td>
<td>360</td>
<td>100</td>
<td>185.6</td>
<td>275.6</td>
<td>260</td>
</tr>
</tbody>
</table>

Source: Field work

come from the Gezira where malaria is endemic throughout the year and where malaria is the largest single cause of death at 37% (Elhassan 1998).

In all, the survey concluded that, during the main malaria season, at least 50% of the population suffered from malaria at least once a month, with a further 20% claiming to be afflicted more frequently. The length of an attack for 85% of cases was 1 to 15 days, with 15% claiming to suffer more severely. The average number of days that inhabitants were down with malaria was eight per month. No fatalities were reported among the sample during the survey periods.

Malaria and Nutrition in Gameir

Further cultural factors in the patterns of malaria in Gameir relate to nutrition levels. The traditional diet of many migrants centres on sorghum, which is converted into a thin flexible bread (kisra), eaten with a sauce (mulah) made from vegetables and fresh or dried meat. Urbanization influences have led to the increasing use of baked wheat bread in place of kisra. Table 2 gives average figures for food consumption per day by household, based on measurement of main meals taken in the household. In Table 3 these figures are converted into consumption of protein, carbohydrates, and fats by household and per caput. If protein intake is considered, then the average figure per household is 17 grams, giving a per caput figure of 2.18 grams. If this is compared with the recommended figure for Tropical Africa of 27 grams (Latham 1979), then the figure for Gameir is incredibly low. Similar surveys in Omdurman indicate that Gameir had by far the poorest food intake levels in Greater Khartoum (Babiker and Alredaisy 1997). Nevertheless, the figures for Gameir appear to be below the level of reality. This is because there are a variety of other food sources, over and above those accounted for in Table 2, that are, in practice, consumed both within and outside the household, which could not be measured. This is particularly true of squatter communities. One of these other sources relates to food consumed away from the household by those at work. Table 4, based upon some adjustments, indicates clearly that there is an apparent relationship between nutrition levels and the length of a malarial attack. Those households with per caput consumption levels of less than 1,500 calories per day (57% of the sample) are more likely to experience longer bouts of malaria than those approaching the recommended figure of 2,500 calories. These figures are in line with research carried out in the Gezira, which recorded longer and more persistent bouts of malaria when per caput consumption fell below 1,500 calories per day (58.4% of households) (Elhassan 1998). The low and, according to the inhabitants, declining levels of nutrition in Gameir are related to lack of employment and low wages, made worse by a rapid inflation that feeds the high cost of living. The official inflation rate exceeded 100% a year for much of the 1990s (Ibrahim 2002). But these factors are clearly made worse by the large size of households and low levels of literacy. Less than a third of the adult male population had more than a little, primary-level education, and nearly one quarter were illiterate. Nearly all the adult females were without education. These
TABLE 3
Gameir: Average total intake of protein, carbohydrates and fats by household and per caput

<table>
<thead>
<tr>
<th>Protein</th>
<th>Carbohydrates</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>H'hold person</td>
<td>H'hold person</td>
<td>H'hold person</td>
</tr>
<tr>
<td>16.78</td>
<td>2.15</td>
<td>75.49</td>
</tr>
</tbody>
</table>

Source: Field work

TABLE 4
Nutrition levels and malaria in Gameir

<table>
<thead>
<tr>
<th>Calories per Person per day</th>
<th>No. of Households</th>
<th>Average length of a malaria attack</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500</td>
<td>33 (66%)</td>
<td>6 days</td>
</tr>
<tr>
<td>1 500 – 2 000</td>
<td>10 (20%)</td>
<td>5 days</td>
</tr>
<tr>
<td>&gt; 2 000</td>
<td>7 (14%)</td>
<td>4 days</td>
</tr>
</tbody>
</table>

Source: Field work

figures are not out of line with the urban areas as a whole in northern Sudan, where one-third of the male population aged over 10 years of age had received no formal education, according to the 1993 Census (Sudan, Ministry of Finance and Economic Planning 1996), and somewhat better than in rural areas, where the figure was 70%.

Discussion

Though the investigations of Babiker and Alredaisy (1997) suggest that Gameir is the poorest community in Greater Khartoum, with very low nutrition levels, it is clear that somewhat similar situations characterize, to a greater or lesser degree, many other parts of the conurbation, in light of Hamid’s (2000) estimate that 70 to 80% of its urban population live below the poverty line. The irony of the situation is that the figures emerging from food-intake surveys in the rain-land area of the White Nile, where some of these migrants originate, are better than those for Gameir (Alredaisy 1993). So far as the incidence of malaria is concerned, the inadequacies of the local physical environment provide suitable places for anopheles mosquitoes to breed even into the dry season. The mud-brick houses exacerbate the situation. Research in Greater Khartoum (el-Sayed et al. 2000) has shown that, even in localities in close proximity to irrigated areas, house structure makes a difference. Their investigations found that the number of anopheles mosquitoes per room and the bites/man/night ratio were higher in all seasons in mud-brick, as opposed to concrete or fired-brick, houses.

In Gameir this situation is exacerbated by the lack of basic services, resulting in a ruralization of an urban community in the way in which its waste products are dealt with. What may be acceptable as a way of disposal in a low-population-density, rural situation creates severe problems in the urban setting. It is clear that poverty, the ignorance due to lack of education, a poor physical environment, inadequate housing, a lack of basic services, and a rapidly rising population due to migration all contribute to the high incidence of illness in Gameir. Although some doubt has been cast in the past (De Jong-Boon 1985) as to how many of the reported malaria cases are, in fact, malaria rather than some other tropical fever, nevertheless, on the evidence presented here, the burden of illness resulting from repeated attacks of fever is borne particularly heavily by the poorest members of Omdurman society, where low nutrition makes them more susceptible. Much potential income earning time is lost through illness, and its debilitating effects which in turn, increase the level of poverty. The one saving grace of the environment is the long dry season, without which the disease problems would be much worse.

The situation described here is reminiscent of what happened in many British cities during the Industrial Revolution in the 19th century. In Swansea, for example, migrants from many rural parts of Britain and Ireland had arrived by 1850, to comprise 45% of the population (Davies 1971). Reports on the state of public health in Swansea after a cholera outbreak were very unflattering. About a typical street in a slum area, Clark,

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the inspector, wrote “Here are 10 houses and no privy. There is neither privy nor drain of any sort in the lane. The dirty water is thrown at the back of the houses, where it remains stagnant” (Clark 1849). Though climate did not help the disease factor here, the annual rate of population increase, at about 3%, was much lower than is the case for Greater Khartoum. Currently, the population of Greater Khartoum is expanding at a rate that, if continued, will lead to a doubling of the present 3 million by 2015 (Davies 2001). The British solution was for central government to take a strong line through a series of Public Health Acts, from 1848 on, which led to a significant improvement in the health situation during the second half of the 19th century. Another aspect of this development was the emergence of a self-help approach to the solution of society’s difficulties.

The incidence of malaria as a cause of sickness and death in Greater Khartoum cries out for a remedial action. The Greater Khartoum administration faces the classic dilemma that improving the situation in the squatter areas by building houses itself and providing prophylactic measures against malaria is unlikely to solve the problem. Such a policy simply makes the town even more attractive to migrants, who will bring their malarial pests with them. The necessity for government policy, if it is serious about reducing urban growth, is to make rural existence more attractive by greater investment in rural areas, especially in terms of health care and education facilities. This seems a forlorn hope at present, as central government has other pressing commitments. Civil war, periodic drought, and a complete lack of basic services to the countryside are continuing to lead to urban migration. Squatter settlements like Gameir provide an essential locality, where low-income workers, by self-help, can live in a city like Greater Khartoum, where land prices and the cost of building houses are very high.

Nevertheless, there are things that can be done to improve life in the squatter areas. At present “regularization” is little more than a final admission that this area is a part of the city. Quicker acceptance of the fact of a settlement’s existence, with a proper attempt to delineate house plots in regular wide streets before migrants arrive, would be a step in the right direction. People can then believe that any investment they make in housing is secure. This would seem to be a better way to operate than a policy, used on occasion, of using bulldozers to destroy “illegal” settlements, together with a program to transport new arrivals forcibly back from whence they came. This simply does not solve the migration problem, as desperation merely brings them back again, in no time, to the city. Insistence that each self-built house must have its own private latrine, no matter how primitive, and encouragement of the use of masas (a hole dug in the ground, filled with small pieces of red brick and the like, to act as a filter for the discharge of sanitary waters) would also help reduce the incidence of disease. A simple education program, explaining easy ways by which breeding sites for mosquitoes can be minimized, should be introduced. For example, a self-help program involving the elimination of puddles of water could be instituted. The significance of assisted self-help activities in such squatter communities in Greater Khartoum should not be underestimated, as shown by relief activities after the 1998 floods. Provision to such peripheral areas of a potable water supply, proper health services, and cheap public transport to enable dwellers to reach places of employment would all lead to an improvement in nutritional and health levels.

The Government of the Sudan is not unaware of the problem of urban poverty and the importance of the informal sector. The National Comprehensive Strategy, 1992–2002 contains measures to relieve urban poverty, through support for the “Home Based Enterprises” program established jointly by the Ministries of Social Planning and Industry in 1995. However, so far as Gameir is concerned, the program has had no
apparent impact. The general shortcomings of the policy have been summarized by Ibrahim (Ibrahim 2002).

At present, the pressures on Greater Khartoum and other urban areas in the Sudan from urban growth are not lessening. Under these circumstances the future of settlements such as Gameir itself must remain uncertain. Gameir is likely to come under pressure from expanding first- and second-class residential areas and will be upgraded. This will cause the removal of the present occupants, with their problems and difficulties, to another site, peripheral to the city of Omdurman, where the whole process will be repeated all over again.

In Gameir the physical environment has provided suitable conditions for malaria to become established. The people themselves—through poverty, lack of basic hygiene education, and cultural traditions—have contributed to the present crisis. This situation is replicated in many other parts of Greater Khartoum and is a condition typical of many other cities in Africa and the developing world where rapid urban population increase has taken place. Simple, inexpensive remedial processes can alleviate the situation in these squatter settlements. The situation has some similarities with the slums created by the Industrial Revolution in Britain. Such slums and modern squatter settlements become a vital and inevitable part of the urban structure.

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