PART II Chapter 4

TRANSMISSION RISK THROUGH WATER CONTACT

4.1 Water contact studies for the assessment of schistosomiasis infection risks in an irrigation scheme in Cameroon

R. Slootweg, M. Kooyman, P. de Koning & M. van Schooten (1993). *Irrigation and Drainage Systems* **7**: 113-130.

The construction in 1982 of the Lagdo dam in the Benue valley of northern Cameroon resulted in important hydrological changes on both sides of the dam. The pattern of water-related behaviour of the people changed as a result and new risks of water-borne diseases arose. Both vesical (*Schistosoma haematobium*) and intestinal schistosomiasis (*S. mansoni*) were present in certain foci of the Benue valley prior to the construction of the dam, and the rapid development of irrigated agriculture is likely to favour the establishment of permanent populations of snail intermediate hosts of schistosomiasis. In 1986, four years after the construction of the dam but before the first irrigation schemes became operational, the prevalence of *S. haematobium* varied from 7 - 43%. In most villages lower prevalences of *S. mansoni* were recorded: between 4 and 29% (Robert et al., 1989). These prevalences indicated that transmission of both species took place, and that transmission was rather focal.

Since 1987, a 200 ha irrigation scheme is operational in the immediate proximity of the village of Gounougou, situated on the right bank of the Benue near the Lagdo dam. In 1986 the prevalences of *S. haematobium* and *S. mansoni* were 21% and 7% respectively (Robert et al., 1989). A recent survey (december 1992) however, showed that prevalence of vesical schistosomiasis had already increased to 43% (Vroeg, unpubl. data), indicating that transmission has intensified since the start of irrigation. A number of different potential transmission sites could be identified (Figure 13): the Lagdo man-made lake, the irrigation canals receiving water from the lake through the inlet at the East Dike, the rice fields, the drainage canals, the marshy depression between the river and the village that is used for discharge of drainage water, the Benue river, and some isolated foci in which permanent or temporary water is to be found. Before the conctruction of the dam and irrigation scheme, only the depression, the river and the seasonal pools used to be potential transmission sites in the rainy season. With the exception of the seasonal pools, all other sites are nowadays permanently filled with water, and may constitute a suitable habitat for snail intermediate hosts of schistosomiasis.

Snail surveys (Slootweg et al., in press) show that *Biomphalaria pfeifferi* (the intermediate host of *S. mansoni*) is very rare in the area and has only been found on rare occasions in some sites along the shores of the lake and river. *Bulinus* species, some of which can serve as intermediate hosts of *S. haematobium*, have been found in the rice fields, in the field and drainage canals of the irrigation system and in the marshy depression. Although monthly surveys of snail populations as a routine have been carried out for 36 months, infected snails, however, have never been found. All snails were tested for infection with schistosome parasites. Indeed it is a characteristic feature that very low densities of snails, and in particular infected snails, are able to result in considerable infection rates in man. Transmission can be limited to a few spots during a short period of time.

In order to minimize the risk of an important increase of schistosome transmission, different options for prevention have been considered. Although snail control and chemotherapeutic interventions might be required in the future, these measures do not seem to be appropriate at the present moment with few snails to be found and relatively low numbers of infected people with light infections. Since schistosomiasis transmission is dependent of contaminating and exposure activities, a reduction of the risk of exposure (contacts with infected water) of the villagers would seem the first measure to be considered. Therefore, the pattern of exposure due to a variety of different occupational, domestic and recreational activities is analysed in the present study. This study is part of a larger programme on the integrated control of schistosomiasis in the Benue valley, which started with a baseline study on snail dynamics, water contact behaviour and a parasitological survey of the region (Slootweg, 1991).

Secondly, we try to find reasons why people use open water reservoirs. The supply of safe drinking water from a borehole well is compared to other available sources. In irrigation schemes the availability of safe water highly influences schistosomiasis transmission. In the Sudan, Oomen et al. (1988; annex 4) found a significant inverse relation between the amount of safe water available and the prevalence of schistosomiasis. Prevalence decreases with increasing amount of water from borehole wells. The decreasing effect stops when more than 70 l/day/person is available. The prevalence decreased from 80% in villages without water supply to 40% in vilages with more than 70

l/day/person. A prevalence of 40% is considered a minimum level in this highly endemic area . These data suggest that a large part of the infections are caused by nonoccupational watercontacts (domestic, recreational and occasional water contacts) that can be prevented.

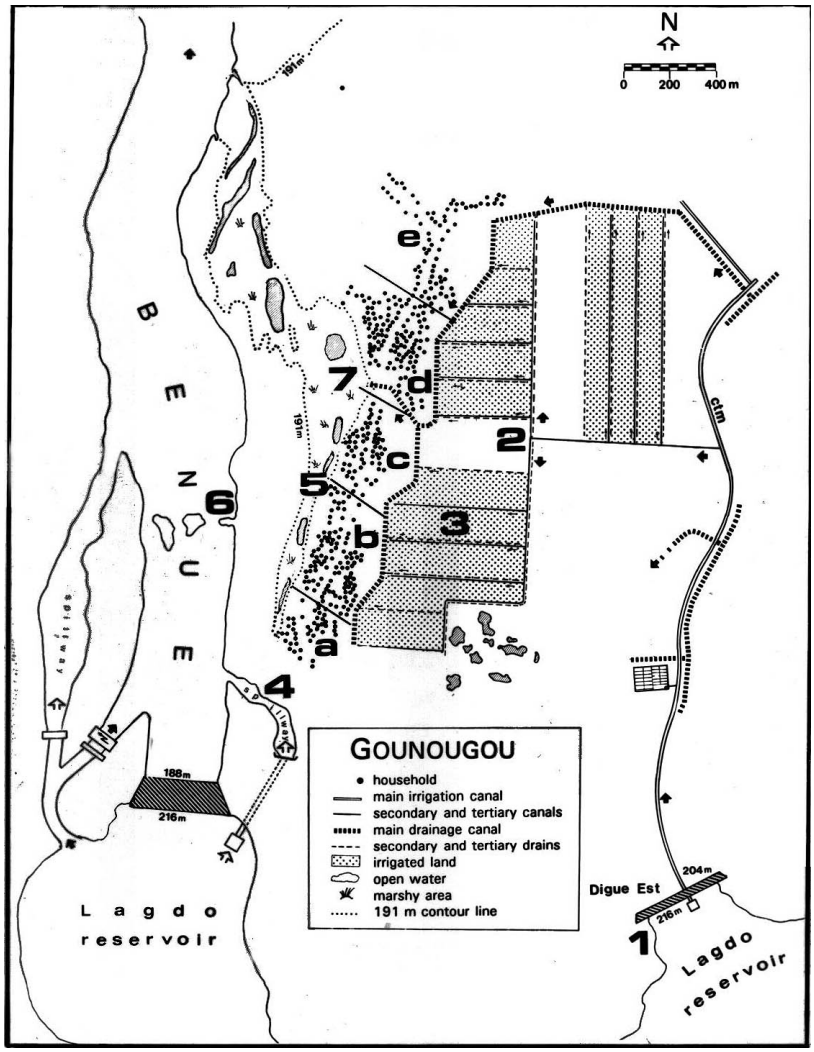

Fig. 13: Gounougou and surroundings before implementation of reconstruction measures (viz. Slootweg and Keyzer, 1993). Indicated are village quarters (a - e) and the seven observation sites. (1) East dike; at 1500m from the village, the main access to the artificial reservoir of Lagdo. Fishermen and traders gather especially in the morning. (2) Irrigation canal (secondary); through a subterranean supply-pipe the irrigation water enters the secondary canals. The first 30m of the two secondary canals are lined. Officially it is prohibited to use the canals for other purposes than irrigation. (3) Rice fields; rice is grown in a 6 months rotation, using high yielding varieties, with production levels reaching 5 tons of paddy/harvest/ha. Fertilizers (NPK and Ureum) are used intensively, pesticides not (yet?). (4) The spillway of the Lagdo dam at the Gounougou side is used for spilling only several weeks a year. The rest of the year it is a dead branch of the Benue. (5) Ford; villagers wanting to visit their lands or going to the washing site at the Benue (6) use this threshold in the depression. The stretch that has to be waded varies between 2m in May and 20m in September. Maximum depth is 70cm. (6) Benue river; at 300m from the village this site is appreciated by the villagers because of its sandy shores and the considerable flow of water. (7) Depression zone; this depression used to be a temporary floodplain pool. Nowadays it is used as the main drain for the irrigation system, resulting in permanent inundation.

Finally, we will describe measures to minimize schistosomiasis transmission, taking into account the very different nature of the observed activities.

The water contact study was performed in and around Gounougou, formerly a village of floodplain fishermen of about 15 families, but nowadays flooded with immigrants from the Extreme Northern Province of Cameroon. The village consists of five quarters (Figure 13), the market quarter (a), Gounougou s.s. (b), Bantaré (c), Lameré (d), crossroads Riao (e) and has 451 households (2234 inhabitants) of multi-ethnic origin, with a large muslim minority (126 households). The main occupations are agriculture (354 household heads) and fishing (34). Paid occupations are held by 35 household heads, working on the hydroelectric station near the Lagdo dam and in government services (teachers, health and extension workers, etc.). The irrigated rice fields of Gounougou are distributed among local inhabitants in 0,25 ha plots. The typical Gounougou family further cultivates maize, cotton, sorgho, groundnuts and cowpeas.

The village possesses a conduit-pipe water supply, a remainder from the period of dam construction. The reliability of this supply is low; often the pipe is dry for several days or has a marginal flow, because of technical difficulties at the pumping station or excessive demand by the upstream users (hydroelectric station and housing area of its personnel). The villagers have agreed not to wash or bath near the waterpoints of the supply pipe in order to avoid long waiting and creation of muddy pools in the middle of the village. Water has to be carried to the homes. Because of these inconveniences many people make use of open water bodies for domestic purposes. No borehole wells are available in the village.

It is impossible to predict to what levels of prevalence schistosomiasis will increase in the future. The scheme is still relavtively new and populations of snails are just beginning to invade the irrigation and drainage system (Figure 14). Slootweg et al. (in press) indicate that the succession of species resambles similar schemes which have been studied in the past. The establishment of more intermediate host species can be expected within several years. For this reason, in the present study we will speak of schistosomiasis transmission risk due to water contact, without considering the actual presence or absence of snail intermediate hosts.

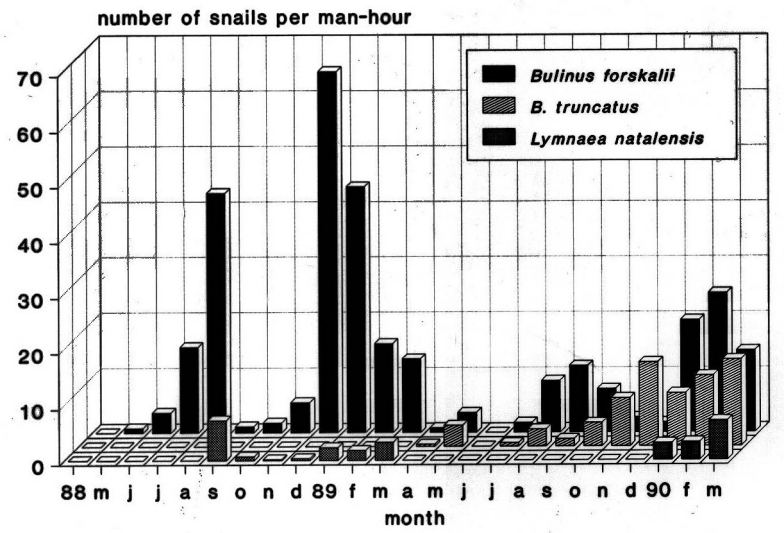

Fig. 14: Development of three frequently encountered snail species at 12 sampling sites in the Gounougou watershed. The colonizing species *B. forskalii* is gradually being replaced by *B. truncatus*, an important intermediate host of vesical schistosomiasis. *L. natalensis* is a snail intermediate host of bloodflukes, a parasite common to cattle.

Methods

Collection of data

After an inventory of the village and all available water reservoirs in the immediate vicinity of Gounougou, seven sites were chosen for the study (Figure 13). All different types of surface water regularly used by the villagers are covered by this choice. Between September 1989 and March 1990, the seven sites were observed seven times using a schedule rotating among the different days of the week. At the end every site has been observed once on every day of the week. The number of observations days thus totals 49 (7 months x 7 sites). Seasonal influence has been eliminated because the observation period covers the rainy season (August and September 1989), the cool dry season (November '89 - January '90) and the hot dry season (February and March 1990). The design of this observation schedule implies that only totalled data on the whole observation period can be interpreted; no comparisons can be made between different months or between different days of the week (cf. Dalton, 1976; Jordan, 1985 ch.3 & 7).

Observation days lasted from 06.00 to 18.00 hours, with two observers (parasitology students) working in three-hour shifts. For each individual water contact the following data were collected: age, sex, body surface exposed to water, type of activity, starting and ending time of an activity (Klump & Webbe, 1987; Kloos et al., 1990). The duration was calculated for each activity; if the same person started with another activity, this was registered as a new water contact. An important phenomenon is the periodicity in activity of schistosome cercariae during the day. About 90% of the active cercariae are usually found between 11.00h and 15.00h (Pitchford et al., 1969; Polderman, 1975; Mouahid et al., 1991). The risk of infection therefore varies considerably during the day, examplified by a study from Sudan where a shift in working hours of canal cleaners to the early morning reduced the prevalence in this highly exposed group (Tameim et al., 1985). So not only duration of the activity but also the moment of the day is considered to be of importance.

Additionally, on a day of uninterrupted water supply through the conduit-pipe, the flow of water was measured at all taps. These data were compared with the number of people depending on these taps per village quarter. The calculation of the amount of water needed per quarter is based on the amount given above of 70 litres/person/day. This is the amount of safe water that is required to minimize the risk of schistosomiasis transmission in the comparable climatic zone of Sudan.

Elaboration of data

The protocol forms were processed with a spreadsheet computer programme. The proportion of body surface area exposed to water was calculated using burn charts after Kloos & Lemma (1980) and Jordan (1985): both feet and ankles (7%); to knees (19%); to thighs (39%); both hands and wrists (6%); to elbows (12%); both entire arms (20%); to neck (88%); entire body (100%).

The activities were classified into 9 groups: bathing, playing (and swimming), washing (clothes and dishes), agriculture (on irrigated rice-fields), fishing with boat, fishing without boat, fetching water, wading, other activities (drinking, cleaning fish, etc.).

Several parameters can be used to estimate the risk of infection with schistosome parasites. In some studies frequency and duration of contact were used (Tayo, Pugh & Bradley, 1980; Husting 1983; Chandiwana, 1987), showing a positive correlation between schistosomiasis prevalence and the product of frequency and duration of contact. Kloos & Lemma (1980) and Kvalsvig & Schutte (1986) proved that the exposure index calculated as the product of frequency, duration and proportion of body surface, was a better predictor of infection. The parameters used in this study follow the authors mentioned above: (a) **frequency**, defined as the absolute number of contacts; (b) **duration**, i.e. the time involved in water contact for one activity (min); (c) **body surface**, i.e. the proportion (%) of total body surface in contact with water, and (d) **exposure index**, i.e. duration x body surface x relative frequency (% of total number of contacts).

Results

Activities and sites that contribute to schistosomiasis infection risk.

Over the eight month period, 3,916 water contacts were observed in 49 days, i.e. on average 80 observed water contacts per day per site. The activities performed by the villagers show very distinct differences in their basic parameters frequency, duration and percentage immersion (Figure 15). The most frequent activity is wading, followed by bathing and washing, together constituting more than 50% of the number of water contacts. Activities of the longest duration are agriculture and fishing without boat. On average people work for one and a half hours continuously on the rice fields; especially the transplantation of seedlings involves prolonged water contact on the fields. Fishing without boat is performed by women entering the water and chasing the fish with baskets; male fishermen are seen with spears, gillnets and fish-traps. On average a person stays for more than one hour in the water. The body surface area in contact with water is highest for (in descending order) bathing, playing and fishing without boat. This is of course to be expected because the other activities only concern contacts with arms and/or legs.

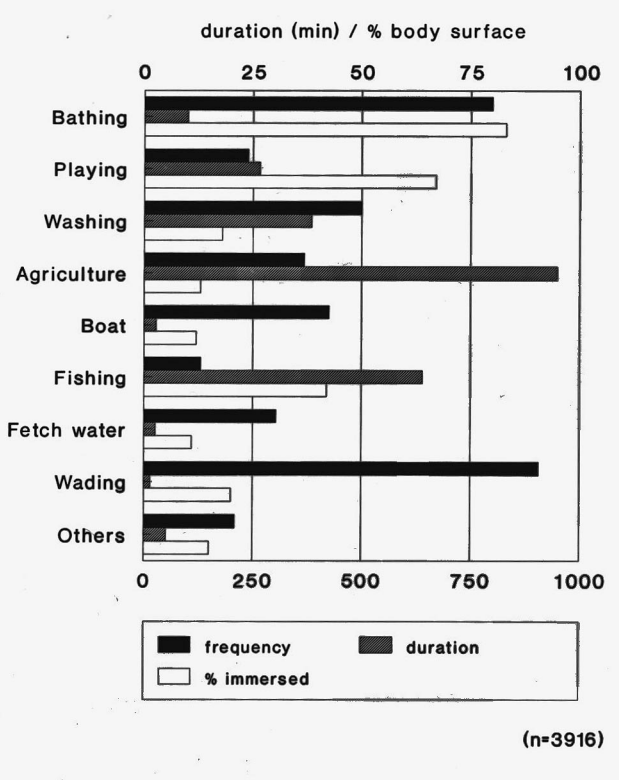

Fig. 15: Total frequency, average duration and average body contact surface per activity, as observed on seven sites during seven months of water-contact study.

The exposure index is a combined measure helping to compare different activities and identify those with high infection risks (Figure 16). Bathing has the highest exposure index, resulting from a very high frequency and over 80% immersion of the body (Figure 15). Fishing without boat, playing, work on the rice fields and washing all have moderate to high exposure indices. The other activities can almost be neglected in a risk analysis (fishing with boat, fetching water, wading and other activities). The exposure index calculated per site gives an impression of the relative importance of water contacts on the different sites (Figure 16). The east dike and the ford have a very low exposure index; the depression zone near the village has by far the highest exposure index, while the other sites take an intermediate position.

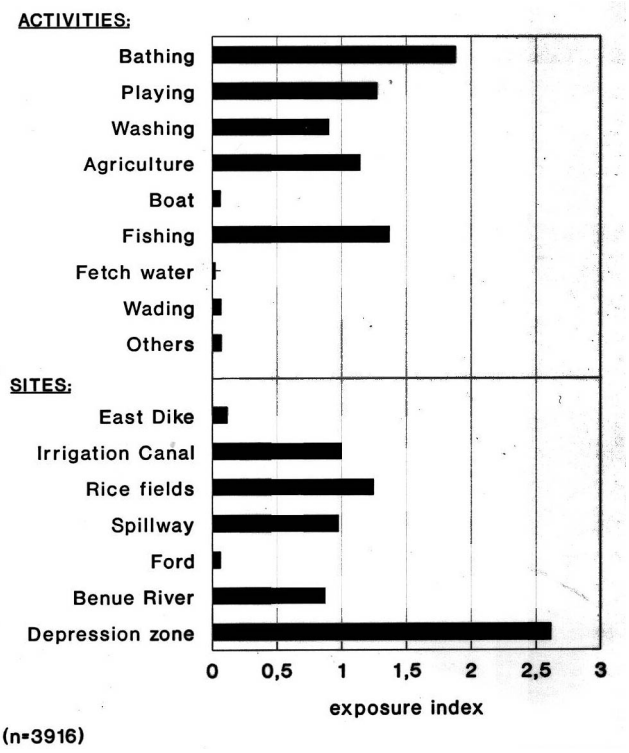

Fig. 16: Exposure index (duration x body surface area x relative frequency) per activity and per site.

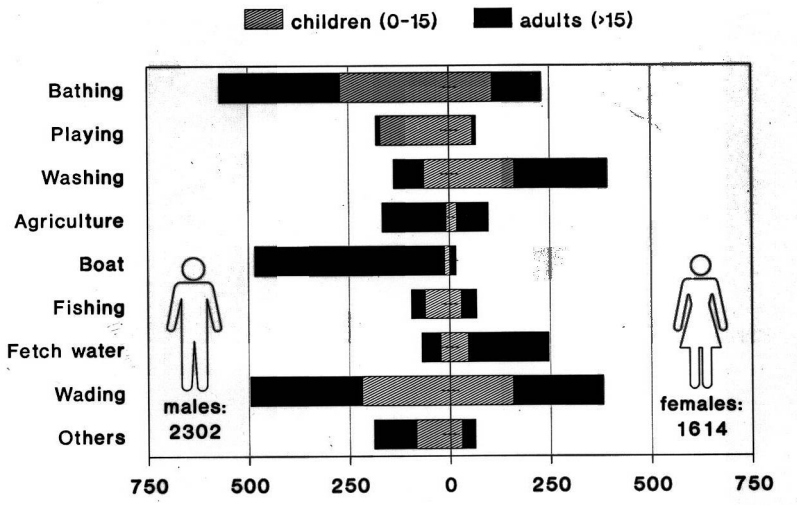

Fig. 17: Numbers of observed water-contacts per activity, differentiated to sexe and age class (children vs. adults).

Differences between the sexes

The differences between the sexes show the classical distribution of tasks (Figure 17). Women are more confined to the compounds performing domestic activities; men are more active outside the households resulting in a higher contact frequency of men (2302 vs. 1614 for women). Women are more often involved in washing and fetching water, i.e. domestic activities. Girls under 15 years of age are also active in domestic tasks (washing), while boys under 15 are more frequently observed playing

and bathing, i.e. recreational activities. Fishing with boat is strictly a male activity, while fishing without boat is performed in comparable numbers by males and females, but some additional remarks have to be made. The techniques applied by men and women are entirely different. Men only have water contact when placing their gill-nets, fish traps or when chasing large fish with spear or arrows while women enter the water with baskets and chase the fish to a corner of the pool where the fish are trapped in the baskets and caught by hand. The average duration of the activity is 137.5 min with a body contact surface of 41%; the average duration for males fishing without boat is 19.2 min with 20% contact surface. Women contribute disproportionally to the elevated exposure index for fishing without boat (Figure 15). The overall exposure indices are similar for men and women (3.8 for men vs. 3.6 for women) although some differences exist in total number of contacts (more men), average body surface (higher for men) and duration of activity (longer for women).

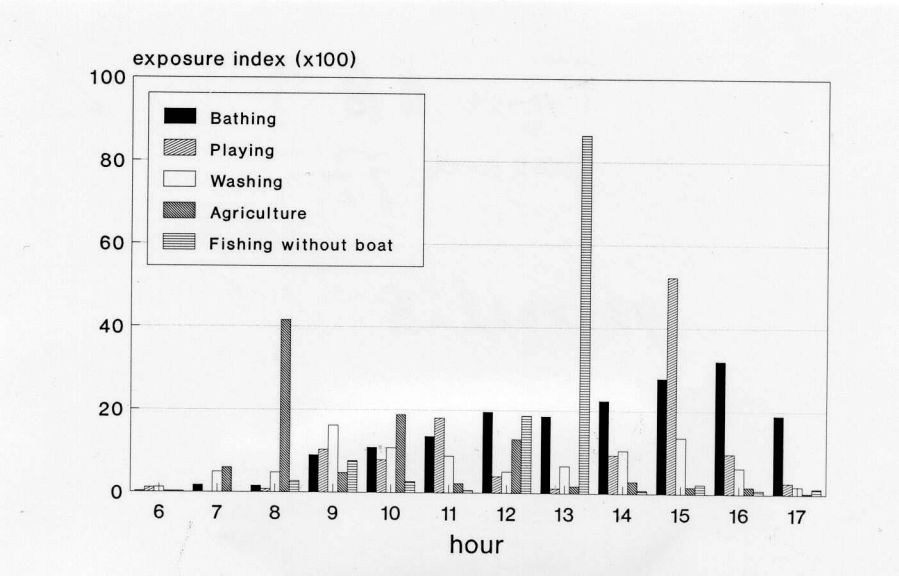

Fig. 18: Exposure index per hour of five high-risk activities throughout the day.

Water contacts in the cause of the day

If we look with some detail into the different activities performed throughout the day (Figure 18) a complicated picture arises. The five activities contributing most to the overall exposure index show a different pattern during the day. Bathing increases gradually during the day towards 17.00 h. Most playing activity is seen between 11-12.00 h and 15-16.00 hours, after school time. Washing is done throughout the day with peaks between 9-10.00h and 15-16.00 h. Agriculture is a morning activity, with a large group starting at 8.00 h. Because the starting moment is represented in the figure it looks as if the activity doesn't continue in the next hours but one must take into consideration the long duration of the activity, on average taking over 90 minutes (Figure 15). The same applies to fishing without boat, being a very irregular and sporadic activity, but nevertheless with a very high exposure in the afternoon after 13.00 hours (average duration of more than 60 minutes).

Taking into account the increased activity of schistosomiasis cercariae between 11-15.00h, all activities can be considered contributing to the transmission risk, although fishing without boat has the highest exposure risk to cercariae.

Water supply and village water needs

The water supply as measured on December 9th, 1989 is compared to the hypothetical water demand of 70 l/person/day, as explained in the introduction (table 3). From these data it is clear that only Gounougou s.s. has enough water at its disposal (if the water supply is not interrupted!). In about six hours the quarter receives the needed amount of water. For the other quarters 12 hours (daylight)

are not sufficient to collect the required amount of water. The crossroads quarter has an acute shortage of water. The way people deal with this shortage is shown by a detailed look on the activities per site (Figure 19; the ford is omitted as a source of water since 98% of the registered activity concerns wading). A striking feature is the contact pattern in the irrigation canal which is almost exclusively used for domestic and recreational purposes by large numbers of persons, in spite of its distance to the village. Obviously the clear and running water coming from the lake is highly appreciated. The spillway, Benue river and the depression zone are used for domestic, occupational and recreational purposes, and even drinking water is often fetched in the depression zone, Benue river and the irrigation canal. Water contact at the East dike and on the rice fields principally is of occupational origin (fishing by boat and agriculture). In the first three columns of table 4 the results are summarized. The depression zone, already characterized by the highest exposure index, is considered a high risk area for all three classes of activities.

Table 3: Water supply and hypothetical water demand per quarter in Gounougou

	Quarter (waterpoints)	House-holds	Inhabit-ants[1]	Demand[2] (l/day)	Supply[3] (l/h)	Time[4] (hours)
A	Market (1)	45	227	15,890	780	20.4
B	Gounougou (3)	120	521	36,470	6,228	5.9
C	Bantaré (2)	67	320	22,400	1,170	19.1
D	Lameré (2)	126	699	48,930	2,064	23.7
E	Crossroads (2)	91	484	33,880	306	110.7
	Total	449	2,251	157,570	10,548	14.9

Number of water points per quarters are given between parentheses.

[1]: Total number of inhabitants per quarter (census december 1988).

[2]: Hypothetical water demand per quarter: number of inhabitants x 70 l/day.

[3]: Actual water supply in liter per hour.

[4]: Time needed to provide the necessary amount of water.

Table 4: Summary of schistosomiasis infection risks and possible mitigating measures.

Activity class	High risk activty	Performed at sites	Appropriate control measures	Practical implications
Domestic	Washing Bathing	2: irr. canal 4: spillway 6: Benue 7: depression	Cercariae-free water supply	Washing and bathing facilities.
Occupational	Fishing without boat Irrigated agricul-ture	3: rice fields 4: spillway 6: Benue 7: depression	Destruction of vector populations. Avoiding cercariae.	Water management and habitat alterations. Molluscicide of snail breeding sites. (Shift in working hours)
Recreation	Playing/ -swimming	2: irr. canal 7: depression	Cercariae-free water reservoirs.	Choice of safe sites through snail sampling. School education.

Discussion

High risk activities and sites The observed activities with highest exposure indices are occupational (agriculture and fishing), domestic (bathing and washing) and recreational (playing). The most frequent activity, wading, does not count at all in the exposure index because of its short duration and minor contact surface. This does nor imply that wading can be completely forgotten in a risk analysis, because a water contact study is a tool in estimating the relative importance of different activities, but data on snail populations and snail infection levels are necessary to assess the actual infection risk.

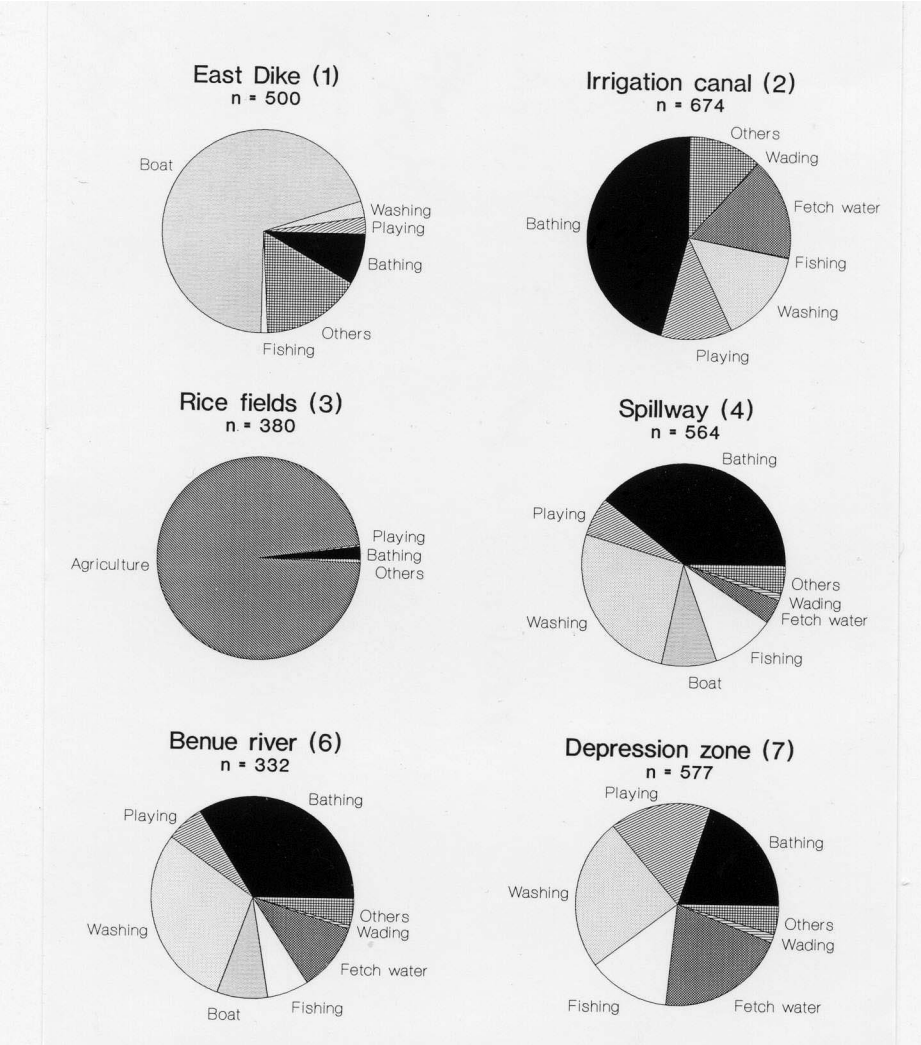

Fig. 19: Relative frequency of activities observed per site (number of observations indicated per site).

All high exposure activities described above are performed in the high risk period between 11-15.00 hours. A special remark can be made concerning the fishing activity in the depression zone (7). This activity has only been registered during one day in the observation period. Nevertheless the exposure index is higher than the index of daily activities like bathing and washing. This illustrates the importance to consider all possible water contacts throughout the year. The epidemiology of schistosomiasis is complex and transmission can depend on these incidental contacts.

The introduction of irrigated agriculture has directly and indirectly created new risks of transmission. Directly, a new type of occupational exposure to potentially infected water was

introduced with the work on the irrigated fields, which was found to be a high-risk activity. Indirectly, the creation of the marshy area very near the village by leading the drainage water of the irrigation scheme through the depression has considerably increased the health risks for the local population.

Household use of open water

The household water supply is clearly not sufficient, and the use of open and untreated water constitutes a major health risk for the population. Washing and bathing is commonly done in one of the available permanent reservoirs, with a preference for those with running water (river (6) and irrigation canal (2)). A glance at the map (Figure 13) shows that people from the Bantaré (c), Lameré (d) and crossroads (e) quarters use the depression (7) for domestic purposes, the spillway (4) is used by people from the market quarter (a), while the river bank (6) and the secondary irrigation (2) canal are used by all villagers. Even drinking water is often collected at these sites. The measurement of the piped water supply gives supportive evidence that the demand surpasses the supply. It must be noted that due to the irrigation scheme and the Lagdo dam, só much open water is available in the direct vicinity of the village, that people who have to wait in line for drinking water might quickly be inclined to use another source of water for bathing or washing. Even a sufficient amount of safe water will probably not stop people from using other readily available sources, so additional measures remain a necessity.

Measures to be taken

Evidently any attempt to reduce the risk of transmission should take into account the very different nature of the activities. While domestic and recreational activities can be transferred to other and safer places, occupational exposure requires an entirely different approach. In the next section we only discuss options considered realistic in the African context, which implies that investments must be low and manageable by local people/authorities. In table 4 the results of the study and the measures to be taken are summarized, classified according to the nature of the activity:

Exposure through domestic activities. For domestic needs, washing facilities should be constructed. The availability of relatively clean irrigation water throughout the year can be used to satisfy the inhabitant's domestic water needs. These washing facilities should fulfil a number of parasitological (A) and public requirements (B):

A1: Water must come from a mollusc-free reservoir.
A2: No human or other polluting activities are allowed upstream from the washing facility.
A3 The excess water from the facility must be drained directly, without reusing the water for other purposes. The chance this water is contaminated by eggs of parasites is considerable.
A4: The area around the washing facility should be kept as dry as possible to avoid contamination of the mud (hookworms larvae live in muddy ground).
A5: The ideal washing site should also have a safe playing area for children accompanying their mothers.

Interviews with women during the observation period also led to several public requirements:

B1: If enough space is available no problems concerning ethnic relation or sex are expected in Gounougou. A washing site per quarter is preferred.
B2: The flow of water must be sufficient to rinse clothes without difficulty.
B3: Separate places should be made for bathing, and washing dishes and clothes.
B4: There must be a sandy field to dry clothes; furthermore shade trees are needed to protect little children.

These wishes expressed by women correspond to those described by Husting (1983) for Bantu women in Zimbabwe. The provision of safe water and sanitary facilities has been given high priority by many authors, not only in relation to schistosomiasis control. In irrigation schemes this aspect of water management has often been neglected. Introduction of irrigation often increases the revenues of the farmers, but can also create major health hazards. Therefore it is a pity that a resource as important as water is not used more effectively by also using it for improvement of the sanitary conditions in and around irrigation systems.

Occupational exposure. Water contacts through occupational activities can hardly be reduced. Fishermen and rice growers are obliged to enter the water. Rubber boots for people working on rice fields will reduce water contact but these are expensive and often not appreciated. The solution must be sought in the control of snail populations by environmental and water management, and/or molluscicide. Regular sampling of the irrigation scheme has revealed the presence of intermediate hosts in field and drainage canals. Regular cleaning of these canals can significantly reduce the number of snails. Even if snail populations cannot be eliminated entirely, transmission can be substantially reduced by regular destruction of the populations. After such an interruption in the development of a snail population, the snails need time to reestablish themselves and, more important, to become infective again. This can take several months. Persisting snail populations can be eradicated by focal molluscicide, although the high price and toxic effects on aquatic animals (including fish) pleads for a restrained use of these chemicals. Many natural plant molluscicides are known, but no commercial product is available yet. In general the mass production of these products is difficult (Mott, 1987). A shift in working hours is not considered feasible, given the amount of labour required in a short period of time during replanting and harvesting. People work entire days during these periods.

Avoiding water contact is even more difficult for fishermen. For them the biggest problem in Gounougou was created by the draining of excess irrigation water into the depression zone (7), especially putting the fishing women at risk. By environmental and water management this swampy zone has later been restructured for small scale agricultural use, and snail populations in the vicinity of the village were eradicated (Slootweg & Keyzer, 1993). At the East dike most fishermen use boats, which does not entail intense water contact.

Exposure through recreational activities. Recreational activities are very hard to control, especially when they involve children. Provision of safe washing facilities will help to reduce the infection risk for young children. For older children safe swimming places have to be indicated. Results of the snail sampling programme show that the Benue river is a safe place because snails cannot survive the current this close to the hydroelectric station, but any change in water regime or in the environment can result in the development of snail population so regular screening by local health or other authorities is desirable. The school can play an important role in educating the children on behaviour and health risks, and maybe even in monitoring of snail populations.

Conclusions

The water contact study as described above has revealed relevant information on the use of water and the associated risk of schistosomiasis transmission in the newly constructed irrigation scheme of Gounougou. The data of this study were analysed in a non-exhaustive manner in order to show general patterns in water contact and water use. For practical use like the implementation of control measures, more detailed questions can also be answered by further analysing the data per site or per activity.

The summary in table 4 shows that irrigation is only partly responsible for the schistosomiasis problem, as high risk activities are also performed outside of the irrigation scheme. However, it is obvious that work on irrigated fields brings about prolonged water contact and that the drainage water from the scheme has created a high risk area very near the village. To our opinion irrigation development can also have beneficial effects on the public health situation, if the availability of water is fully exploited for sanitation of the environment and for community water supply. The popularity of the secondary canal among the villagers for washing and bathing is indicative that this water should not only be used for irrigation but also for laundry and bathing facilities. With relatively simple means such facilities can be provided during the construction phase of a scheme. Furthermore a better management of the drainage system can reduce the numbers of organisms responsible for transmission of diseases (snails as well as mosquitoes); in Gounougou the drainage system has been reconstructed and the results of this intervention are encouraging (Slootweg & Keyzer; op. cit.)

All measures described above are aimed at reducing the risk of infection, and can never guarantee absolute safety. In case an infected person gets complaints, it is desirable that he or she can find medical treatment without too many difficulty at a local health centre. Preliminary data from the Cameroon project suggest that people with complaints after schistosomiasis infection by far produce the largest numbers of eggs (Slootweg, 1991). By treating these people, the health centre plays an important role in controlling the disease. Therefore the role of the primary health care facilities will always be of crucial importance to the control of schistosomiasis. The availability of safe single dose drugs has much improved the effectiveness of health care. The measures to prevent water contacts and to reduce infection risks described above, will keep the rate of reinfection at a low level and together with an effective health care facility the schistosomiasis problem can be kept under control.

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