Report

Namibia: Mapping of Schistosomiasis and Soil-Transmitted Helminths
Phase 1 - Caprivi and Kavango Regions

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Cover photograph taken by José C. Sousa-Figueiredo at Namyindu Primary School, Kabe, Caprivi

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1. ACRONYMS

LATH	Liverpool Associates in Tropical Health
LSTM	Liverpool School of Tropical Medicine
MDA	Mass Drug Administration
MoHSS	Ministry of Health and Social Services
NTD	Neglected Tropical Diseases
STH	Soil-Transmitted Helminths
WHO	World Health Organisation

2. EXECUTIVE SUMMARY

Schistosomiasis and Soil-Transmitted Helminth (STH) infections, four of the most common Neglected Tropical Diseases (NTDs) in sub-Saharan Africa, are thought to be endemic in Namibia. With the availability of deworming drugs, the Government of Namibia is now ready to start Mass Drug Administration (MDA) to treat school-age children with these infections. To better target this MDA intervention, an updated disease map is crucial for ensuring future cost-effectiveness. Phase 1 of mapping using rapid and microscopy-based protocols was conducted in November 2012. This included 5918 students from 99 schools, representing a school sampling coverage of 1:4 schools in total. All sampled children were treated on site with praziquantel and albendazole and no adverse reactions were encountered. The distribution of urogenital and intestinal schistosomiasis in Caprivi and Kavango regions was found to be highly focalized while STH infections were ubiquitous in Kavango but largely absent in Caprivi. The high quality disease map, with increased sampling density, will allow the government to better plan chemotherapy strategies at the regional or constituency level, maximizing efficiency and minimizing drug wastage.

3. BACKGROUND

Schistosomiasis and soil-transmitted helminth (STH) infections are believed to be endemic in Namibia (http://www.thiswormyworld.org/maps/namibia). The World Health Organization (WHO) estimates that all Namibian children are at risk for STH (i.e. 750,000) and that 275,000 children are at risk for schistosomiasis. However, these estimates are based on very few epidemiological surveys and not based on accurate and systematically gathered data. Due to this lack of up-to-date information, a mapping initiative was initiated in 2012. The protocol for the mapping of schistosomiasis and STHs in Namibia calls for a phased approach. Figure 1 below shows these phases geographically, with phase 1 covering the Caprivi and Kavango regions.

Figure 1: Map of Namibia's governmental regions, mapping phases and hydrographic details

The mapping protocol has the following primary objectives:

1. To understand levels of schistosomiasis and STH in Namibian school-aged children
2. To identify the type(s) of schistosomiasis (intestinal or urogenital) endemic in Namibia
3. To establish a strategic plan for mass drug administration of albendazole and praziquantel at the school-level
4. To establish the need for treatment of preschool-aged children

4. FIELDWORK

Fieldwork took place between the 15th of November and 1st of December 2012. Ethical approval was granted by both LSTM and MoHSS. Prior to departure to the field, the team from LATH (José Figueredo, Moses Arinaitwe and Prof. Russell Stothard) held a training workshop on schistosomiasis and STH, the morbidity caused by these diseases, their diagnosis, treatment and control. Participants included four Ministry of Health and Social Services (MoHSS) staff from central level and twelve regional staff, along with fifteen graduates from the Polytechnic of Namibia. In Windhoek, meetings were held with representatives from the World Health Organization (WHO) and several departments of the MoHSS. All sampled children were provided with praziquantel and albendazole by members of the mapping team.

4.1. SET UP IN THE FIELD
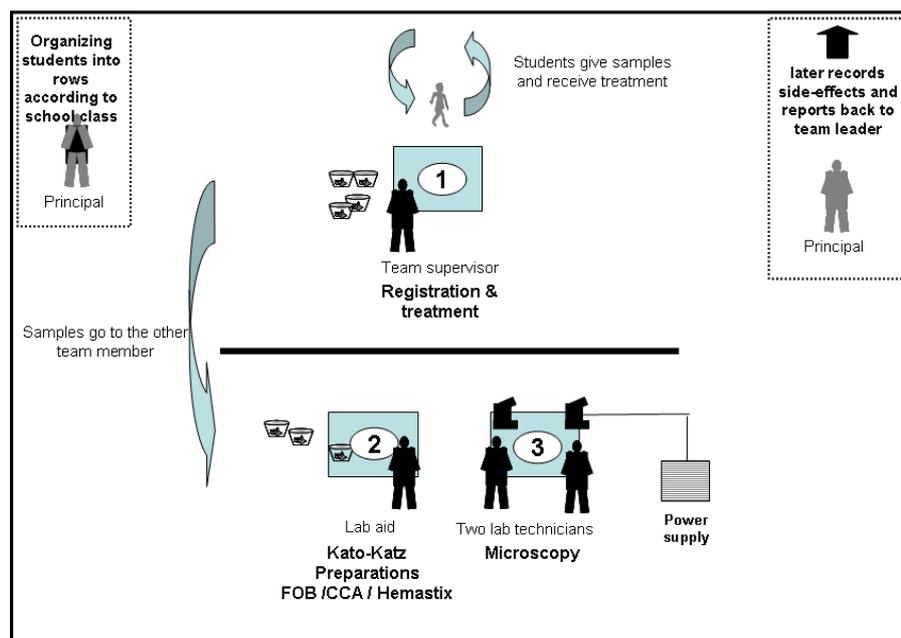
Figure 2: Schools surveyed with rapid diagnostic tests and microscopy. Team is composed of a team leader, one laboratory aid and two lab technicians. The team was mobile using a single 4x4 vehicle and spent a full day at each school for processing samples. The Questionnaire applied by the team supervisor can be seen in Appendix 3. This 'classical' surveillance method is to provide traditional epidemiological evidence to bolster directly findings from rapid diagnostic teams as shown in Figure 3.

Figure 3: Schools surveyed by a rapid diagnostician. Team composed of a single person whom is dropped off at the school by a vehicle (meaning a single vehicle can carry four technicians and work at four schools each day). A working day is finished by lunch-time. The questionnaire applied can be seen Appendix 3. This rapid surveillance method follows from recent advances in state-of-art research in diagnostics.
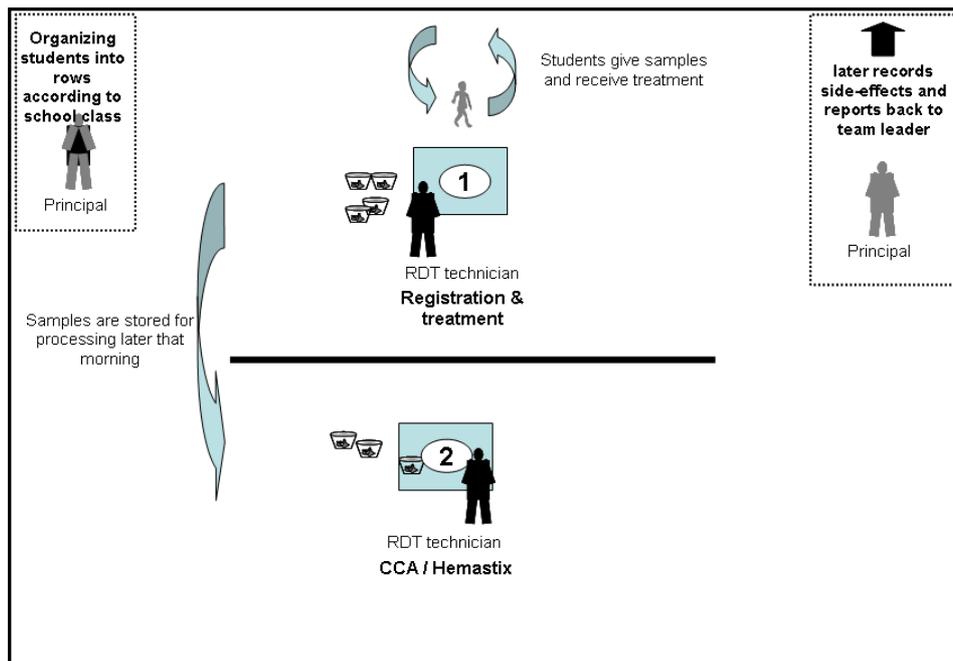
5. RESULTS FROM SCHOOL SURVEYS

5.1. QUESTIONNAIRE

Of the 397 schools registered in Caprivi and Kavango regions (2011 census), a total of 99 schools were visited by the mapping teams (i.e., sampling one in every four), 23 in the Caprivi region and 76 in the Kavango region. For a full list of the schools visited, please see Appendix 1. At each school, a questionnaire (for complete data by region see Appendix 4) was implemented and data gathered informs us that overall 83% of schools had latrines, despite the fact that only 61% had latrines in good working condition, and that 74% of schools had a safe water source. Caprivi and Kavango regions are very rural and far away from the capital, therefore one would expect lower standards of hygiene and sanitation but these numbers are encouraging. With this in mind, however, there is still work to be done, especially in provision of safe water locally. In the schools with safe water source, 55% had access to tap water and 45% had access to borehole water. See Fig. 4 for questionnaire data detailed by region (Caprivi and Kavango) and overall.

LATH was informed that Namibia had implemented an albendazole distribution campaign in 2012 targeting school-aged children. Data gathered during the questionnaire informs us that coverage of this campaign was minimal, with only 26% of school having received treatment in 2012 and 46% of schools having received treatment in the recent past; the levels of treatment coverage attained at each school it is presently not known.
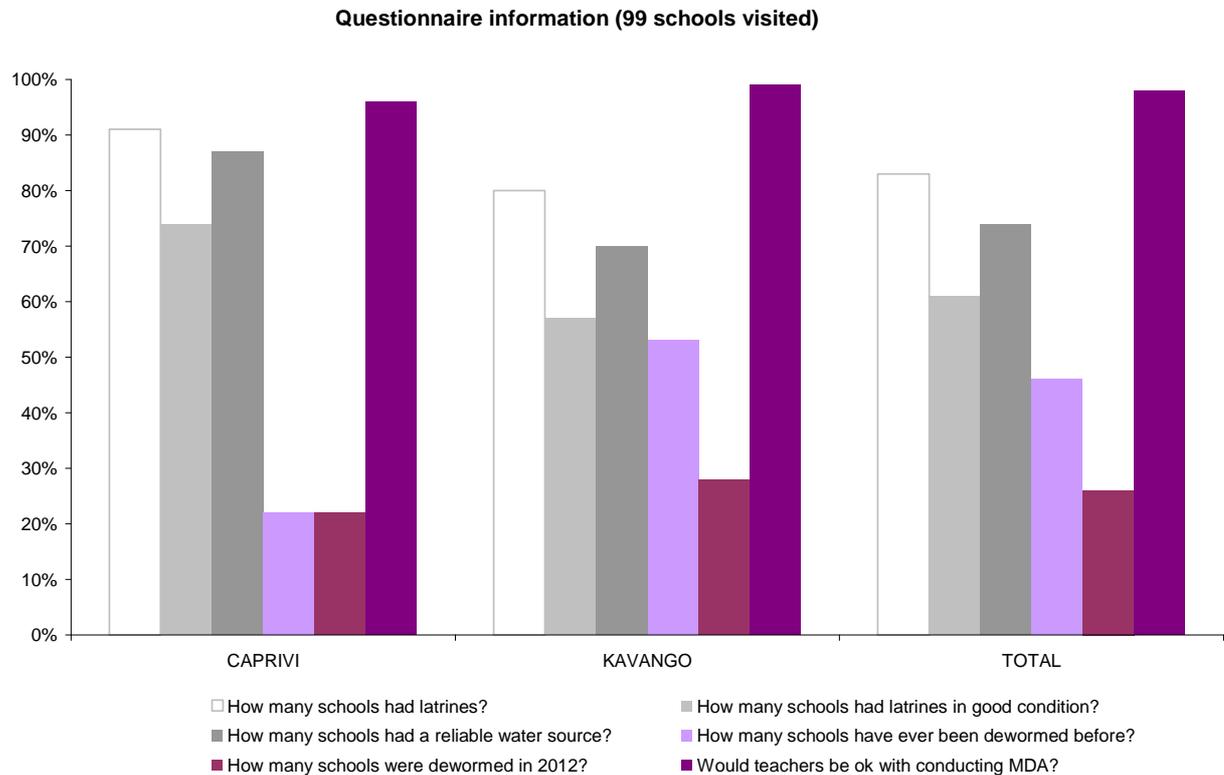
Questionnaire information (99 schools visited)

Legend:
- ☐ How many schools had latrines?
- ☐ How many schools had latrines in good condition?
- ☐ How many schools had a reliable water source?
- ☐ How many schools have ever been dewormed before?
- ☐ How many schools were dewormed in 2012?
- ☐ Would teachers be ok with conducting MDA?

Figure 4: Percentage of positive responders to each questions (each bar colour) by region and overall. Note that these teachers have now been primed and assessed in their future participation in MDA exercises; in short, teachers are willing to assist.

5.2. POPULATION STUDIED

In the 99 schools visited, 5918 children were screened using rapid diagnostic tests for schistosomiasis. The mean age of students surveyed was 9.4 years and ranged between 3 and 17 years. There was an equal proportion of boys and girls in the survey and an equal proportion of young (3-7 year olds) and older (8-17 year olds) school-aged children. All children were recruited from primary school. Of these 99 schools, 20 schools were additionally surveyed using microscopy techniques with the main objective of detecting levels of soil-transmitted helminths and other parasitic worms. Intestinal and urogenital schistosomiases were also diagnosed during microscopy

surveys to confirm that rapid diagnostic tests were working correctly. A total of 1201 students were included in this subset. These children were also surveyed for non-visual blood in faeces as a proxy for bowel morbidity using faecal occult blood tests.

5.3. SCHISTOSOMIASIS

Results from the rapid diagnostic tests show that schistosomiasis, although prevalent, does not reach alarming levels (see Fig. 5). Prevalence of schistosomiasis (both intestinal and urogenital) was found to be 16% in Caprivi and 18% in Kavango (overall prevalence of 17%). Recorded levels varied from 7% (Katima Mulilo Rural and Rundu Rural West) to 48% (Kongola).

Prevalence of urogenital schistosomiasis (as measured by microhaematuria) reached 7% in Caprivi and 8% in Kavango. Nevertheless, it is important to note that due to the nature of this infection, distribution is often focalized or heterogeneous, and Namibia is no exception. This will in turn affect the way we interpret the results. In this case for example, our survey shows an overall low prevalence in Caprivi (<10%) but it also shows that certain areas such as Kabe constituency prevalence can reach higher levels (23%). In fact, one of the schools visited in Kabe constituency had an overall prevalence of 60% - a clear hotspot of transmission. In Kavango, the overall prevalence was 8%, with Kapako constituency having the highest prevalence of 17%. As in Caprivi, the survey also identified hotspots for transmission in Kavango such as Dikungu Primary school in Mukwe constituency, where prevalence of urogenital schistosomiasis reached the maximum recorded value of 68%. Snail surveys helped to shed light on these patterns (see below).

As for intestinal schistosomiasis (measure using the CCA rapid diagnostic test), prevalence reached 10% in Caprivi and 11% in Kavango (overall prevalence of 11%). Like urogenital schistosomiasis, the distribution was highly focalized, with constituencies such as Kongola (in Caprivi) reaching 48%. The highest levels were recorded at Sikaunga Primary school in Kongola Constituency where levels reached 78%, and Katwitwi Primary school, Mpungu constituency, Kavango, where levels reached 77%.

The treatment needs of pre-school children do not appear to be a priority given the low levels of encountered disease. Nonetheless if there were sufficient amounts of praziquantel available, further consideration of treatment of these younger children in Kongola should be explored.
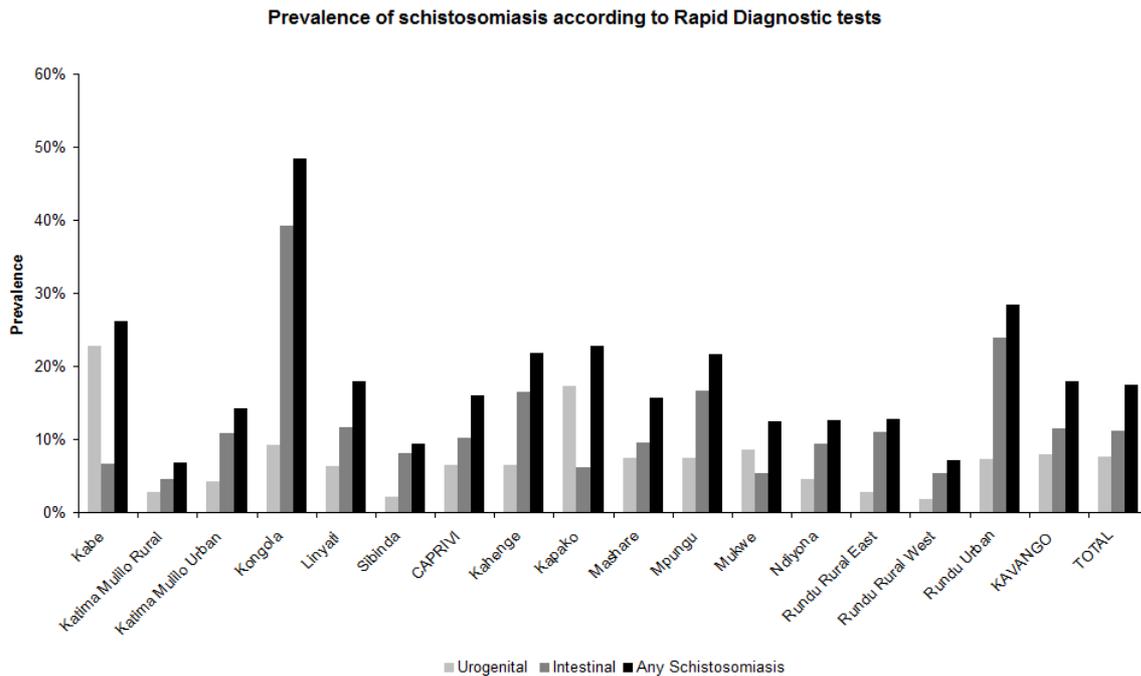
Prevalence of schistosomiasis according to Rapid Diagnostic tests

Figure 5: Prevalence of schistosomiasis (both types and any) according to rapid diagnostic tests in each of the constituencies, by region and total. For actual data and confidence intervals, see tables in Appendix 4. Note the raised focality, or concentration of the disease burden, in Kongola (i.e. constituency 10).

5.4. SOIL TRANSMITTED HELMINTHS AND OTHER WORMS

No cases of *Ascaris* or *Trichuris* were identified in these two regions suggesting that these diseases are not endemic locally and the environment is not suitable for their future establishment. Hookworm, however, was fairly common among school-children, especially in Kavango region where prevalence reached 28% as opposed to the 4% in Caprivi (overall prevalence of 22%).

Hookworm prevalence levels within Caprivi varied between 0% in Katima Mulilo and 10% in Kongola. Prevalence levels in Kavango varied between 12% Kapako and 64% in Mpungu, with a clear east to west increasing trend. The highest prevalence level was recorded at Sikumba Junior Primary School, Mpungu constituency, Kavango region, where 82% of the schoolchildren surveyed were found to have hookworm eggs in their faeces.

Apart from the standard STH infections, this mapping survey also identified significant levels of *Hymenolepsis nana* (dwarf tapeworm) and *Enterobius vermicularis* (threadworm). The prevalence of these other worms reached 1% in Caprivi and 5% in Kavango, where the highest recorded prevalence was at Kapako constituency, Kavango region, with levels reaching 9%. The most common worm was

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H. nana, see Fig. 6 for graphical representation of prevalence levels recorded for STHs and other worms.

Prevalence of STHs and other intestinal worms in Caprivi and Kavango
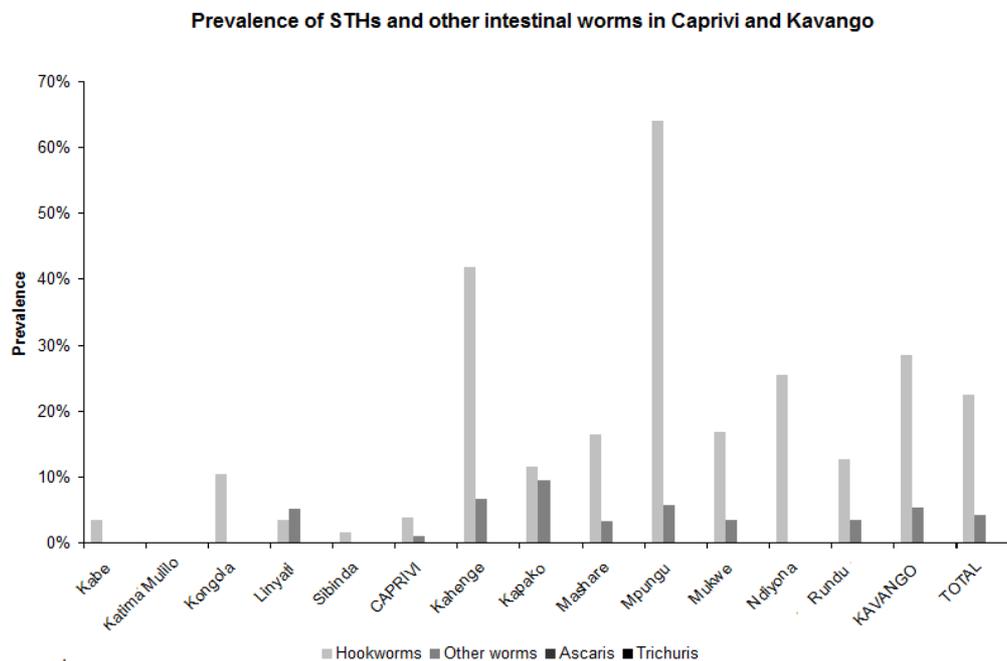
Figure 6: Prevalence of soil-transmitted helminths and other worms according to microscopy in each of the constituencies, by region and total. Note that Katima Mulilo is now a single unit (Katima Mulilo Rural and Urban together) as well as Rundu (Rundu Urban together with Rundu Rural East and West). For actual data and confidence intervals, see tables in Appendix 4.

6. RESULTS FROM SNAIL SURVEYS

Ad hoc surveys were undertaken by Moses Arinaitwe during Phase 1 of mapping. The results of the snail surveys reflect the same disease distribution as that revealed by the school surveys: very few sites contained a snail population (i.e. *Biomphalaria* or *Bulinus*) capable of transmitting disease, but those sites that did, had abundant snail populations representative of these genera. In Caprivi, flooding could be the cause for such focalized distribution and points towards a seasonal epidemiology that has poignancy for predicting future re-infection patterns geographically after MDA.

The main species of snails found were *Bulinus*, the intermediate host for urogenital schistosomiasis. As we moved towards Kavango region, snails started to show up in larger numbers and far more

regularly. Additionally, in a single site towards the west of Kavango, the intermediate host for intestinal schistosomiasis, *Biomphalaria*, was also found, and in relative abundance.

These results indicate that transmission potential for urogenital schistosomiasis is high in these two regions, but the fact that snails were not found at every site suggests that disease distribution will not be homogeneous, i.e. some areas are at high risk, while others have no risk. This is largely different from the situation in the Great African Lakes or in the river systems of Western Africa, where snails are ubiquitous.

The four river systems in this area are crucial to the survival of the snails, and the flooding patterns of the Kwando, Kubango, Kobe and Zambezi rivers should be taken into account when conducting treatment and surveillance.

As a side note, another very important snail was found in these regions – *Lymnaea*. These snails serve as the host for human and veterinary fascioliasis. Cattle fascioliasis is a disease of enormous economic importance, therefore animal welfare departments (such as the Namibian Regional Veterinary Services) should liaise with the MoHSS to better tackle this disease. Importantly, due to the abundance of snails and cattle in these two regions, Veterinary Services should also consider investigating into cattle schistosomiasis (*Schistosoma bovis*), as they will also pose a burden into the local economy. In the future, the issue of species hybridization (cattle and human schistosomiasis) should also be investigated as cattle may be posing as a reservoir for human infections. This is particularly important as presently the performance of praziquantel on killing hybrid schistosomes is not known.

7. RECOMMENDATIONS FOR TREATMENT, THE PROTOCOL AND FUTURE WORK

Overall, Phase 1 of mapping was a success and brought together a new dialogue between teachers, researchers and all local health stakeholders. Indeed, those involved were excited to take part in the work, and for many this type of field work was a new experience. Support from the University of Namibia (Prof. Bock), that kindly gave us all the conditions to train all 30 people involved, and from the Polytechnic of Namibia (Prof. Noden), that helped us assemble the field team with enthusiastic students, was invaluable. The MoHSS (central level) provided vehicles, fuel and drugs, which were extremely useful, and the regional offices were incredibly supportive.

7.1. RECOMMENDATIONS FOR FUTURE FIELD-WORK ACTIVITIES

- In future phases, a pre-visit should be conducted by LATH staff to organize the in-country procurement, as not to overburden the local Geneva Global staff.

- In preparation for Phase 1, cars and drugs were only confirmed at the last-minute; a stressful issue that could have been avoided if we knew the system.

- Appropriate letters should be sent well in advance requesting cars, drugs and regional assistance.

- A visit should also be paid to the regions where the work will take place to assess and inform schools of the work to come, and assess existence of camps or hostels to stay overnight.

7.2. PREVIOUS DEWORMING INITIATIVES

The information gathered by the questionnaire indicates that the coverage numbers achieved by previous albendazole distribution campaigns are unacceptable according to WHO guidelines. In a future vertical integrated control programme, Namibia should aim for at least 75% coverage. One aspect that could be hindering the performance of past campaigns is the fact that despite treatment being school-based; it is being administered by nurses from constituency/regional level, and not by the teachers themselves. It is very hard for a single nurse to cover all the schools in the area and therefore better activation of local teachers is needed. It would be advisable to follow the guidelines set by WHO that state that treatment against STHs and schistosomiasis should be done in a school-based fashion using the teachers as drug administrators. Data from this survey suggests that teachers would be very receptive to training and would like to be involved in such a campaign, as shown in Fig. 4.

7.3. SCHISTOSOMIASIS AND PRAZIQUANTEL ADMINISTRATION

Data from the rapid diagnostic tests showed that schistosomiasis was present in every constituency surveyed. Furthermore, there was evidence of co-infections in some school-children by both types of schistosomiasis, making these environments unique for research. Apart from three constituencies (two in Caprivi and one in Kavango), prevalence of schistosomiasis exceeded 10% but never

exceeded 50% (moderate risk according to WHO), meaning biennial school-based treatment is absolutely necessary (See Fig. 7). Deworming guidelines by WHO are in Appendix 5.
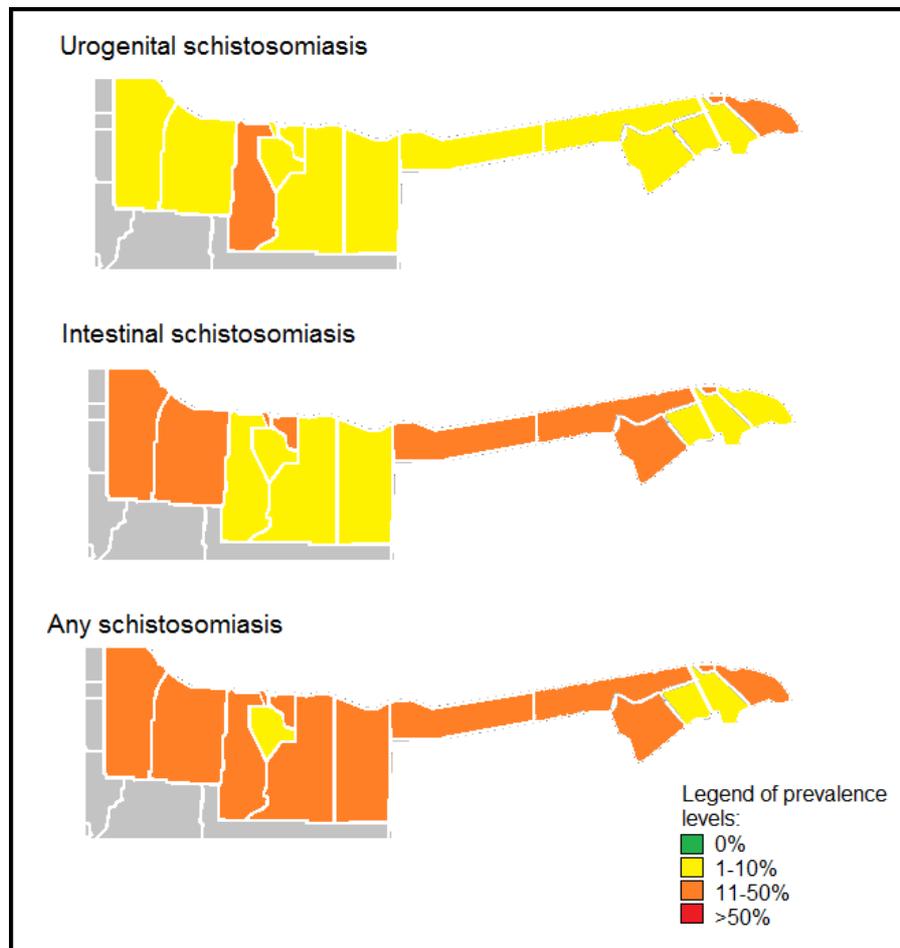
Figure 7: Prevalence of schistosomiasis (urogenital, intestinal and any type) by constituency. For constituency names, please see Appendix 2.

The overall moderate risk of schistosomiasis (prevalence between 10-49%) and the fact that transmission is highly focalised makes this area a "low hanging fruit" for transmission elimination. Importantly, not only did levels of schistosomiasis fail to reach alarming levels (>50%) at a constituency level, but also heavy schistosomiasis infections were uncommon, with only a few constituencies being highlighted as problematic (see Fig. 8). Nevertheless, it is important to remember that even within these deceptively moderate levels of schistosomiasis our survey did identify hotspots where prevalence of schistosomiasis reached close to 80% and where burden of disease will be highest and hard to combat.
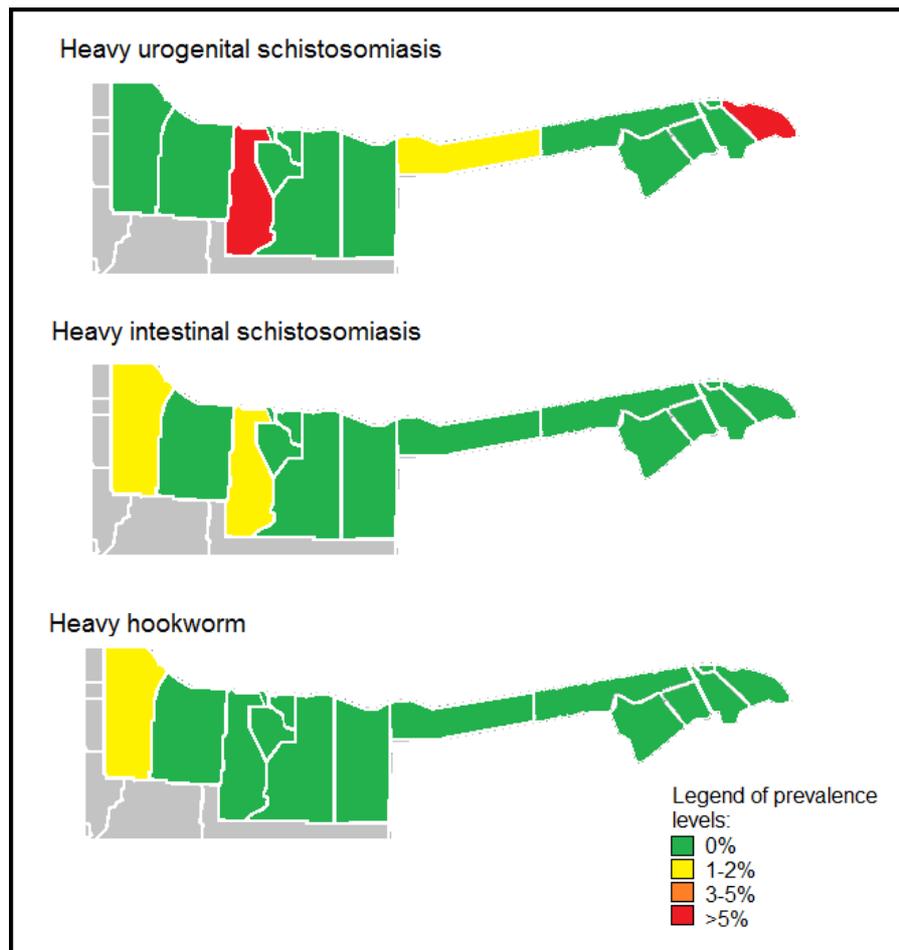
Figure 8: Prevalence of heavy infections for schistosomiasis and hookworms by constituency. For constituency names, please see Appendix 2. Note that urogenital schistosomiasis may be influencing the local epidemiology of HIV, the prevalence of which is raised in this area (Dr Norbert Forster, *personal communication*).

7.4. STH AND OTHER WORM INFECTIONS AND ALBENDAZOLE DISTRIBUTION

Of the three common STH infections, only hookworm was present in these two regions of Namibia. Hookworm infection prevalence followed a clear east to west dynamic (see Fig. 9), with Caprivi having an overall prevalence of 4% and Kavango having an overall prevalence of 28%. Of particular importance is Mpungu constituency, far-west Kavango region, which had the highest level of the survey reaching 68%.

These results suggest that albendazole distribution at a school-level could be conducted every five years in Caprivi (at least once during primary school years) and every year in Kavango, whereby in Mpungu constituency treatment should be done twice yearly and included the whole community during one of the yearly rounds. In fact, it was only in Mpungu constituency that heavy infections

were recorded (see Fig. 8), further emphasising the need to focus more efforts into combating this disease in this constituency. Deworming guidelines by WHO are in Appendix 5.
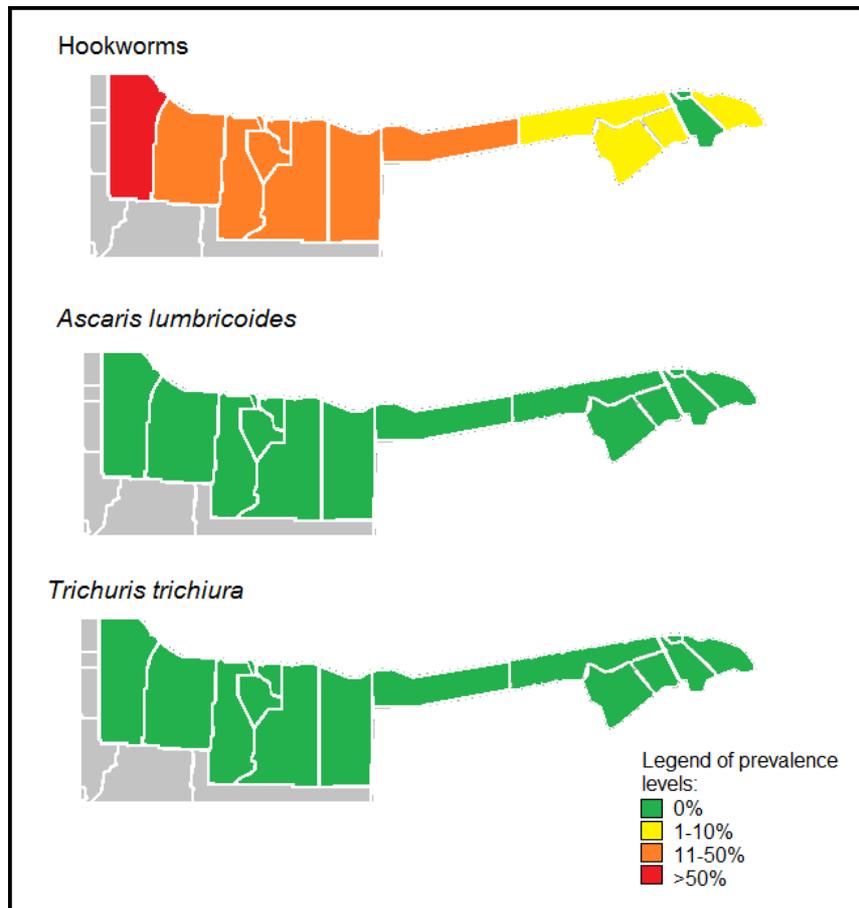
Figure 9: Prevalence of STH infections (Hookworms, *Ascaris lumbricoides and Trichuris trichiura)* by constituency. For constituency names, please see Appendix 2.

H. nana infections were highly prevalent in Kavango, especially towards the west. This is a very similar dynamic to that of Hookworms. *H. nana* and *E. vermicularis* transmission is much like that of the STHs, with very few differences. For this reason, these two worms tend to share the same epidemiology as STH infections (See Fig. 10).

H. nana, the dwarf tapeworm, can be treated using single dose praziquantel, much like schistosomiasis, while *E. vermicularis*, the threadworm, can be treated using albendazole. This means that a successful deworming campaign can have incredible impact on these diseases. Infections such as these, even though known for causing morbidity among children, tend to go under-diagnosed and untreated, especially in school-children whom are not targeted by national control campaigns.
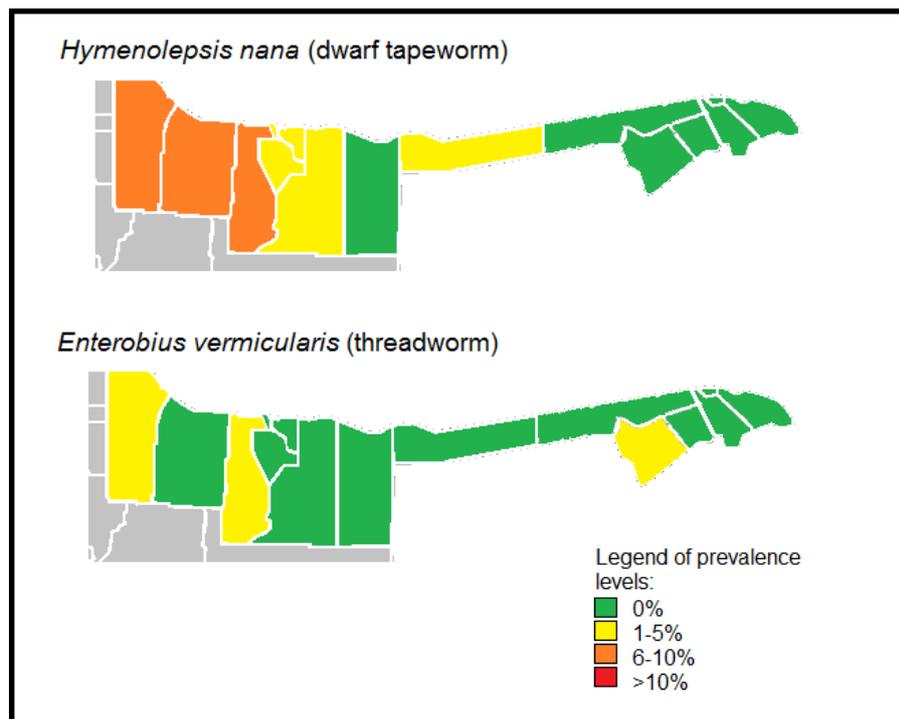
Figure 10: Prevalence of *H. nana* (dwarf tapeworm) and *E. vermicularis* (threadworm) by constituency. For constituency names, please see Appendix 2.

7.5. STUDYING YOUNG CHILDREN DURING SCHISTOSOSMIASIS MAPPING

Depending on the transmission environment, the peak risk for infection with *Schistosoma* parasites varies in age, but it is believed that for schistosomiasis as a whole, it is somewhere between 10 and 14 years of age. This is why World Health Organization guidelines for schistosomiasis mapping include only children from this age bracket. Therefore, the risk of infection (and therefore prevalence) before that "risky" age bracket is somewhat of a mystery as most mapping protocols neglect the young school-aged children. This was acceptable until very recent research has found that, in certain environments, even infants can be at risk of infection. It all depends on the environment for transmission; i.e. the type of water bodies (can younger children play without fear), the water contact behaviour (is it mainly water collection or do kids play, swim and fish) and health and sanitation conditions (are all children bathed in locally sourced and untreated freshwater). If all the conditions are there, then prevalence of schistosomiasis among those out of school could be high. To avoid this health inequity, a new way to detect level of transmission among preschoolers is to sample younger school aged children as a proxy.

If children between the ages of six and nine are as much at risk of infection as those between ten and fourteen, then one can safely presume that those entering school were already at risk of

infection beforehand and could be at risk for morbidity even before they were eligible to treatment during school-based programmes. Recent work in Uganda has estimated that children below the age of six live at half the risk of infection as those in school, and in Uganda where school-based mapping has identified areas exceeding in 70% prevalence means that preschool-aged children are at moderate to high risk of infection and need treatment urgently to avoid morbidity developing in school-years.

In this survey, and for the first time in recent history, we have decided to survey young (from first two grades) and older (ten year olds and above) children during a schistosomiasis mapping initiative. From the complete sample size of 5918 children, 2930 were young (ages ranging between 3 and 9, mean age of 7) and 2988 were older (ages ranging between 10 and 17, mean age of 12), meaning both age ranges were equally represented in our dataset. Ours results show that prevalence of urogenital schistosomiasis was equally distributed between both age groups. On the other hand, intestinal schistosomiasis was slightly more common among the older children, although the difference was only marginally significant (P-value of 0.054). For data see Table 1. If our younger school-aged children were at equal risk to contract the infections here investigated as the older school-aged children, then this means that those out of school and below the age of six are also likely at risk of infection, meaning they could be warranted treatment.

However, what one must realise is that the actual overall prevalence of infection was quite moderate for schistosomiasis. If the same relationship as that found in Uganda holds true in Namibia, then we are looking at prevalence levels close to 5-7% for schistosomiasis in preschoolers. Moreover, the prevalence levels identified by the morbidity indicators deployed during this survey (identification of visual blood in urine and microscopic amount of blood in stool for urogenital and intestinal schistosomiasis respectively) tell us that although risk of disease is moderate, risk of morbidity is minimal, likely due to the seasonality of transmission. These levels of infection (estimated between 5-7%) and morbidity (estimated <1%) indicate that Namibian preschool-aged children from these two regions are not in need of praziquantel treatment.

Importantly, a proper survey including preschoolers and school-aged children should be conducted in these regions to ascertain the actual relationship (or correlation) between level of infection in young and older children.

	Young school-aged children			Older school-aged children			*P*-value
	No. Positive	No. surveyed	Prevalence	No. Positive	No. surveyed	Prevalence	
Infections							
Urogenital schistosomiasis	208	2930	7.1%	240	2988	8.0%	0.19
Intestinal schistosomiasis	303	2930	10.3%	357	2988	11.9%	**0.054**
Morbidities							
Visual blood in urine	7	2930	0.2%	12	2988	0.4%	0.38
Microscopic blood in stool	14	537	2.6%	24	664	3.6%	0.41

Table 1: Prevalence of schistosomiasis and morbidities associated with it in Kavango and Caprivi according to age

7.6. USE OF RAPID DIAGNOSTIC TESTS AND MAPPING RESOLUTION

The use of modern, easy-to-use rapid diagnostic tests has brought about new possibilities in science. Until the early 90s, schistosomiasis mapping was conducted based on microscopy protocols; urine filtration for urogenital schistosomiasis and the Kato-Katz technique for intestinal schistosomiasis. In the late nineties, microhaematuria, or presence of non-visual blood in urine, was found to be a good proxy for diagnosis of urogenital schistosomiasis and from then on, even WHO guidelines recommend the use of microhaematuria rapid tests for mapping of urogenital schistosomiasis. Since then, the scientific community has been actively pursuing a viable rapid diagnostic test for intestinal schistosomiasis. While there are still many variants in development, only one is available commercially - the circulating cathodic antigen (CCA) test. This test measures amount of worm

compounds which are passed out through the child's urine. This mapping initiative is at the forefront of research, and it constitutes the first time the CCA test is being used on a larger scale.

Our data suggests that both the microhaematuria test and the CCA test performed very well - microhaematuria sensitivity 82% and specificity 91%; CCA sensitivity 93% and specificity 96%. These performances were estimated based on the few schools where both microscopy and the rapid diagnostic tests were employed (20 schools) and it clearly indicates that the infections identified by these two tests in the schools where microscopy was not employed (remaining 79 schools) were correctly diagnosed.

These tests are very easy to use and yield very quick and reliable results, meaning a team composed of a single person can survey a school (60 children) in less than three hours, while a microscopy team would require at least eight hours and would be composed of at least four people and a vehicle. This has immense impact on costs. The budget for Phase 1 mapping indicated that each child surveyed using rapid diagnostic tests cost $7.65, while the same child to be surveyed using standard microscopy methods would cost $27.95. If we remove the rapid diagnostic component from the microscopy schools we are still looking at a budget of around $20 per child surveyed. Here, the biggest weights are clearly staff per diems (more staff for more days) and transportation (dedicated vehicle). A single vehicle can carry four to five rapid diagnosticians and carry out the mapping of eight to ten schools in a single day while a microscopy team can only map a single school in the same time span.

These costings will therefore influence the resolution of the map. Mapping resolution stands for how much detail we want from a map. For example, for soil transmitted helminths we know that focality is not an issue and sampling five to ten schools per ecological zones is more than enough (WHO guidelines). This is because these worms depend largely on large-scale environmental factors, such as type of soil, temperature and rainfall. For schistosomiasis the situation is more complex, as the parasites depend on minute-scale factors such as presence of water body, chemical and physical properties of the water body, availability of snails and many more.

To explain the implication of costings in mapping resolution here is a practical example. If we followed current WHO guidelines, we would have settled for microscopy only, meaning that for the same budget we would have conducted mapping in 44 schools (60 children per school), and the mapping activities would have taken around 20 working days. The protocol which we used allowed us to sample 99 schools (60 children per school) and the mapping activities took ten working days. By sampling 99 schools we were able to identify many schools with no infection, but also schools with a lot of infection (see. Appendix 7). If we look at the figures in Appendix 7 we see that although

the average was moderate at regional and constituency levels, some school were highly affected by these infections. This means that while for the first 5 years treatment could be distributed at a regional level, once infection is cleared from the low infection schools, more work should be done in the high transmission schools, including more treatment and improvements in water and sanitation. We were able to identify these high transmission schools because of our sample size of 99. If we had settled for 44 there is a high probability that some of the high transmission schools would not have been selected and we would have lost that information. And while on its own these high transmission schools were important finds, there is a larger implication: the prevalence levels gathered at these schools have incredible impact on the constituency and regional averages, meaning that their absence may have tilted the prevalence graph from moderate to low transmission, meaning it would have had terrible and irreversible implications to the treatment regimen recommendations.

In conclusion, the use of rapid diagnostic tests lowers the price per child sampled allowing the researcher to aim for a larger sample size (more children per school and more schools) than that which was the norm using standard protocols. For diseases such as soil transmitted helminths rapid diagnostic tests are non-existent and even if they were not, it is unlikely we would feel the need to increase mapping resolution for STH infections as they are more evenly distributed in the regions. For schistosomiasis on the other hand, the difference between 44 schools sampled and 99 schools sampled during a mapping initiative could amount to tremendous implications in policy making.

7.7. A MAPPING INITIATIVE WITH PROPERTIES OF MONITORING AND EVALUATION

Normally, after a mapping initiative a monitoring and evaluation (M&E) project is developed and implemented to run concurrently with the mass drug administration (MDA). This M&E project usually costs one third of the mapping initiative but it is conducted every year (or biennially), whereby researchers follow a cohort of children from grade 1 to grade 5 and ascertain if these children (a cohort) are improving in the presence of treatment. A project such as this would involve more children per school but significantly less schools than those sampled by the mapping initiative. An M&E project is very important because standard mapping protocols do not gather information that can be used to track MDA programme's performance. This protocol, on the other hand, includes some aspects of the M&E which could potentially allow the Namibian Government to decide not to conduct a standard M&E and therefore save time and money. This mapping initiative could be repeated at the end of a 5 to 6 year drug cycle and impact could be readily assessed as this protocol measured prevalence of morbidity associated with these diseases (microscopic blood in urine and

stool), measured intensity of infection (quantified infections) and its geographical reach is in excess of any M&E protocol.

In the microscopy schools, we quantified infection intensity by counting eggs in school (standard protocol during M&E). As for the rapid diagnostic schools, there is also information which could be used as proxy of infection severity. Each of these two tests gives out a semi-quantitative reading. The CCA test tells us how much protein it identified in the urine according to the shade of the test band (light red to dark red), while the Hemastix test tells us how much blood was in the urine by the change in colour (from light green to dark green/blue). This means that these tests can give us more information than just a simple positive/negative like a pregnancy test. And this information could also be used if this mapping initiative were to be repeated in 5 or 6 year's time. For example, a region may have similar prevalence to what it had at baseline, but the amount of triple positives diminished. This is very similar as to how we use infection intensity according to egg counts in standard M&E protocols.

So, in conclusion, this protocol has not only allowed us to ascertain where the infections are and provide enough evidence for an accurate treatment recommendation, but it has also served as a great basis to ascertain performance of future treatment programmes. This, without the added expenditure of a complete M&E cohort study.

8. CONCLUSIONS

It is clear that the previous albendazole distribution campaign did not meet the WHO requirement and therefore greater support should be given to raise the performance of this programme. LATH/LSTM has experience of advising on and directing MDA campaigns for NTDs, including schistosomiasis and STH, and can offer this support to the End Fund to provide effective and cost efficient drug administration to combat these diseases in Namibia, to ensure WHO targets are achieved with direct supporting evidence.

The data gathered suggests that there is a desperate need for treatment against schistosomiasis and STH infections in these regions. Additionally, in some constituencies any school-based treatment campaign should run in tandem with community-based campaigns related to treatment and hygiene and sanitation (especially provision of safe water at schools). For a summary of the recommendations see Table 2.

Although transmission varied between constituencies, even more so for schistosomiasis due to its focalized nature, to target the treatment regimen on a school-by-school basis would be highly costly and would involve many assumptions (as many schools were not surveyed and the exact prevalence levels remain unknown). What we do know, however, is that due to the overall prevalence of these diseases, for the first five years at least, a praziquantel and albendazole distribution campaign should use the regions as implementation units. After five years, the implementation unit may then be downscaled to the constituency-level as some areas will be free of infection while other will need continued deworming.

Due to the overall good school-enrolment numbers in Namibia and obvious political will, this pilot survey suggests that a successful school-based campaign will have tremendous impact on burden of schistosomiasis, soil-transmitted helminths, and the previously neglected worms *H. nana* and *E. vermicularis*. The fact that Namibia lies on the southern fringe of the schistosomiasis-endemic regions of Africa, the fact that transmission is likely seasonal and associated with rains and floods, the fact that morbidity is low and that transmission is only moderate puts these two regions of Namibia in a great position to be one of the first areas to successfully eliminate schistosomiasis. Like some areas of the Sahel, the island of Zanzibar and some irrigation schemes in Egypt and Sudan where elimination is thought to be achievable, so it should be in Kavango and Caprivi regions of Namibia.

	Recorded Prevalence	Praziquantel	Albendazole	Hygiene and Sanitation improvements
Caprivi	Schistosomiasis 16% STH infections 4%	Biennial treatment	Treatment at least once during primary school years (e.g. every five years)	Kabe and Kongola constituencies
Kavango	Schistosomiasis 18% STH infections 28%	Biennial treatment	Annual treatment *	Mpungu, Kahenge and Kapako constituencies

Table 2: Recommendations. *Mpungu constituency should treat twice yearly and include community-wide deworming at least once a year. Deworming guidelines by WHO are in Appendix 5.

APPENDIX 1: LIST OF SCHOOLS VISITED

	Region	Constituency	Name of school (alphabetical order)	GPS coordinate		No. of students surveyed
				East	South	
1	KAVANGO	RUNDU URBAN	ALPO MBAMBA JR SS	19.75569	-17.92087	60
2	KAVANGO	RUNDU URBAN	ANDREAS KANDJIMI	19.78847	-17.92378	60
3	KAVANGO	MPUNGU	ANNASTASIA MURANGI PS	18.41783	-17.98083	60
4	KAVANGO	MUKWE	BIRO SENIOR PS	21.33694	-18.00361	60
5	CAPRIVI	KATIMA MULILO RURAL	BUKALO PS	24.52974	-17.70839	60
6	KAVANGO	KAHENGE	CALIKAWO PS	18.73525	-18.27372	60
7	CAPRIVI	SIBINDA	CHINCHIMANE PS	24.12028	-17.98139	60
8	KAVANGO	NDIYONA	CUMAGCASHI PS	20.69536	-18.28778	59
9	KAVANGO	MUKWE	DIKUNGU PS	21.39167	-18.05445	60
10	KAVANGO	KAPAKO	ENKONDJO PS	19.36897	-18.32389	58
11	KAVANGO	KAPAKO	ERAGO PS	19.27386	-18.19535	60
12	KAVANGO	MPUNGU	ERKKI HAUSIKU JR PS	18.42049	-18.19965	54
13	KAVANGO	MPUNGU	GAVA JR PS	18.43056	-17.8875	63
14	CAPRIVI	KATIMA MULILO URBAN	GREENWELL MATONGO PS	24.2842	-17.51217	60
15	CAPRIVI	KATIMA MULILO RURAL	GUNKWE PS	24.28889	-17.65972	54
16	KAVANGO	KAHENGE	HAISISIRA PS	19.10694	-17.83889	60
17	KAVANGO	KAPAKO	HALILI PS	19.43417	-17.88389	59
18	KAVANGO	RUNDU RURAL WEST	HAMUEYI PS	19.74306	-18.22667	60
19	KAVANGO	KAHENGE	HEMA JR PS	18.97933	-18.1625	59
20	CAPRIVI	KATIMA MULILO RURAL	IBBU CS	24.52139	-17.96333	60
21	CAPRIVI	KATIMA MULILO RURAL	IZIMWE PS	24.68917	-17.83055	59
22	KAVANGO	MPUNGU	KAAKUWA SENIOR PS	18.46611	-17.77444	60
23	KAVANGO	MUKWE	KAKE PS	21.5015	-18.09019	60
24	KAVANGO	MUKWE	KAMBIMBA PS	21.11414	-18.13195	60
25	KAVANGO	KAHENGE	KANANANA PS	18.71306	-17.72583	60
26	KAVANGO	NDIYONA	KANDJARA JUNIOR PS	20.77417	-18.20167	44
27	KAVANGO	MPUNGU	KANKUDI PS	18.49639	-17.73611	60
28	KAVANGO	MUKWE	KANOROMBWE PS	21.56806	-18.12472	60
29	KAVANGO	NDIYONA	KANYUMARA JR PS	20.6155	-18.04617	60
30	KAVANGO	MPUNGU	KASARA SP	18.27639	-17.80806	66
31	KAVANGO	NDIYONA	KASHIRA KAMPENDJE JR PS	20.80733	-18.0415	60
32	CAPRIVI	KABE	KASIKA PS	25.0925	-17.81944	60
33	KAVANGO	KAPAKO	KASOTE CS	19.70444	-17.90389	61
34	KAVANGO	NDIYONA	KATERE PS	20.77722	-18.02556	60
35	KAVANGO	MPUNGU	KATWITWI PS	18.4216	-17.40343	60
36	KAVANGO	MUKWE	KAYANGA PS	21.28222	-17.97944	60
37	KAVANGO	RUNDU RURAL EAST	KAYENGONA PS	19.87722	-17.89389	60
38	KAVANGO	RUNDU RURAL EAST	KEHEMU SP	19.79306	-17.91222	59
39	CAPRIVI	KONGOLA	KONGOLA CS	23.39227	-17.79567	60
40	KAVANGO	MASHARE	KORO PS	20.36222	-18.04944	60
41	KAVANGO	NDIYONA	LIVAYI CS	20.99077	-18.20559	60
42	CAPRIVI	SIBINDA	LUSU CS	24.18847	-17.87846	60
43	KAVANGO	MASHARE	MABUSHE SENIOR PS	20.35738	-17.9081	60
44	KAVANGO	KAHENGE	MANGETTI CS	18.58917	-18.73528	62
45	CAPRIVI	SIBINDA	MASOKOTWANI CS	24.20417	-17.79528	66
46	KAVANGO	KAHENGE	MATAVA PS	18.82472	-17.78639	60
47	KAVANGO	RUNDU RURAL EAST	MAYANA PS	19.90278	-17.89556	60
48	KAVANGO	KAHENGE	MAYENZERE PS	19.15972	-17.85861	60

49	KAVANGO	MASHARE	MBAMBANGANDU JR PS	20.03228	-17.9102	60
50	CAPRIVI	LINYATI	MBAMBAZI PS	23.58806	-18.24389	60
51	KAVANGO	MUKWE	MBAMBI PS	21.00056	-17.97472	60
52	KAVANGO	MUKWE	MBAPUKA PS	21.13472	-17.94222	60
53	KAVANGO	KAPAKO	MBEYO JR PS	19.41028	-18.27667	61
54	KAVANGO	KAHENGE	MBURU-URU JR PS	18.73167	-18.06111	70
55	KAVANGO	KAHENGE	MPEZO JR PS	19.07	-18.571	63
56	KAVANGO	KAPAKO	MPORA SENIOR PS	19.26718	-18.43246	60
57	KAVANGO	MPUNGU	MPUNGU PS	18.22972	-17.67667	60
58	KAVANGO	RUNDU RURAL EAST	MUHOPI PRIMARY SCHOOL	19.98806	-17.91222	60
59	KAVANGO	MPUNGU	MUKEKETE PS	18.0675	-17.59528	60
60	KAVANGO	KAPAKO	MUKUNDU JUNIOR PS	19.56083	-17.95333	60
61	KAVANGO	NDIYONA	MUKUNI JR PS	20.43383	-17.92	60
62	CAPRIVI	KATIMA MULILO URBAN	MULUMBA PS	24.31	-17.49167	60
63	KAVANGO	MPUNGU	MUNGOMBA PS	18.34667	-17.61611	60
64	KAVANGO	KAPAKO	MUPINI JR PS	19.62444	-17.86742	62
65	KAVANGO	MPUNGU	MUTENGO JR PS	18.565	-17.58944	60
66	KAVANGO	MUKWE	MUTHINDUKO JUNIOR PS	21.31751	-18.08573	60
67	CAPRIVI	KATIMA MULILO RURAL	MUYAKO CS	24.39972	-17.88861	60
68	CAPRIVI	KATIMA MULILO RURAL	NAMALUMBI PS	24.35278	-17.54833	60
69	CAPRIVI	KABE	NAMIYUNDU PS	24.86556	-17.555	60
70	KAVANGO	MPUNGU	NAMUNTUNDU PS	18.48306	-17.48806	60
71	KAVANGO	KAHENGE	NAUCOVA PS	19.16444	-18.00944	60
72	KAVANGO	MASHARE	NCUSHE JR PS	19.72722	-18.53306	61
73	KAVANGO	NDIYONA	NDONGA LINENA CS	20.46972	-17.95167	60
74	KAVANGO	RUNDU RURAL EAST	NGCANGCANA JP SCHOOL	19.83	-17.99806	53
75	CAPRIVI	KATIMA MULILO RURAL	NGOMA PS	24.71056	-17.91861	60
76	CAPRIVI	LINYATI	NGONGA PS	23.32543	-17.95643	60
77	KAVANGO	RUNDU RURAL WEST	NKUTU PS	19.51778	-18.04028	58
78	KAVANGO	KAHENGE	NZINZE PS	18.9275	-17.82667	60
79	KAVANGO	RUNDU RURAL WEST	RUDOLPH NGONGO PS	19.77635	-17.92166	60
80	KAVANGO	MASHARE	RUNDJARARA PS	20.31167	-17.88667	60
81	KAVANGO	RUNDU URBAN	RUNDU JUNIOR PS	19.78028	-17.91639	60
82	KAVANGO	KAPAKO	RUUGA CS	19.53528	-17.87611	60
83	CAPRIVI	LINYATI	SANGWALI PS	23.63861	-18.26611	60
84	KAVANGO	MUKWE	SHAMUNARO JUNIOR PS	21.36923	-18.26985	60
85	KAVANGO	NDIYONA	SHINYUNGWE COMBINED	20.88722	-18.02972	60
86	CAPRIVI	LINYATI	SIBBINDA PRIMARY SCHOOL	23.82315	-17.78598	61
87	CAPRIVI	KABE	SIFUHA PS	24.58556	-17.59944	60
88	KAVANGO	MPUNGU	SIKAROSOMPO JR PS	18.51361	-17.89167	60
89	CAPRIVI	KONGOLA	SIKAUNGA PS	23.4175	-17.73639	60
90	CAPRIVI	SIBINDA	SIKUBI CS	23.89142	-17.74527	60
91	KAVANGO	MPUNGU	SIKUMBA JR PS	18.46	-18.06444	60
92	CAPRIVI	KATIMA MULILO RURAL	SILUMBI CS	24.50444	-17.77083	60
93	KAVANGO	KAPAKO	SINZOGORO PS	19.49972	-17.88583	60
94	KAVANGO	KAPAKO	SIVARA PS	19.32861	-17.86194	60
95	KAVANGO	MASHARE	TARATARA SP	20.32292	-18.21504	61
96	KAVANGO	KAHENGE	TONDORO CS	18.79194	-17.77528	60
97	KAVANGO	RUNDU RURAL WEST	TUSHEPENU PS	19.99067	-18.247	48
98	KAVANGO	KAHENGE	YINSU CS	18.59722	-17.80472	57
99	KAVANGO	MASHARE	YURU PS	20.05639	-18.02222	60

APPENDIX 2: CONSTITUENCIES

Figure legend:

Kavango region (1-9)
1 - Mpungu
2 - Kahenge
3 - Kapako
4 - Rundu rural west
5 - Rundu urban
6 - Rundu rural east
7 - Mashare
8 - Ndiyona
9 - Mukwe

Kavango (10-15)
10 - Kongola
11 - Linyati
12 - Sibinda
13 - Katima Mulilo Urban
14 - Katima Mulilo Rural
15 - Kabe

APPENDIX 3: MAPPING SCHOOL QUESTIONNAIRE

School Information Form

A. Site Details		
1. Date of visit	*(DD-MMM-YYYY)*	|___|___|-|___|___|___|-|___|___|___|___|
2. Team Leader Initials		|___|___|___|
3. Region Name		
Constituency Name		
4. Constituency Code	*(CCC)*	|___|___|___|

B. GPS	
1. Arrival decimal degrees **east**	|___|___|___|.|___|___|___|___|___|___|___|___|___|___|
2. Arrival decimal degrees **south**	|___|___|___|.|___|___|___|___|___|___|___|___|___|___|

C. School details		
School Name		
1. School Code	*(SSS)*	|___|___|___|
2. Name and contact of Principal	Cell:	
4. Number of classes taught		|___|
5. Number of teachers		|___|

D. Enrolment numbers	**Boys** Enrolled	**Girls** Enrolled
Total	1. |___|___|___|___|	2. |___|___|___|___|

E. Questionnaire	
1. Any latrines at the school-site? (0=No; 1=YES)	|___|
2. If YES, please specify condition of latrines (e.g. in working condition)	|_____|
3. Is there a source of water at the school? (0=No; 1=YES)	|___|
4. If YES, which? (specify, e.g. water-pump)	|_____|
5. Have the children in the school ever been de-wormed? (0=No; 1=YES)	|___|
6. If YES, was it this year? (0=No; 1=YES)	|___|
7. Would the teacher be OK with conducting treatment without a nurse present? (0=No; 1=YES)	|___|

APPENDIX 4: RESULT TABLES

Constituencies	No. schools	No. students	Urogenital (haematuria test)		Intestinal (CCA test)		Any (both tests)	
			prevalence	95% CI	prevalence	95% CI	prevalence	95% CI
Kabe	3	180	23%	17–30%	7%	3–11%	26%	20–33%
Katima Mulilo Rural	8	473	3%	1–5%	4%	3–7%	7%	5–9%
Katima Mulilo Urban	2	120	4%	1–9%	11%	6–18%	14%	8–22%
Kongola	2	120	9%	5–16%	39%	30–48%	48%	39–58%
Linyati	4	241	6%	4–10%	12%	8–16%	18%	13–23%
Sibinda	4	246	2%	1–5%	8%	5–12%	9%	6–14%
CAPRIVI	**23**	**1380**	**7%**	**5–8%**	**10%**	**9–12%**	**16%**	**14–18%**
Kahenge	13	791	6%	5–8%	16%	14–19%	22%	19–25%
Kapako	11	661	17%	14–20%	6%	4–8%	23%	20–26%
Mashare	7	422	7%	5–10%	9%	7–13%	16%	12–19%
Mpungu	14	843	7%	6–9%	17%	14–19%	22%	19–25%
Mukwe	10	600	9%	6–11%	5%	4–7%	13%	10–15%
Ndiyona	9	523	5%	3–7%	9%	7–12%	13%	10–16%
Rundu Rural East	5	292	3%	1–5%	11%	8–15%	13%	9–17%
Rundu Rural West	4	226	2%	0–4%	5%	3–9%	7%	4–11%
Rundu Urban	3	180	7%	4–12%	24%	18–31%	28%	22–36%
KAVANGO	**76**	**4538**	**8%**	**7–9%**	**11%**	**11–12%**	**18%**	**17–19%**
TOTAL	**99**	**5918**	**8%**	**7–8%**	**11%**	**10–12%**	**17%**	**17–18%**

Table 3: Number of students and schools per constituency involved in the rapid mapping. Prevalence values (and confidence intervals) for urogenital and intestinal schistosomiasis. "Any" to the prevalence of having one or the other type of infection. The difference between the prevalence of any and the sum of both infections is the prevalence of co-infections.

Constituencies	No. schools	No. students	Hookworm infections		Other intestinal worms		Faecal occult blood	
			prevalence	95% CI	prevalence	95% CI	prevalence	95% CI
Kabe	1	60	3%	0–12%	0%	0–6%	0%	0–6%
Katima Mulilo Rural	1	54	0%	0–7%	0%	0–7%	0%	0–7%
Katima Mulilo Urban	0	NA	NA	NA	NA	NA	NA	NA
Kongola	1	58	10%	4–21%	0%	0–6%	0%	0–6%
Linyati	1	60	3%	0–12%	5%	1–14%	12%	5–23%
Sibinda	1	66	2%	0–8%	0%	0–5%	2%	0–8%
CAPRIVI	**5**	**298**	**4%**	**2–7%**	**1%**	**0–3%**	**3%**	**1–5%**
Kahenge	2	122	42%	33–51%	7%	3–13%	8%	4–15%
Kapako	3	182	12%	7–17%	9%	6–15%	3%	1–6%
Mashare	1	61	16%	8–28%	3%	0–11%	0%	0–6%
Mpungu	3	180	64%	56–71%	6%	3–10%	4%	2–8%
Mukwe	3	180	17%	12–23%	3%	1–7%	3%	1–6%
Ndiyona	1	59	25%	15–38%	0%	0–6%	2%	0–9%
Rundu Rural East	2	119	13%	7–20%	3%	1–8%	2%	0–6%
Rundu Rural West	0	NA	NA	NA	NA	NA	NA	NA
Rundu Urban	0	NA	NA	NA	NA	NA	NA	NA
KAVANGO	**15**	**903**	**28%**	**26–32%**	**5%**	**4–7%**	**3%**	**2–5%**
TOTAL	**20**	**1201**	**22%**	**20–25%**	**4%**	**3–5%**	**3%**	**2–4%**

Table 4: Number of students and schools per constituency involved in the microscopy mapping. Prevalence values (and confidence intervals) for hookworm infections, infections by other intestinal worms (*Hymenolepsis nana* and *Enterobius vermicularis*) and prevalence of faecal occult blood (proxy for bowel morbidity).

	CAPRIVI	KAVANGO	TOTAL
N schools surveyed	23	76	99
N students surveyed	1380	4538	5918
How many schools had latrines?	91%	80%	83%
How many schools had latrines in good condition?	74%	57%	61%
How many schools had a reliable water source?	87%	70%	74%
Type of water source? **Tap**	60%	53%	55%
Borehole	40%	47%	45%
How many schools have ever been dewormed before?	22%	53%	46%
How many schools were dewormed in 2012?	22%	28%	26%
Would teachers be ok with conducting MDA?	96%	99%	98%

Table 5 - Results from the questionnaire

APPENDIX 5: WORLD HEALTH ORGANIZATION (WHO) TREATMENT GUIDELINES

Table 2.2 Recommended control strategies for schistosomiasis in school-age children

Category	Prevalence of schistosomiasis among school-age children at baseline	Control strategy	
		Preventive chemotherapy	Additional interventions
Schools in high-risk areas	≥50% if based on parasitological methods *or* ≥30% if based on questionnaires for visible haematuria	Treat all school-age children (enrolled and non-enrolled) once a year	Improve sanitation and water supply Provide health education
Schools in moderate-risk areas	≥10% and <50% if based on parasitological methods or >1% and <30% if based on questionnaires for visible haematuria	Treat all school-age children (enrolled and non-enrolled) once every two years	Improve sanitation and water supply Provide health education
Schools in low-risk areas	≥1% and <10% if based on parasitological methods	Treat all school-age children (enrolled and non-enrolled) twice during their primary-school years (e.g. once on entry and once on exit)	Improve sanitation and water supply Provide health education

Table 2.3 Recommended control strategies for soil-transmitted helminth (STH) infections in school-age children[a]

Category	Prevalence of any STH infection at baseline	Control strategy	
		Preventive chemotherapy	Additional interventions
Schools in high-risk areas	≥50%	Treat all school-age children (enrolled and non-enrolled) twice a year[b]	Improve sanitation and water supply Provide health education
Schools in low-risk areas	≥20% and <50%	Treat all school-age children (enrolled and non-enrolled) once a year	Improve sanitation and water supply Provide health education

[a] When the prevalence of any STH infection is under 20%, large-scale preventive chemotherapy interventions are not recommended. Affected individuals should be treated on a case-by-case basis.

[b] If the resources are available and the prevalence is towards the higher end of the interval, a third drug distribution might be added (in this case, the frequency will be every 4 months).

Tables from: WHO (2011). Helminth Control in School-Aged Children. A guide for managers of control programmes. Second Edition. WHO, Geneva

APPENDIX 6: FINANCES

SCHISTO MAPPING IN NAMIBIA - PHASE 1

Actual Expenditure

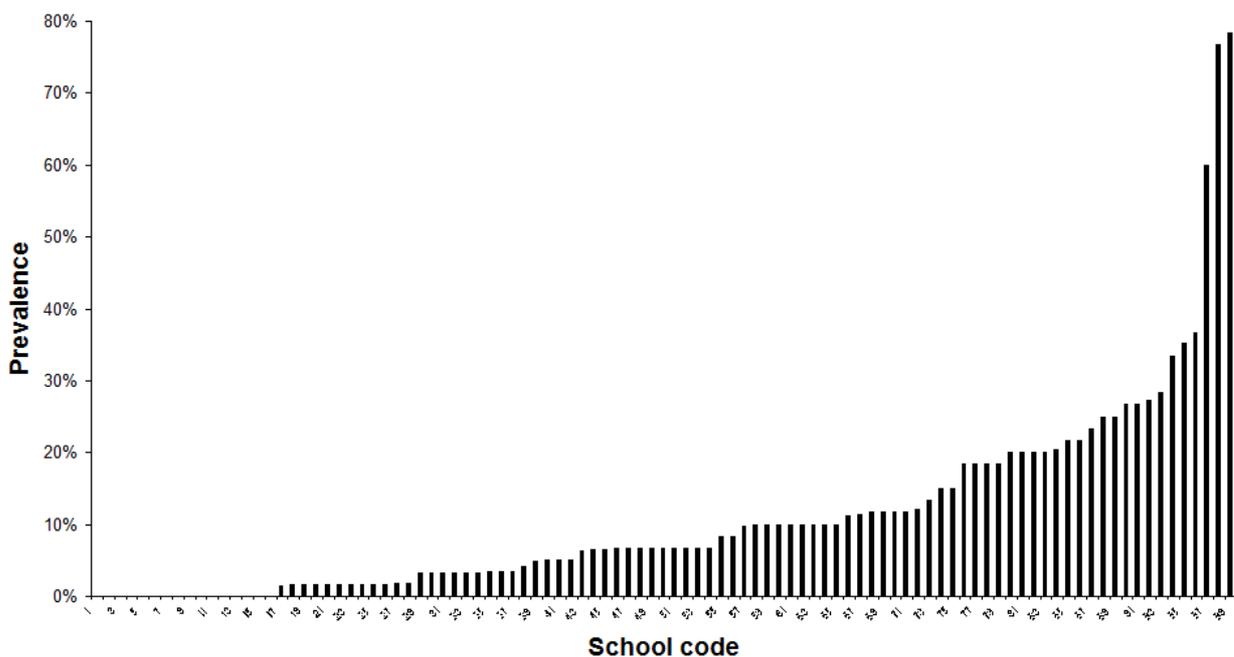| Activity	Budget as per Proposal £	Actual Expenditure £
Personnel	27,786.00	27,553.77
Travel	4,500.00	2,834.74
Accommodation & Subsistence	6,660.00	5,701.85
Ethical Approval	350.00	250.00
Mapping	51,242.00	31,288.27
Malacology	0.00	0.00
Sub Total	**90,538.00**	**67,628.63**
Management Fee	12,550.00	8,014.97
TOTAL LATH EXPENDITURE	**103,088.00**	**75,643.60**
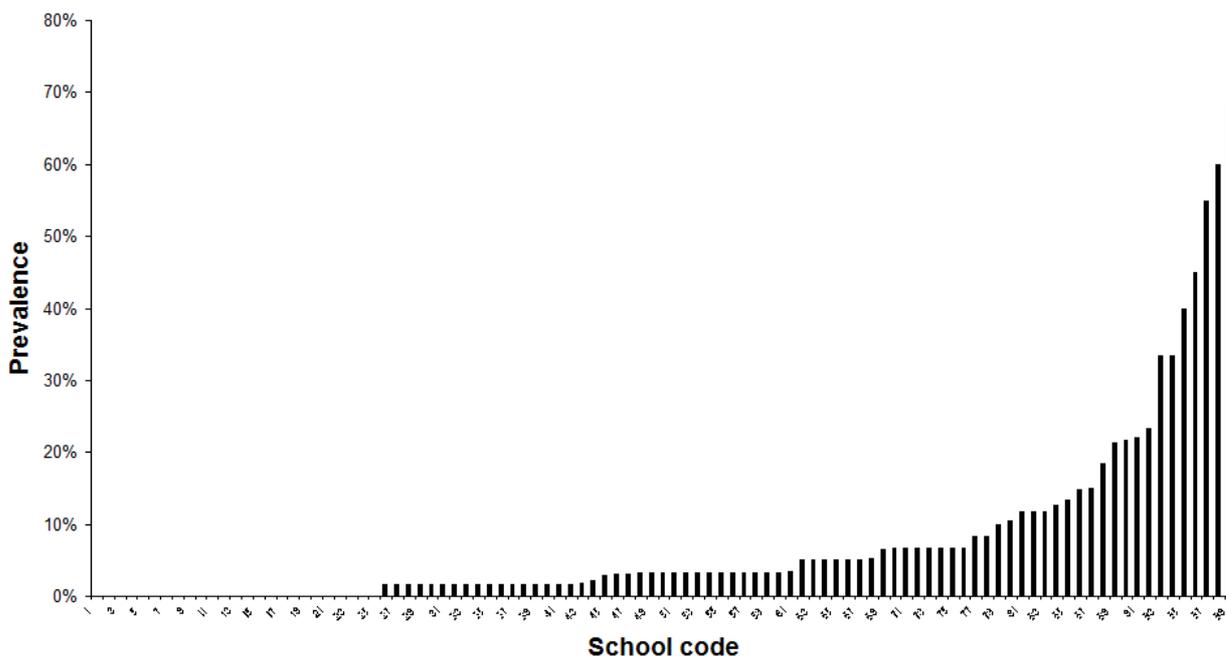
Figure: Distribution of urogenital and intestinal schistosomiasis by school in Kavango and Caprivi regions. The school codes are non-identical between the two graphs, they are simply sequential numbers, i.e. school 99 did not have the highest percentage of both types of infection.

APPENDIX 8: PHOTOS FROM THE MAPPING

Professor Russell Stothard during the first workshop with MoHSS employees

Mr Moses Arinaitwe going over diagnostic techniques

Polytechnic of Namibia graduates practicing microscope-based diagnosis of NTDs

Mr. José Figueiredo meeting with Caprivi region MoHSS directorate

Mr Moses Arinaitwe conducting malacology in Caprivi region

A child receiving treatment: on the left is a teacher holding the praziquantel dose pole; and on the right is one of the field RDT technicians, Julius, with a second teacher giving treatment and registering the child

Field RDT technician Julius conducting CCA tests (for intestinal schistosomiasis)

Team campsite in Rundu (Kavango region)