THE IMPACT OF POOR WATER QUALITY ON WATER USERS' HEALTH

Final Report

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IWMI
International Water Management Institute

Introduction

The city of Hyderabad, located on the Deccan plateau, is situated in a semi-arid zone where the majority of the rainfall occurs during a short monsoon season lasting from June to July. To overcome water shortages, recharge groundwater and to extend the irrigation season the (rural) population in and around Hyderabad have for centuries used water storage tanks (lakes) for domestic and agricultural water uses.

The rapid growth of the city of Hyderabad, from less than 300,000 at the beginning of the twentieth century, to over 6 million in 2001 has resulted in urban encroachment and the indiscriminate disposal of untreated domestic and industrial wastewater into the different lakes. The majority of the lakes situated in the urban and peri-urban areas are severely polluted by wastewater which could have a negative impact on the health of those that depend on tank water for their livelihoods. This document will present a study which investigated the impact of wastewater polluted tanks on the health of water users in occupational contact (farmers and washer-men) and those living in close proximity of these lakes. For the study a severely polluted lake (Nala Cherevu) and a comparatively 'clean' lake (Amber Cherevu) were selected.

Background

For many years it has been the general belief that better (drinking) water quality would result in less diarrhoeal disease and thus better health within the household. More recently, the importance of water availability and use has been stressed [1]. The general consensus now is that the quantity of water used by people is at least as important, and often more important, for diarrhoeal disease control than the quality of that water [2]. However, vulnerable groups within the population especially children are still at risk of diarrhoeal disease as a result of exposure to poor quality water.

Wastewater in developing countries generally carries a wide diversity of human pathogens, reflecting the diseases present in the population served by the sewage network [3]. The highest risks associated with the direct occupational use of wastewater or the use of wastewater polluted water, as based on theoretical and epidemiological considerations, (including persistence in the environment, infective dose and immunity), is considered to be infection with intestinal nematodes. These infections are mainly due to: *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), *Ancylostoma duodenale* and *Nector americanus* (hookworms)[4].

Study Design

Study aim

To critically evaluate the impact of poor quality tank water on the health of farming families and families living in close proximity to polluted tanks, in Hyderabad, India.

Study design

A cross-sectional study (Table 1) was conducted to investigate the prevalence of intestinal nematode infections in farmers and dobi's who were occupationally exposed to tank water. A four month cohort study in combination with a water quality assessment at both lakes was undertaken to assess the incidence of diarrhoea and other diseases. The outcome measures for assessing risk of exposure to different water qualities were the prevalence and intensity of intestinal nematode infections in stools in both adults and children and the incidence of diarrhoea in particular, but also other health problems in children and adults.

Table 1 Number of selected individuals per exposure group

	Adults	Children	Total
Residents close to Amber Cherevu	79	51	130
Residents close to Nala Cherevu	87	36	123
Dobi's at Amber Cherevu	64	39	103
Farmers at Nala Cherevu	83	44	127
Total	313	170	483

<u>Intestinal nematodes</u>

Intestinal nematode prevalence was assessed in fresh stools. Fresh stool samples were collected in pre-labelled 50 ml stool sample containers. Each individual received a container labelled with a unique ID number and the individual's name in Telugu. The formal-ether concentration technique was used for analysis, as it has consistently shown higher recovery, especially in light infections as compared with other techniques [5].

Severity of intestinal nematode infections was quantified by taking a pre-weighted stool sample of approximately 2 grams, which was dissolved in 6 ml of formalin (30% formaldehyde). After proper mixing, this was transferred to a Parasep tube in which 2 ml of ether-acetate was added. The tubes were centrifuged at 2500 rpm for two minutes, after which formal water and fat were drained off. All residue in the tube was analyzed in a saline solution under a 10 by 10 magnification for helminth eggs and larvae.

Following the results of the survey, only those individuals that had provided a positive stool sample were provided with anthelminthic medication. Medication was personally delivered to the household by an IWMI research assistant and care was taken that the medication was taken in the correct way. The chosen medication for intestinal nematode infections was a broad spectrum anthelminthic (Albendazole) which has proven to be highly efficient with negligible side effects and is widely available [6].

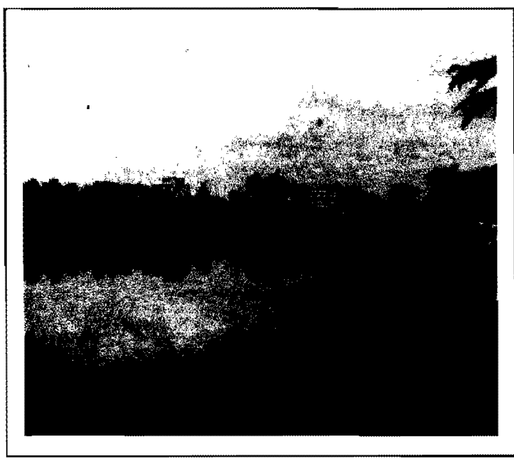
Diarrhoea and other diseases

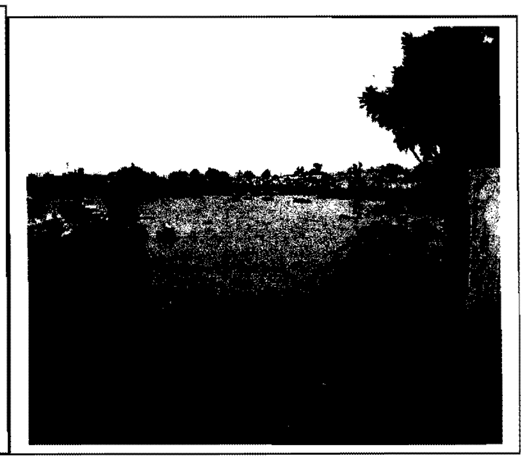
Diarrhoea is most common among children and less common in adults (as result of regular exposure to disease agents). Diarrhoea prevalence was therefore only be investigated for children up to the age of 12. Diarrhoea in this study is defined as three or more loose or watery stools in a day [7]. During the course of the study each selected household was visited on a weekly basis by a female research assistant, who recorded the number of days with diarrhoea during the past week. Dysentery was defined as 'bloody' diarrhoea. Other diseases were noted down when reported by study participants. However malaria was only noted down if the case was confirmed by a medical doctor.

Water quality

Tank water samples were collected on a monthly basis during the period from August 2004 - November 2004. Water samples were collected from representative sites unaffected by human activity. Samples at Amber Cherevu were collected from a site next to the road running through the middle of the lake at a rocky outcrop. Samples at Nala Cherevu were collected at the middle of Southern side of the lake away from the road and human habitation.

Images showing the view from the sample points at Nala (left) and Amber Cherevu (right)





The main water quality outcome parameters were the concentration of intestinal nematode eggs (eggs/litre) and *Escherichia coli* (colonies/100 ml). Water samples were further tested for biochemical oxygen demand (BOD mg l^{-1}), dissolved oxygen (DO mg l^{-1}), electro-conductivity (EC dS/m) and dissolved nitrogen (NO_3^- mg l^{-1}).

Intestinal nematode egg analysis in water samples was done by the adapted Bailenger method [8], which was found to have the highest egg recovery of four tested methods [9]. *Escherichia coli* was analysed by the membrane filtration technique while DO and EC were measured *in-situ* by a hand-held meter (Model 85, YSI, Ohio, USA). Nitrate and BOD were analysed following standard methods [10] in private laboratories.

Household selection

Agricultural households using water from Nala Cherevu were randomly selected from village census lists. Individuals were selected on a household basis, in which all eligible adults and children in a household were included (Table 1), though analysis happened on an individual level. A total of 25 households were selected with a total population of 127; 44 children and 83 adults. The dobi's were not necessarily living close to Amber Cherevu and as a result they were much harder to locate. We selected 25 households with a total population of 113; 49 children and 64 adults. For the 'diarrhoea' survey households within 250 meters of each of the lakes were selected, for Nala Cherevu households were located at the North-Eastern border of the lake close to the main road to Warangal, while at Amber Lake the households were situated at the Northern edge of the lake. A total of 50 households were selected with a total population of 253, of which 101 were adults (age > 18) and 152 were children. During the course of the study, a household questionnaire (Annex 1) was completed to assess socio-economic status, educational level, hygiene practices and access to water supply and sanitation.

Results

Water quality

The results of the water quality tests (Table 2a, 2b, 2c) show clearly that Amber Cherevu was much cleaner than Nala Cherevu. However relatively high *E.coli* counts found in water samples from Amber Cherevu indicate that water was unsuitable for drinking purposes based on World Health Organization (WHO) guidelines [11]. During the course of this study all water samples collected at Amber Cherevu were found to be free of intestinal nematode eggs. BOD concentrations were found to be low, while DO concentrations were relatively high which was supported by the presence of fish and people fishing in the lake. This would indicate a more or less stable water quality all year round

Table 2a: Mean water quality parameters for both lakes in the period August – November 2004 (values in parentheses indicated ± 1 Standard Deviation)

	Unit	Amber Cherevu	Nala Cherevu
BOD	mg l^{-1}	19 (4)	62 (23)
DO	mg l^{-1}	5.64 (0.5)	0.25(0.2)
E.coli	CFU/100 ml	$2.3\ 10^{3}$ ($2.3\ 10^{3}$)	$1.5\ 10^{7}$ ($1.4\ 10^{7}$)
Electro-conductivity	dS/m	1.03 (0.2)	2.35 (0.3)
Nematode eggs			
Ascaris	Eggs/litre	0.0 (0.0)	0.0 (0.0)
Hookworm	Eggs/litre	0.0 (0.0)	34 (60)
Dissolved Nitrogen	mg l^{-1}	1.3 (0.5)	26.3 (5.0)

Table 2b: Monthly variations in water quality at Amber Lake in the Period August – November 2004

	August	**September**	**October**	**November**
BOD	24	19	17	16
DO	5.72	5.85	4.99	6.01
E.coli	5.1E+03	3.2E+03	5.3E+02	5.0E+02
Electro-conductivity	1.06	1.02	1.06	0.98
Nematode eggs				
Ascaris	0	0	0	0
Hookworm	0	0	0	0
Dissolved Nitrogen	1	2	1	1

Table 2c: Monthly variations in water quality at Amber Lake in the Period August – November 2004

	August	**September**	**October**	**November**
BOD	33	57	84	73
DO	0.47	0.07	0.21	0.24
E.coli	3.5E+07	4.0E+06	1.7E+07	2.0E+07
Electro-conductivity	1.97	2.34	2.37	2.73
Nematode eggs				
Ascaris	0	0	0	0
Hookworm	10	123	4	0
Dissolved Nitrogen	21	30	28	26

The water samples collected from Nala Cherevu had high *E.coli* counts and were in 3 out of the 4 months positive for hookworm. Egg concentrations ranged from 10 eggs per litre to 123 eggs per litre. These concentrations based on drinking water and agricultural reuse guidelines [11 12], make Nala Cherevu water unsuitable for drinking and agricultural purposes.

Water samples collected from Nala Cherevu were found to be foul smelling, and clearly contaminated by domestic wastewater. BOD values as a result were found to be high, but lower than had been previously observed (IWMI-unpublished). The recent construction of a bund around the North-Eastern side of the lake could have played an important role in this water quality improvement.

Household characteristics

The age of adults selected for this study was on average, 30+ with the adult participants selected at Nala Cherevu slightly older as compared with those selected at Amber Cherevu. Similarly, the average age of children at Amber Cherevu was also lower as compared with that of children at Nala Cherevu (Table 3). There was a significant difference in schooling, with adults living around Nala Cherevu having attended school on average 5 years longer then adults at Amber Cherevu. Although and attempt was made to have a similar socio-economic make-up of selected households at both lakes, the selected households at Amber Cherevu proved to be poorer as compared to those at Nala Cherevu.

This socio-economic classification was based on the possession of key household items (Annex 1) and household construction. Ownership of television was common around Nala Cherevu and some households even owned a car, while at Amber Cherevu only a single household owned a television and none of the households owned a car.

Water supply and sanitation characteristics were fairly similar for the selected households at both lakes. The large majority of households at both lakes had their own latrine and only a small group used publicly recognized defecation sites. Per capita water use, a good indicator of personal hygiene, was below the recommended 50 litre per capita per day [13] but similar in both groups of households.

Table 3: Key household characteristics of households selected at Amber and Nala Cherevu

	Amber Cherevu n = 27	Nala Cherevu n = 23*
Age		
Adults	32.9 (13.2)	37.8 (15.3)
Children	7.8 (5.3)	9.6 (4.7)
Education (years)		
Adults	3.1 (5.3)	8.4 (6.9)
Children	2.6 (3.0)	5.9 (3.5)
House construction		
Poor	0%	4%
Medium	96%	61%
Good	4%	35%
Latrine		
No	30%	26%
Yes	70%	74%
Socio-economic status		
Poor	70%	26%
Medium	15%	30%
Rich	15%	44%
Water Supply		
Public Stand-post	7%	22%
Household tap	93%	78%
Per Capita Water use (l/day)	26.9 (10)	30.5 (15)

* Values in red indicate the results of a social-economical survey conducted around the lake

Stool analysis

A total of 196 participants handed in a stool sample (Table 4) resulting in a compliancy of 82.5%. However, compliancy in farmers was 92.5% which was much higher as compared with the compliancy in dobi's of whom only 69% handed over a stool sample. Hookworm was the most common nematode infection with an overall prevalence of 27.6% (54/196), followed by *Ascaris* with a prevalence of 8.7% (17/196) and *Trichuris* with a prevalence of 8.2% (16/196).

However, the prevalence of hookworm in those occupationally exposed to water from Amber Cherevu was significantly lower as in those working with water from Nala Cherevu. *Ascaris* and *Trichuris* infections were even found to be completely absent from adults and children exposed to Amber Cherevu water. *Ascaris* and *Trichuris* infections were common in farmers using Nala Cherevu water even though eggs from both these nematode were not found in Nala Cherevu water.

In general, the intensity of infection as based on WHO criteria was low as the WHO classifies intensities of infects below 1,000 eggs per gram for hookworm and below 10,000 *Trichuris* or *Ascaris* eggs per gram as low [14] and no significant difference in intensity of infection was found between both groups of water users.

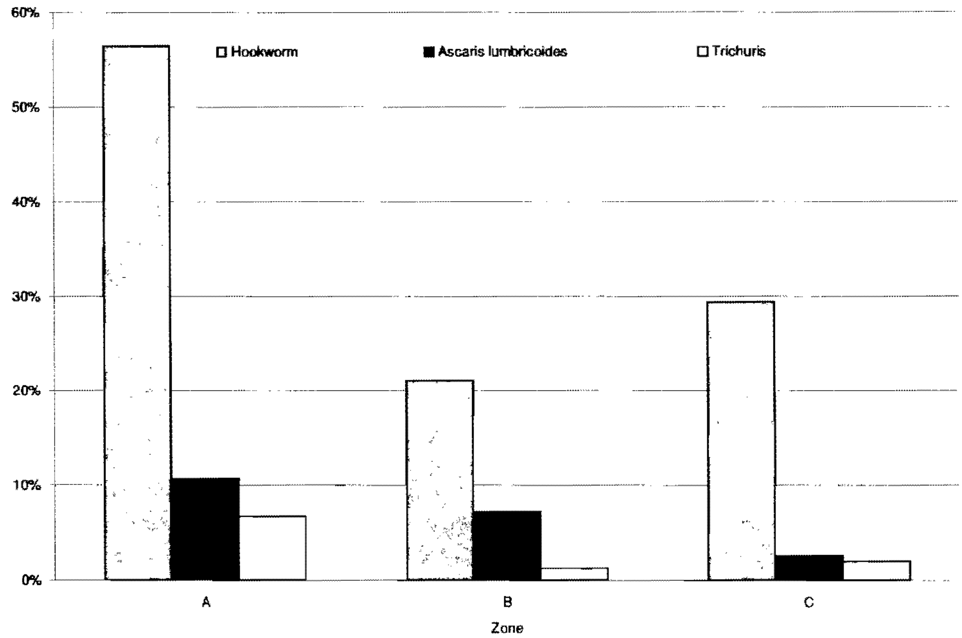
Table 4 Intestinal nematode prevalence (%) and intensity (eggs/gram) of infection in adults and children at Amber (AC) and Nala Cherevu (NC).

	Ascaris		Hookworm		*Trichuris*	
AC	**Prevalence**	**Intensity**	**Prevalence**	**Intensity**	**Prevalence**	**Intensity**
Adults	0/52 (0%)	0	3/52 (6%)	4	0/52 (0%)	0
Children	0/27 (0%)	0	2/52 (4%)	201	0/27 (0%)	0
NC	**Prevalence**	**Intensity**	**Prevalence**	**Intensity**	**Prevalence**	**Intensity**
Adults	11/78 (14%)	183	37/78 (47%)	123	8/78 (11%)	31
Children	6/40 (15%)	81	14/78 (35%)	69	8/40 (20%)	518

Survey's conducted in the city of Hyderabad are scarce so it is hard to say if the hookworm and *Ascaris* prevalence is high or low as compared to other groups. However, a survey conducted in 1989 of industrial workers showed a hookworm prevalence of 2.5% and a *Ascaris* prevalence of 15%. The Ascaris prevalence in both exposure and age groups was comparable to this survey. However, the hookworm prevalence in all exposure was considerably higher as compared to the prevalence found in industrial workers.

A survey conducted in farmers along the Musi-river, where farmers used untreated wastewater (80 eggs/litre), partially treated wastewater (15 eggs/litre) and wastewater free of nematode eggs showed a clear decrease in prevalence with increased distance from the city and lower hookworm and *Ascaris* concentrations in irrigation water (Figure 1). Farmers using water from Nala Cherevu used water which could be considered to be of a quality between untreated and partially treated wastewater and showed a hookworm prevalence which was in between these two groups. The *Ascaris* prevalence in the three groups of farmers along the Musi-river showed a less clear difference and no difference between Musi farmer and Nala Cherevu farmers was observed.

Figure 1 Hookworm, *Ascaris* and *Trichuris* prevalence in farmers using untreated wastewater (A), partially treated wastewater (B) and clean irrigation water (C)



Disease survey

A total of 253 individuals were followed for 112 days (1st of August – 20th November), resulting in a total of 28,336 person observation days. The most common diseases during this period of study in both adults and children were fever and the common cold (Table 5a and 5b). Diseases typically associated with poor water quality like diarrhoea and dysentery were less common and the incidence in general was low, with children only suffering 3.2 days out of 1000 days of diarrhoea. Children as expected suffered more from diarrhoea as compared with adults. Further, children at Nala Cherevu suffered more days from diarrhoea as compared with children from Amber Cherevu, though this difference was not statistically significant.

Table 5a : Number of people and number of days affected by disease

	Amber Cherevu		Nala Cherevu	
Adults	**n = 49**		**n = 52**	
	# people	Days	# people	Days
Diarrhoea	1	6	1	3
Dysentery	2	9	-	-
Fever	6	26	7	44
Common Cold	11	63	5	83
Malaria	1	10	-	-
Children	**n = 78**		**n = 74**	
	# people	Days	# people	Days
Diarrhoea	3	8	5	14
Dysentery	-	-	-	-
Fever	5	25	12	115
Common Cold	6	21	14	99
Skin Problems	2	17	2	8
Viral infection	-	-	1	4

The disease data showed a clear seasonality with the majority of the disease incidence taking place in the month of August, with October and November more or less disease free. During the course of the period under investigation only 20% of the households were found to be free of disease. In Annex 2 the results of a disease survey conducted by the social economic component of the Lake study are presented. This data shows the same diseases as presented in this survey however the incidence of disease is higher than reported in this study which can be explained by the recall period which was set for three months. For health studies, this is considered to be too long for effective recall and is likely to have resulted in an over reporting of the disease incidence as compared to this survey.

Table 5b: Disease incidence for adults and children at both Amber and Nala Cherevu

	Amber Cherevu	Nala Cherevu
Adults*	**n = 49**	**n = 52**
Diarrhoea	0.7	0.4
Dysentery	1.1 – 1.1**	0.0
Fever	3.2	1.5 – 0.4**
Common Cold	2.3	0.9
Malaria	1.2 – 0.2**	0.0
Children*	**n = 78**	**n = 74**
Diarrhoea	1.2	2.0 – 0.2**
Dysentery	-	-
Fever	3.8	11.8 – 3.0**
Common Cold	3.6	10.9
Skin Problems	2.6	1.0
Viral infection	0.0	0.5

*Disease incidence in person days ill/1000 person days

**Work or school days lost as a result of disease

Children at Nala Cherevu suffered significantly more from fever and cold as compared to children around Amber Cherevu. During the course of the study one adult reported a case of malaria, while a child at Nala Cherevu suffered from a case of viral fever, whether this was a case of Dengue fever or Japanese Encephalitis was unknown.

The burden of disease was low, with only 1.3 days out of 1000 (0.13%) working days missed at Amber Cherevu as a result of disease. Children as a result of disease did not miss any school days. The burden of disease for adults living in close proximity to Nala Cherevu was lower as compared to Amber Cherevu with only 0.4 (0.04%) days out of a 1000 working days missed as a result of disease. However, children missed 3.2 school days out of 1000 school days as result of disease.

Discussion

Water Quality

Water quality at Amber Cherevu was considerably better as compared to Nala Cherevu. However, water quality at both lakes was unsuited for drinking purposes as a result of high *E.coli* counts. The source of *E.coli* pollution at both lakes lies in the disposal of wastewater into the lake and the fact that the borders of the lakes are used as a public defecation sites. However, none of the selected households (at both lakes) reported that they used lake water for drinking purposes and thus especially at Amber Cherevu, where the *E.coli* concentrations were low but for one month, the health risks could be expected to be minimal. The *E.coli* concentrations at Nala Cherevu were high throughout the study period and the appearance of the lake indicated that large quantities of raw sewage are disposed into the lake. It seems however that the construction of a bund to the north side of the lake has resulted in an improved water quality. The high concentrations of *E.coli* in Nala Cherevu would pose a significant risk to those exposed to the water. However of all the households selected at Nala Cherevu none reported any domestic usage of lake water.

The presence of hookworm eggs in Nala Cherevu water made the water unsuitable for irrigation based on the World Health Organization guidelines[12]. However, farmers downstream of the Lake were happy to use the water as a result of the perceived high nutrient content of the water. Farmers grew parra grass, though an increasing number of farmers also grew vegetables, including different varieties of spinach, tomatoes, cabbages and eggplant. The cultivation of vegetables was considered lucrative as it provided a higher farm income as compared to the cultivation of parra grass and paddy. This was mainly because vegetables fetched a higher price at the market but also because it generated a steady income throughout the year, whereas especially for paddy the income was concentrated during only two periods of the year. Farmers seem to take potential health risks as a result of the water from Nala Cherevu for granted.

A bi-annual anti-parasitic treatment programme for the approximately 500 individuals exposed to Nala Cherevu water would come to a total cost of 12,000 Rupees and in combination with the promotion of footwear and improved hygiene and sanitation education would be able to minimize health risks a result of this water use and would have likely much wider health implications.

Disease survey

The disease incidence and especially the incidence of water borne diseases like diarrhoea and dysentery was low and showed no significant difference between the two lakes. This finding does not come as a surprise as households at both lakes indicated that they did not use water for drinking or domestic purposes and had thus very little interaction with the lake. Most of the households rely on municipal water, which is of reasonably good quality and seems to be sufficiently available to guarantee a reasonable 'healthy' per capita water use.

The incidence of none (waste) water related diseases like fever and the common cold was much higher as compared to the incidence of the water related diseases. This brief study showed a significant difference in the incidence of both fever and the common cold in children living at Nala Cherevu as compared to children living at Amber Cherevu. The reason for the higher incidence of fever and cold in children of Nala Cherevu is hard to explain as the water quality at both lakes is unlikely to have played a role. The fact that the settlements next to Nala Cherevu were more cramped and that the area as a whole seemed to be much more built up could have resulted in a quicker spread of the common cold and fever or flu among its residents as compared to Amber Cherevu where the houses were much more scattered around the lake and the area was much less built up. Another explanation could have been that Nala Cherevu is situated next to a busy road and that dust and exhaust fumes could have contributed to rise in the incidence of the common cold and potentially other respiratory track infections.

Participants of the study at Nala Cherevu and Amber Cherevu both complained that because of the tanks they suffered more from mosquitoes. During the course of the study a case of malaria was reported in Amber Cherevu and a case of viral fever, either dengue of Japanese encephalitis was reported at Nala Cherevu. The vector for malaria is the anopheles mosquito which tends to prefer clean water habitats, while the vector for dengue and or Japanese encephalitis is the Culex or Aedes mosquito which both tend to breed even in severely polluted water bodies. This could suggest a possible linkage between water quality and vector borne diseases. However, the study population was too small and the duration of the study to short to say anything about the prevalence of malaria, dengue and or Japanese encephalitis in relation to the water quality at both lakes.

Relevance of this survey

The rehabilitation of the lakes in and around Hyderabad was undertaken to improve groundwater recharge, groundwater quality and to improve the general environmental situation, though never with the idea to improve the health of its users or those living in the close proximity of the lakes. The potential to improve the health of its users and those living in the close vicinity of the lakes was considered as a possible additional benefit.

Well designed epidemiological studies could help provide valuable feed-back on the impact of large and often costly interventions, such as the cleaning up of lakes or rivers. However care needs to be given on how much can be achieved within the budget constraints. Studies on the incidence of diarrhoea pre and post an intervention often require large sample populations as a result of the high background levels of diarrhoea in children and because diarrhoea has many different causes other than just poor water quality.

This makes epidemiological studies often expensive and a significant outcome can not always be guaranteed. Hookworm has shown a very strong association with agriculture and marginal water quality irrigation and as was shown in this study is much more suitable for a successful epidemiological assessment of the improvement of water quality.

Conclusions

Based on the findings of this study it can be concluded that living in the close proximity of a severely polluted lake does not necessarily lead to a higher risk of water borne disease as this short study showed no increased risk of either diarrhoea or dysentery in the most vulnerable group (children). A likely explanation is the ample availability of sufficient and clean water provided by the local utility for domestic and drinking water purposes.

The use of water from Nala Cherevu, which contained above permessible concentrations of hookworm eggs, resulted in a high prevalence of hookworm and other nematode infections in farming families. A ban on water use from Nala Cherevu should be carefully considered as it would deprive farming families of their livelihood, while crop restrictions, in which farmer would not be allowed to grown vegetables, would be hard to enforce and may take away the profitability for farmers. It is debatable if the the treatment of water from Nala Cherevu would be economically viable considering the relatively small flow from the lake and the small number of farming families using water from Nala Cherevu. The most sustainable and affordable option would be the regular treatment of farming families with anti-parasitic medication and the promtion of improved hygiene and sanitation practices and the use of footwear.

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Annex 1

Household Questionnaire

Date: / /	Lake:	HH ID#:

To be filled out before interview

Head of the Family name:					
# of adults:		# of children 5-15		# of children <4	

Religion of family
1. Hindu 2. Muslim 3. Other__________________

Observations

O. 1. What kind of material is the floor in the compound made of?
1. Soil 2. Mixture of dung and soil 3. Tiles/stones 4. Other____________

O. 2. What kind of material are the walls of house made of?
1. Wood/sticks/bamboo 2. Mixture of dung and soil 3. brick or stones with plaster 4. Concrete 5. Other____________

O. 3. Do you see wastewater pools or streams on the compound or just in front of the house in the street?
0. No 1. Yes

O. 4. Do you see animals in the compound?
0. No 1. Yes

O. 5. Do you see a latrine in the compound?
0. No 1. Yes

Questions

Q. 1.	Do you own your own house?
	0. No 1. Yes

Q. 2.	Do you own land?
	0. No 1. Yes _______ acres
Q. 3.	How many rooms does your house have?
	1. 1 2. 2 3. 3 4. more than 3
Q. 4.	Do you have a latrine at your house?
	0. No 1. Yes

Note: fill out what people say, not what you have observed yourself

Q.5.	Which of the following household items do you own?
	1. Bicycle 2. Buffalo/Bullock cart 3. Refrigerator 4. Scooter/Motorbike 5. Tractor or car 6. Colour Television 0. None of these items

Note: More than one answer is possible, enter all that are reported

Q. 6.	Where do you normally get water for cooking and washing?
	1. Manjara standpost 2. From a household connection to a WSS in our house 3. From a household connection to a WSS in another house 4. Groundwater (bore, hand pump or deep well) 5. Other_____________

Note: If people answer that they obtain water from more than one source mark both

Q.7.	How times per week do you fetch/get water?	
	1. everyday 2. once every two days 3. once every three days 4. once every four days 5. Other_________________	

Q. 8.	How many jerry cans/pitchers of water do fetch each time when you go to get water?	
	1. 1 2. 2 3. 3 4. Other_________________	

Q. 9.	What kind of animals do you own?
	0. None 1. #_______buffaloes 2. #_______goats/sheep 3. #_______chickens

	4. other:____________________

Q. 10.	**Where do your buffaloes and cows stay during the day?**
	0. We have no buffaloes or cows **1. In the field** **2. In a special animal shed outside the household** **3. On the compound** **4. Somewhere else_____________**

Q. 11.	**Where do the buffaloes and cows stay during the night?**
	0. We have no buffaloes or cows **1. In the field** **2. In a special animal shed outside the household** **3. On the compound** **4. Somewhere else_____________**

This last question you only ask when you really don't know

Q. 12. Caste of family
0. None **1. Reddy's** **2. Yadav's** **3. Goud's** **4. Kachi** **5. Mudhrasi's** **6. Scheduled castes *(Harijans)*** **7. Scheduled tribes *(Dalits)*** **8. Other_________________________**

Check to make sure there is an answer recorded for every question.

Thank the person for his/her time! Ask if they have any questions

Annex 2

Details of health related problems in the family										
Sl. No	Item	Description	Type of Symptoms/Illness No.							
			Fever	Cough/ Cold	Breathless ness	Blood motions	Vomiting	Skin diseases	Malaria	Headache
1	Health problem (last 3months)	Yes	49	4	0	1	2	3	1	1
		No	111	156	160	159	158	157	159	159
		Total	**160**	**160**	**160**	**160**	**160**	**160**	**160**	**160**
2	Person affected	Men	7	0	0	0	0	0	0	0
		Women	10	2	0	0	1	3	1	0
		Child	32	2	0	1	1	0	0	1
3	No of days bedridden	Up to 5 days	13	1	0	1	0	1	0	0
		6 to 10 days	31	2	0	0	2	1	1	0
		> 10 days	5	1	0	0	0	1	0	1
4	Cause/reasons for Illness	Drainage water	0	0	0	0	0	0	0	0
		Mosquito bites	32	1	0	0	0	0	1	0
		Foul smell	1	0	0	1	0	0	0	1
		Polluted water	4	3	0	0	1	3	0	0
		Pollution	1	0	0	0	0	0	0	0
		Mosquitoes & Polluted water	5	0	0	0	0	0	0	0
		Foul smell& Drainage water	2	0	0	0	0	0	0	0
		Mosquitoes &smell	4	0	0	0	0	0	0	0
		Foul smell& polluted water	0	0	0	0	1	0	0	0

Annex 3

Short resume of those involved in the study

Jeroen Ensink (Project leader)

Tasks in this project:: Study design, stool sample and water quality analysis, data analysis and write up of report

Background: In 1999 I completed my Msc in water management and health from Wageningen Agricultural University, the Netherlands and since then I have worked six years with the International Water Management Institute (IWMI) in Pakistan and India. I have been involved and managed several projects which aimed to evaluate the links between water management, human health and the environment. I am currently completing my PhD at the London School of Hygiene and Tropical Medicine on the risks of hookworm infection in farmers as a result of marginal water quality use in agriculture.

Research Assistants: Urmila Mata (Left) and Rama Devi (Right)

Tasks in this project: Disease interviews, household surveys, stool and water sample collection and data entry

Background: Urmila Mata is a nurse by training but has for the last 1.5 years, been involved in a project evaluating the impact of contaminated Musi-water on the health of farmers living downstream of the city of Hyderabad. Rama Devi is originally a teacher but has for the last three years been involved as a research assistant with IWMI in research activities related to marginal water quality use in agriculture.