



WATER & RISK

Dear Reader,

It is a pleasure to provide you with a new issue of our Newsletter on Water&Risk.

The last edition has been published quite a while ago and if we are lucky you might have spent a thought on asking yourselves where we disappeared.

Well, good things take a while! We have been busy and found new authors that provided us with insights into their work.

But like meeting old friends: it does not matter how long you have not seen each other. What matters is that you meet again, catch up and enjoy each other's company. Learning what has happened in the past and what new plans are on the menu.

I think, at present we continue to look more into long-known principles of water uses, giving them new meanings and acknowledging their value, while carefully considering associated risks. Maybe those risks out-value the benefits, but often we find it to be vice versa.

With the rapid changes that our societies are facing, water management is becoming more and more a critical issue. We are calling for more drinking water for our growing populations, and also the growing agricultural demands are leading to an increase of water abstraction. Achieving food security for our communities under increasing unstable seasonal patterns and uncertain weather conditions poses a challenge for farmers worldwide. Aspects of water and sanitation count for occupational hygiene and personal hygiene of every farmer. They might be exposed to a variety of water-related health risks during their daily work routine and at their homes. Risks that are not necessarily considered to be such or that are accepted as a disturbance of daily life by the individuals.

We are still trying to get a better understanding about the complexity of water and risks. While data are gathered, models developed and knowledge is generated, we are still far away from understanding all processes that affect us. But this gives rise to optimism, that we will be able to provide you with more news about the research on water and risk.

Andrea Rechenburg

WHO CC for Health Promoting
Water Management & Risk Communication
Bonn, Germany
andrea.rechenburg@ukb.uni-bonn.de



Urbanization, sanitation and population growth, how do they affect water quality?

A modelling study on *Cryptosporidium* in Bangladesh and India

Surface water is an important environmental transmission route of diarrhoea-causing pathogens. People can become infected when ingesting contaminated water either as drinking water, during recreation or via irrigated crops (Medema and Schijven 2001). Human excreta can contaminate water when sanitation systems are used that do not safely confine or adequately treat human excreta, such as toilets hanging above a stream, open defecation, or sewerage not connected to treatment plants.

The Sustainable Development Goals, the follow-up of the Millennium Development Goals, target a decrease by half of the release of untreated sewage and an end to the practice of open defecation. However, sanitation improvements are lagging behind current fast-paced urbanization, especially in the growing number of urban slums in developing countries (WHO/UNICEF JMP 2000).

Monitoring data on waterborne pathogens in the environment are scarce, especially in the developing world, as monitoring is costly and time-consuming. Therefore, a model was developed to study the effect that sanitation changes, urbanization and population growth may have on human emissions of *Cryptosporidium* oocysts (the robust survival stage of the pathogen) into surface waters. This model is an adaptation of the global *Cryptosporidium* model by Hofstra et al. (2013). Bangladesh and India were chosen as case study areas, being examples of developing countries with high population density, fast urbanization rates, and where a range of different sanitation systems are in use.

The model predicts urban centres to be hotspots of human *Cryptosporidium* emissions (Figure 1). We estimate that 53% (Bangladesh) and 91% (India) of total emissions originate in urban areas. In Bangladesh, 50% of oocysts come from only 8% of the country area, in India from a mere 3% of the country area.

The model can be used to estimate the contribution of populations using different sanitation systems to the total emissions (Figure 2). In Bangladesh, most emissions come from direct sources (sanitation systems that cause faeces to reach the environment directly, such as hanging toilets and urban open defecation). In India, most



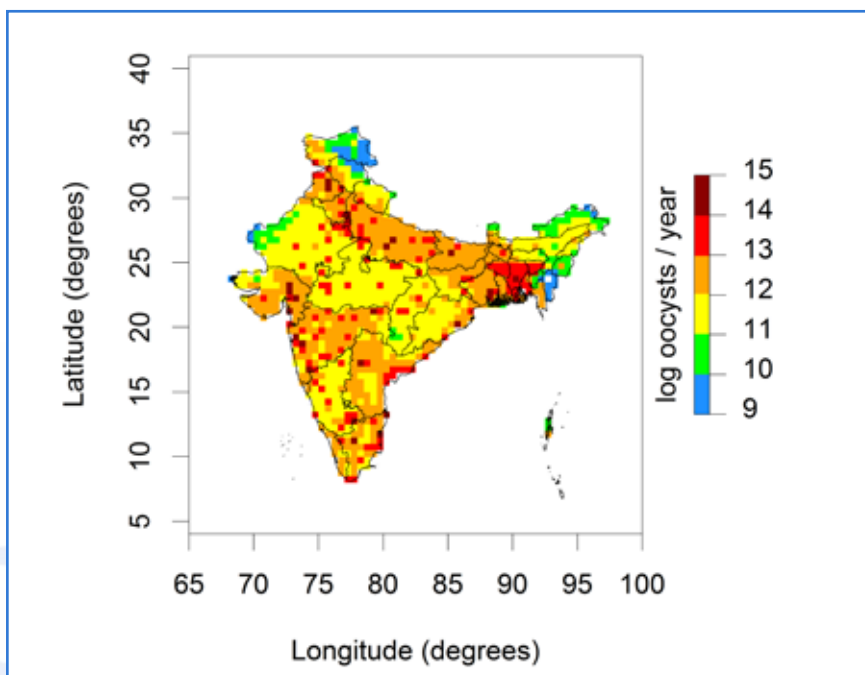


Figure 1: Modelled *Cryptosporidium* emissions to the surface water in Bangladesh and India for the year 2010. This map shows that the model pinpoints urban centres as emission hotspots. Source: Lucie Vermeulen et al. 2015

emissions come from sewer connections with inadequate treatment.

The model was used in a scenario analysis to explore what may happen in future. Two scenarios were defined, representing conditions in 2050. First, a 'business as usual' scenario was defined. In this scenario it was assumed that the proportion of people connected to the different sanitation types in urban and rural areas are the same as today. Sewage treatment levels stay the same (only primary treatment). Second, a 'sanitation improvements' scenario was defined. In this scenario it was assumed that open defecation is no longer practiced and that hanging toilets are no longer used. The urban population that was using these sanitation systems is now mostly connected to the sewage system (75%) or on-site systems such as septic tanks and latrines (25%). For the

rural population this is the other way around: people are now mostly connected to on-site systems (75%) and less to sewage systems (25%). Sewage treatment levels are improved; one third is primary treatment, one third secondary and one third tertiary treatment. Both scenarios use population growth and urbanization estimates for the year 2050 from the Millennium Ecosystem Assessment projections.

According to the scenario analysis, in the future, population growth and urbanization may worsen water quality in Bangladesh and India, even when sanitation systems are improved (Figure 3). Under the 'business as usual' scenario, oocyst emissions will increase by a factor of 2.0 for India and 2.9 for Bangladesh between 2010 and 2050. Under the 'sanitation improvements' scenario,

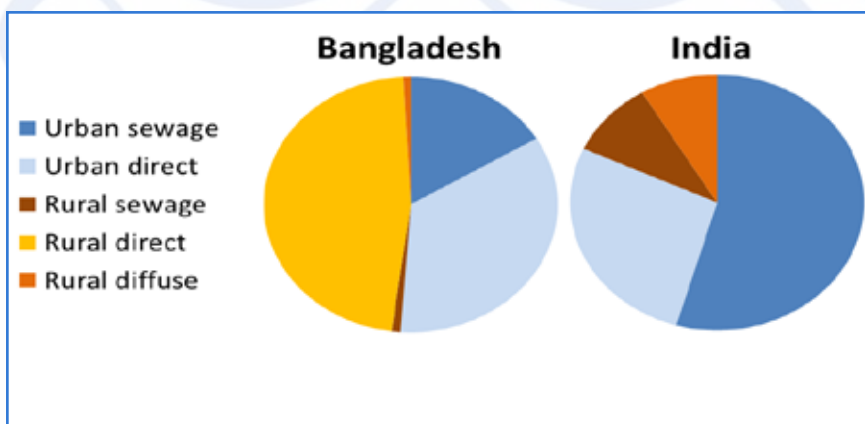
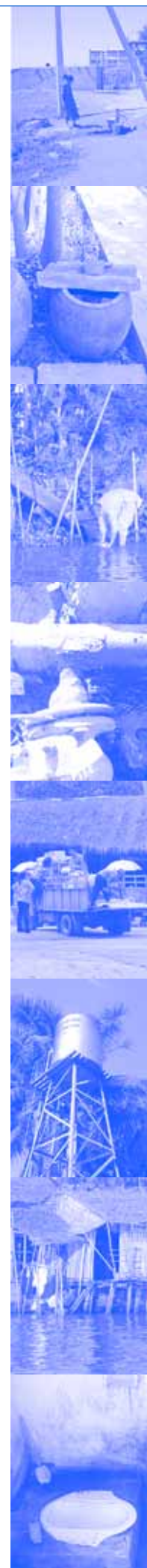


Figure 2: Contribution of populations using different sanitation systems to the total *Cryptosporidium* emissions into surface water. Direct emissions are defined as coming from sanitation systems in which human faeces reaches surface water directly (such as hanging toilets and urban open defecation, for which it was assumed that faeces are transported with open drains). Diffuse emissions are defined as faeces that are deposited on land and can reach the surface water via runoff (open defecation in rural areas). Source: Lucie Vermeulen



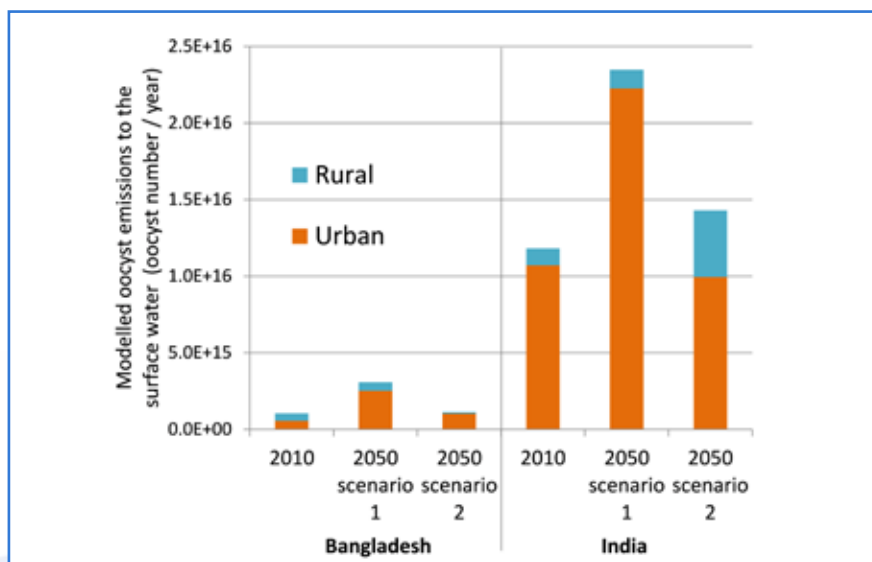


Figure 3: Total annual human *Cryptosporidium* oocyst emissions to the surface water under two scenarios in Bangladesh and India. Adapted from Source: Lucie Vermeulen et al. 2015.

oocyst emissions will increase by a factor of 1.2 for India and 1.1 for Bangladesh between 2010 and 2050.

This study shows that population growth, urbanization and the development of sanitation systems can significantly influence future water quality related to human excreta in Bangladesh and India. It has to be noted that humans are not the only source of *Cryptosporidium* in the environment, as it is a zoonotic pathogen. Nevertheless, for the current study on population growth, urbanization and sanitation, only human emissions were taken into account.

Modelling studies can be highly useful to 'get the bigger picture' of water quality problems. The present model is not validated since suitable water analysis data are unavailable, to our knowledge. Research efforts should be made to gather relevant monitoring data for comparison with the model results. While this case study for Bangladesh and India is an example, it is also possible to employ this model in other regions or even globally. Similar conclusions may hold true in other areas of the developing world and for other waterborne pathogens. Recently, an adaptation of this model was made for Rotavirus, also a diarrhoea-causing pathogen (Kiulia et al., 2015). Further work is planned on the effect of livestock *Cryptosporidium* emissions to surface waters, and on extending the model with a hydrological module to predict concentrations in the surface water and ultimately risk of infection.

The publication describing the research discussed in this article can be found here: Modelling the impact of sanitation, population growth and urbanization on human emissions of *Cryptosporidium* to surface waters—a case study for Bangladesh and India. Lucie C Vermeulen et al. 2015 *Environ. Res. Lett.* 10094017

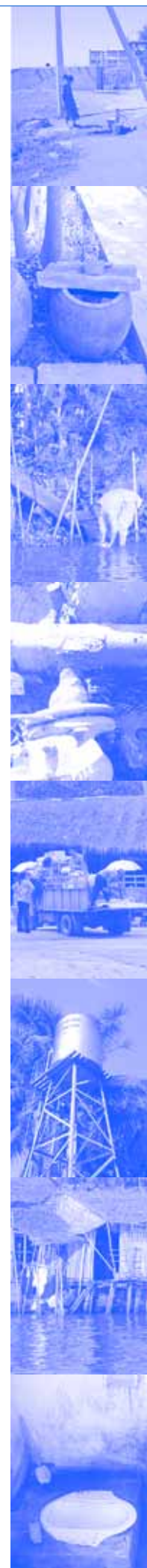
<http://iopscience.iop.org/article/10.1088/1748-9326/10/9/094017>

References

- Hofstra, N.; Bouwman, A. F.; Beusen, A. H. W.; Medema, G. J. (2013): Exploring global *Cryptosporidium* emissions to surface water. In: *Science of the Total Environment* 442, 10–9.
- Kiulia, N.M.; Hofstra, N.; Vermeulen, L.C.; Obara, M. A.; Medema, G. J.; Rose, J. B. (2015): Global occurrence and emission of rotaviruses to surface waters. In: *Pathogens* 4 (2), 229–255.
- Medema, G. J.; Schijven, J. F. (2001): Modelling the sewage discharge and dispersion of *Cryptosporidium* and *Giardia* in surface water. In: *Water Research* 35 (18), 4307–4316.
- WHO/UNICEF JMP (2000): *Global Water Supply and Sanitation Assessment 2000 Report*.

Lucie C. Vermeulen

Environmental Systems Analysis Group,
Wageningen University, the Netherlands
lucie.vermeulen@wur.nl



WASH and Wastewater-Irrigated Urban Agriculture in Ahmedabad, India

Diarrheal disease remains one of the leading causes of morbidity and mortality worldwide (Schmidt et al., 2011; Clasen et al., 2015). In 2004, 17% of the global under-five mortality was attributed to diarrhea, with the largest absolute number of diarrheal deaths occurring in India (WHO/UNICEF, 2009). Various systematic reviews have highlighted the effectiveness of Water, Sanitation and Hygiene (WASH) interventions in reducing diarrheal incidence (Clasen et al., 2010; Wolf et al., 2014; Clasen et al., 2015; Ejemond-Nwasiaro, 2015). However, despite efforts to improve sanitation infrastructure, sewage treatment capacities in most developing countries cannot keep up with increasing urban sewage volumes, leading to the discharge of untreated wastewater into surface waterways (Drechsel & Evans, 2010). Farmers rely on such surface water sources for irrigation, thus exposing themselves, their crops and potentially their wider community, to pathogens found in wastewater.



Figure 1: Wastewater discharge. Source: Timo Falkenberg

methodological framework of this study assumes a failure of the primary barrier at the municipal level. Therefore, faecal pathogens are released into surface waterways and introduced into communities via wastewater irrigation.

The study was conducted between September 2013 and August 2014 in bi-monthly intervals, following 204 households located in Ahmedabad (India), consisting of 1263 individuals. The methods used can be divided into three categories: cohort methods, cross-sectional methods and microbiological methods.

The cohort study forms the heart of the research since the primary outcome variable, health status, is assessed periodically throughout the research period. A health diary, adopted from Herbst (2006), was utilized to prospectively capture disease information.

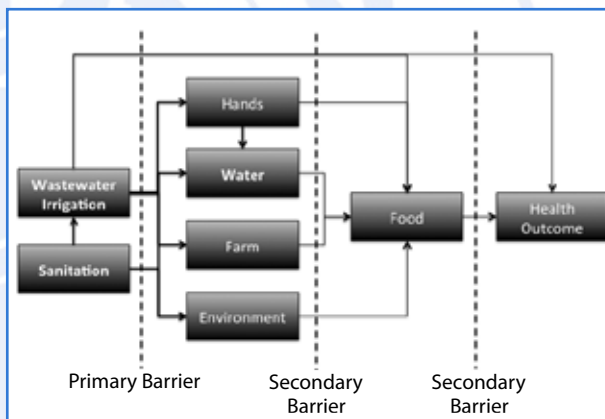


Figure 2: Methodological Framework (adopted from Wagner & Lanoix, 1958) Source: Timo Falkenberg

Study Design and Methodology

The study investigates the impact of wastewater irrigation and WASH factors on the incidence of diarrhoeal disease. It is hypothesized that wastewater irrigation introduces an additional source of exposure to the well-established WASH factors, creating similarly significant health risks. The methodological framework adopted for the study is based upon the F-diagram, which was developed by Wagner & Lanoix (1958) to highlight the transmission routes of faecal-oral diseases. Faeces form the pathogen stock, from which the pathogens are further transferred via water, hands, arthropods and food, to be ultimately ingested by a susceptible host (Bartram, 2015). Apart from illustrating the multiple transmission routes of faecal-oral pathogens, the diagram highlights primary and secondary barriers. Primary barriers prevent the release of faecal pathogens from faeces into the environment, whilst secondary barriers stop faecal pathogens that have entered the environment from reaching a susceptible host (Curtis et al., 2000). The

To avoid missing data and reporting fatigue, households were visited bi-monthly, to collect and/or expand the health diary. Additionally, during each visit a hygiene spot check was conducted.

The observational method for the spot check relies on a checklist of factors indicating hygiene behaviour. The checklist was adopted and extended from Webb et al (2006) and is divided into five categories: Environment, Sanitation, Water, Food and Personal Hygiene.

The cross-sectional methods consist of three surveys: baseline, farm and hygiene survey. These provide socio-economic and demographic information on the households as well as information on sanitation type, water and food storage, water treatment, farming practices, and preventive behaviours. The surveys are used to categorize households into various strata for analysis.

The final methodical component is the microbiological analysis of water for quantifying the primary exposure variable. The degree of faecal contamination is

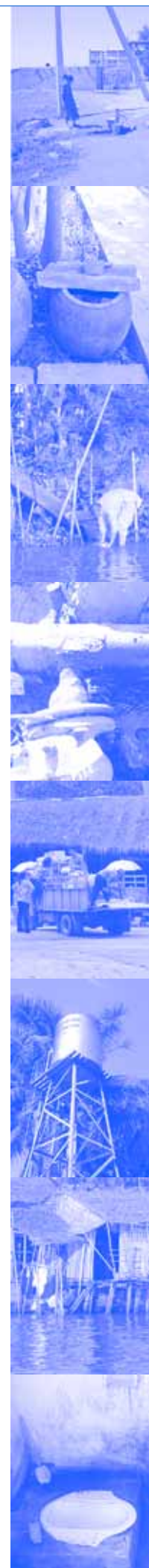




Figure 3: Irrigation water abstraction with electric pumps.
Source: Timo Falkenberg

determined by the quantification of *E. coli* using the Multiple Tube Fermentation method, employing the most probable number (MPN) technique. Four rounds of water sampling were conducted, representing the local four major seasons: summer, monsoon, post-monsoon and winter. During each round three types of samples were drawn: two drinking water samples (source and storage) and one irrigation water sample.

Research Area

Ahmedabad is the largest city of Gujarat state, situated in the northwest of India (WaterAid, 2006). The larger urban area of Ahmedabad has a population of 6.5 million people, whereas the city itself has a population of 5.6 million people (GOI, 2011). Ahmedabad is divided by the Sabarmati River into west Ahmedabad and east Ahmedabad, which are connected by five bridges (Mahadevia, 2002). Although Ahmedabad has two wastewater treatment plants, with a capacity of 180 million liters per day (mld) and 75 mld respectively, a large proportion of wastewater (168mld) is discharged into Sabarmati River



Figure 4: Wastewater irrigation.
Source: Timo Falkenberg

without treatment (see Mahadevia). “The quality of the river water is steadily seen to be deteriorating as it flows through the city” (Ray, 1997). The sanitation situation is much worse in the peripheral areas, where no sewerage system exists and “sewage is left out in the open through local drains” (AMC, 2006). “An estimated half a million people defecate in the open” (WaterAid, 2006).

During the pilot study, conducted in September 2012, four communities were purposively selected, each representing an irrigation water type: ground, river, canal or waste water. The control group population utilized ground water and was situated in the north of the city (upstream). The exposure groups were located downstream, in the south of the city, and relied on different types of surface water for irrigation.

Selected Results

The incidence of diarrheal disease in the entire sample was 11.5 episodes per 1000 person-weeks throughout the 12-month interval. The groundwater group showed the lowest incidence rate (7.93 episodes per 1000 person-weeks), while the exposure groups showed similarly elevated diarrhea incidence with the wastewater and surface water group having 13.1 and 13.4 episodes per 1000 person-weeks, respectively. Comparing the incidence rate of the control and exposure group (combining surface and wastewater farmers) produced a highly significant incidence rate ratio of 1.68, indicating almost 70 percent higher diarrhea incidence in the exposure group.

Households with access to sanitation had a lower diarrhea incidence compared to those resorting to open defecation, with incidence rates of 10.0 and 13.2 per 1000 person-weeks, respectively. The incidence rate ratio indicates a 25 percent point lower diarrhoea incidence among households with sanitation. The odds ratio shows a 20% decrease in the likelihood of suffering from diarrhoea among households with sanitation.



However, no significant difference in the incidence rate ratios and the odds ratio were observed when comparing exposure to unsafe and to safe irrigation water stratified by sanitation (Table 1).

Segregating the sample by those with access to safe drinking water at the point-of-use and those with unsafe drinking water, a significant difference was observed, with an incidence rate ratio of 1.29. Whilst households with safe drinking water had a diarrhoea incidence of 9.47 per 1000 person-weeks, the population exposed to unsafe drinking water showed an incidence of 12.3 per 1000 person-weeks. The calculation of the odds ra-

Variable	Odds Ratio	95% CI
Bivariate		
Unsafe Irrigation Water	2.00	1.64 – 2.46
Access to Sanitation	0.822	0.69 – 0.98
Unsafe Drinking Water	Jan 33	1.05 – 1.68
Logistic Regression (selected variables only)		
Unsafe Irrigation Water	1.685	1.091 – 2.603
Access to Sanitation	1.169	0.809 – 1.690
Unsafe Drinking Water	1.001	0.999 – 1.002
Water Storage	0.745	0.640 – 0.867
Hand Washing before eating	0.757	0.584 – 0.981
Soap present	0.470	0.292 – 0.756
Socio-Economic Status	0.973	0.837 – 1.131
Proportion of Children	4.316	2.262 – 8.235
Household Size	1.095	1.048 – 1.145

Table 1: Odds Ratios of Selected Variables. Source: Timo Falkenberg

tio reveals a 30 percent increase in the odds of having diarrhoea when exposed to unsafe drinking water at the point-of-use.

The bivariate analysis suggests that exposure to unsafe irrigation water leads to large adverse health effects. However, the exposure to unsafe drinking water and the absence of sanitation facilities also affect health. As the proportion of the sample with access to safe drinking water and sanitation is not fully balanced between the exposure and control groups, a logistic regression analysis was conducted (Figure 2). Among the three exposure variables, only exposure to unsafe irrigation water produced significant results. Safe water storage behaviour, as well as hand washing before food consumption, showed preventive effects with odds ratios of 0.75 and 0.76, respectively. The strongest preventive effect was associated with an observed access to soap, which halved the odds of suffering from diarrhoea. The proportion of children in the household had the largest adverse effect with an odds ratio of 4.32. This is not surprising as children are the primary risk group for diarrhea and thus experience higher incidence rates.

The results show that wastewater irrigation significantly contributes to the diarrhoeal disease risk, outweighing the impact of exposure to unsafe drinking water and lack of sanitation. Consequently, it is necessary to expand the fight against diarrhoea to include the additional exposure source: wastewater irrigation. The chronic dysfunctioning primary barriers in most developing countries coupled with increasingly limited freshwater

resources result in increasing prevalence of wastewater irrigation. It is thus necessary to add attention to wastewater irrigation in WASH programmes and adopt primary and secondary barriers at the farm level.

Acknowledgements

This research study was financed by a grant of the Hermann Eiselen Doctoral Programm of the foundation Fiat Panis. The study was a co-operation between the Center for Development Research (ZEF), the University of Bonn and the Indian Institute of Public Health, Gandhinagar (IIPH-G), Public Health Foundation of India.

References

Ahmedabad Municipal Corporation (AMC) (2006): *City Development Plan Ahmedabad 2006-2012*.

Bartram, J. (2015): *Routledge Handbook of Water and Health. Routledge, London, 750pp*.

Clasen, T. F.; Bostoen, K.; Schmidt, W. P.; Boisson, S.; Fung, I. C. H.; Jenkins, M. W.; Scott, B.; Sugden, S.; Cairncross, S. (2010): Interventions to improve disposal of human excreta for preventing diarrhea. In: *Cochrane Database of Systematic Reviews*, 6: CD007180.

Clasen, T. F.; Alexander, K. T.; Sinclair, D.; Boisson, S.; Peletz, R.; Chang, H. H.; Majorin, F.; Cairncross, S. (2015): Interventions to improve water quality for preventing diarrhea. In: *Cochrane Database of Systematic Reviews*, 10: CD004794.

Curtis, V.; Cairncross, S.; Yonli, R. (2000): Domestic hygiene and diarrhoea – pinpointing the problem. In: *Tropical Medicine and International Health* 5 (1), 22-32.

Drechsel, P.; Evans, A. E.V. (2010): Wastewater use in irrigated agriculture. In: *Irrigation and Drainage Systems* 24 (1), 1-3.

Ejemot-Nwadiaro, R. I.; Ehiri, J. E.; Arikpo, D.; Meremikwu, M. M.; Critchley, J. A. (2015): Hand washing promotion for preventing diarrhea. In: *Cochrane Database of Systematic Reviews*, 9: CD004265.

Government of India (2011): Urban Agglomerations/Cities having population 1 lakh and above. In: *Census of India 2011*. Available from: http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/India2/Table_2_PR_Cities_1Lakh_and_Above.pdf [20 May 2012].

Herbst, S. (2006): Water, sanitation, hygiene and diarrheal diseases in the Aral Sea area (Khorezm, Uzbekistan). *Ecology and Development Series* 43. Cuvillier, Göttingen, 200 pp.

Mahadevia, D. (2002): Communal Space over Life Space: Saga of Increasing Vulnerability in Ahmedabad. In: *Economic and Political Weekly* 37 (48), 4850-4858.

Ray, C. N. (1997): How Polluted Is Ahmedabad City? Environmental Risk Assessment. In: *Economic and Political Weekly* 32 (40), 2508 2510.

Schmidt, W.-P.; Arnold, B. F.; Boisson, S.; Genser, B.; Luby, S. P.; Barreto, M. L.; Clasen, T.; Cairncross, S. (2011): Epidemiological methods in diarrhoea studies – an update. In: *International Journal of Epidemiology* 40 (6): 1678–1692.

Wagner, E. G.; Lanoix, J. N. (1958): Excreta Disposal for Rural Areas and Small Communities. *World Health Organization Monograph Series no. 39, Geneva, 187 pp*.



- WaterAid (2006): Sanitation For All – Still a Long Way to Go: *Learnings & Approaches*. WaterAid India, New Delhi, 124 pp.
- Webb, A. L.; Stein, A. D.; Ramakrishnan, U.; Hertzberg, V. S.; Urizar, M.; Martorell, R. (2006): A simple index to measure hygiene behaviours. In: *International Journal of Epidemiology* 35 (6), 1469-1477.
- WHO/UNICEF (2009): Diarrhoea: Why children are still dying and what can be done, The United Nations Children's Fund, New York. Available from: http://apps.who.int/iris/bitstream/10665/44174/1/9789241598415_eng.pdf
- Wolf, J.; Prüss-Ustün, A.; Cumming, O.; Bartram, J.; Bonjour, S.; Cairncross, S.; Clasen, T.; Colford Jr., J. M.; Curtis, V.; De France, J.; Fewtrell, L.; Freeman, M. C.; Gordon, B.; Hunter, P. R.; Jeandron, A.; Johnston, R. B.; Mäusezahl, D.; Mathers, C.; Neira, M.; Higgins, J. P. T. (2014): Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: systematic review and meta-regression. In: *Tropical Medicine and International Health* 19 (8), 928-942.

Timo Falkenberg

Center for Development Research (ZEF),
University of Bonn, Germany
timo.falkenberg@gmail.com



WORLD HEALTH ORGANIZATION

EUROPE

Wetland-related Diseases, Health Risk Perceptions and Behaviour in Ewaso Narok Swamp, Kenya

Wetlands are increasingly used worldwide and their implications on human health are thus receiving more and more attention (Corvalán et al. 2005). A technical report published by the World Health Organization and the RAMSAR Secretariat in 2012 underlines the health benefits related to wetlands. These include the provision of ecosystem services, such as the supply of safe water and nutrition, water purification and flood retention. Usually, wetlands are of critical importance for the populations settling around them, as they derive their livelihoods from these ecosystems (Horwitz et al. 2012). At the same time and as underlined in the WHO & RAMSAR report as well, wetlands can threaten human health and are known sources of water-related diseases if contaminated with infectious agents (Malan et al., 2009; Cools et al., 2013; Derne et al., 2015). As water-related diseases affect quality of life, agricultural productivity, family and social networks, and consequently socioeconomic development, they need to be addressed in the context of wetland use.

Contracting Diseases in Wetlands – A Question of Use?

While reflecting on the transmission of water-related diseases, not only the particular ecological characteristics of wetlands need to be considered. Human behavioural patterns play a major role, too (Appleton 1983). For generations, wetlands and their socio-economic potential have been used. The extent of this exploitation has varied between different regions and socio-economic groups, with a strong tendency to increased exploitation over time. The most common uses, as found in East Africa, are: extraction of water for domestic use (includ-

ing drinking water), crop production, pastoralism, fishery and collection of building materials (Sakané et al., 2011). Each of these activities is differently linked to water contact and water-related transmission pathways that entail different health risks (Derne et al. 2015; Appleton 1983; Cools et al. 2013). However, still little is known about the specific implications of wetland use and the transmission of diseases.

One model case of a wetland in East Africa was extensively studied by the author in 2015. The Ewaso Narok Swamp in semi-arid Laikipia, Kenya, is a 20 km long papyrus swamp in the administrative centre Rumuruti, about 250 km north of the country's capital Nairobi (Thenya, 2001). Similarly to other wetlands in East Africa, Ewaso Narok Swamp is primarily used for food production and the area is characterized by increasing population growth. 400 wetland users participated in the study that focused on their knowledge of wetland-related diseases, their perception of health risks arising from wetland use and their health risk behaviour.

According to Boy (2011), the condition of the Ewaso Narok Swamp is subject to ongoing degradation due to extensive use and exploitation, with corresponding ongoing reductions in water quantity and deterioration of water quality. The study in 2015 revealed that generally, different wetland uses were associated by the users with different diseases in varying magnitudes (Figure 1). Almost all respondents perceived the domestic use of water as an outstanding threat to human health (Figure 1).

Domestic Use of Wetland Water – A Challenge?

Most wetlands serve as an important source of water for rural communities, especially in the dry season (Figure

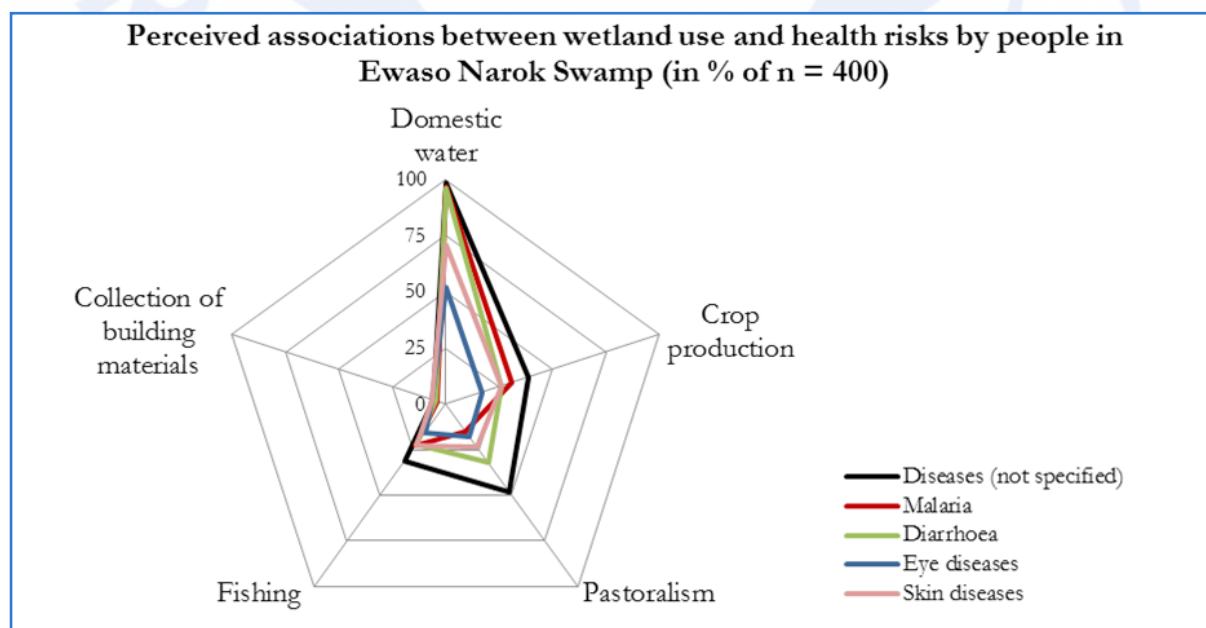


Figure 1: Perceived associations between wetland use and health risks by people in Ewaso Narok Swamp, Kenya. Source: Carmen Anthonji





Figure 2: 'The swamp is our only water source. It brings diseases'. (Pastoralist in Ewaso Narok Swamp)
Source: Carmen Anthonj

2). This brings along risks: fetching water from rivers or streams and storing water under unsafe conditions outside the house, in such ecosystems, exposes people to the risk of contracting vector-borne diseases like malaria, as *Anopheles* mosquitoes prefer wetlands for breeding (Cools et al., 2013). The ingestion of untreated wetland water is known to be a health risk factor due to the possible intake of pathogens causing diarrhoea, cholera, typhoid fever and other waterborne diseases (Appleton, 1983; Fuhrmann et al., 2015; Mulatu et al., 2015).

The use of wetland water for personal and domestic hygiene is linked to water-washed diseases (Berthe & Kone, 2008; Fuhrmann et al., 2015). For example, by direct contact with infested wetland water, especially while swimming, fishing or while washing clothes or utensils, people can contract schistosomiasis (Resh,

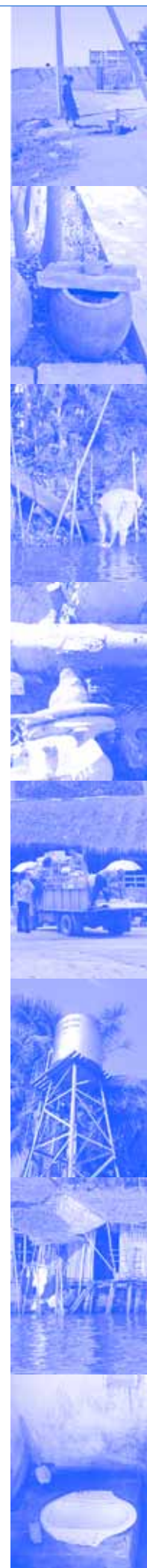
2010), a waterborne disease which is closely linked to unsafe sanitation practices (Appleton & Madsen, 2012). Thus, the domestic use of wetland water poses several challenging health risks which the people living in Ewaso Narok Swamp recognize (Figure 1).

Wetlands and WASH – Where Do We Stand?

All those potential wetland-related health risks make safe water, adequate sanitation and good personal hygiene (WASH) crucial preconditions for the prevention of diseases (Bartram und Cairncross 2010; Prüss-Üstün et al. 2014). An observational assessment of the domestic water sources and storage, sanitation facilities and personal hygiene carried out during the household



Figure 3: Observational assessment of water sources and sanitation facilities in Ewaso Narok Swamp.
Source: Carmen Anthonj



survey in Ewaso Narok Swamp painted a gloomy picture, though (Figure 3).

Located in a rural setting, people in Ewaso Narok Swamp lack proper access to safe water and adequate sanitation. The wetland is the most important source of drinking and domestic water to many of the users. The assessment revealed that in the households and homesteads, water storage was inadequate and storage containers were polluted and uncovered. Many of the sanitation facilities were also inadequate, showing signs of faecal contamination and lack of access to water, soap and towels (Figure 3). A large share of wetland users in the study area practice open defecation, thereby contaminating the environment and putting themselves and others at risk of contracting diseases.

Wetland-related Diseases, Health Risk Perceptions and Behaviour - Well Then?

The ongoing study pursues the overall aim of closing the research gap on diseases related to wetland use, health risk perception and health risk behaviour through presentation of a model case from Kenya. Preliminary findings suggest that the Ewaso Narok Swamp, like other wetlands, can threaten human health as it is a source of water-related diseases. In particular, the domestic use of wetland water is perceived as exposing the people to risks of contracting diseases. This is an important aspect to be considered, especially with regard to Kenya's Vision 2030, the Sustainable Development Goals and WHO/UNICEF JMP Assessment on water, sanitation and hygiene. The study intends to contribute to the development of a health impact assessment tool for wetlands.

Acknowledgements

The research is part of the project GlobE Wetlands in East Africa - Reconciling future food production with environmental protection, which is financially supported by the German Federal Ministry of Education and Research (grant number 031A250 D).

References

- Appleton, C. C. (1983): Wetlands and Public Health. In: *Journal of the Limnological Society of Southern Africa* 9 (2), 117–122.
- Appleton, C. C., & Madsen, H. (2012). Human schistosomiasis in wetlands in southern Africa. In: *Wetlands Ecology and Management*, 20(3), 253–269.
- Bartram, J.; Cairncross, S. (2010): Hygiene, Sanitation, and Water: Forgotten Foundations of Health. In: *PLoS Med* 7 (11), e1000367.
- Boy, G. (2011): *Laikipia - A Natural History Guide*. Laikipia Wildlife Forum, Nairobi, 84 pp.
- Cools, J.; Diallo, M.; Boelee, E.; Liersch, S.; Coertjens, D.; Vandenberghe, V.; Kone, B. (2013): Integrating human health into wetland management for the Inner Niger Delta, Mali. In: *Environmental Science & Policy* 2013 (34), 34–43.

Corvalán, C. F.; Hales, S.; McMichael, A. (2005): *Ecosystems and human well-being: health synthesis: a report of the Millennium Ecosystem Assessment*. WHO, Geneva, 53 pp.

Derne, B. T.; Weinstein, P.; Lau, C. L. (2015): Wetlands as Sites of Exposure to Water-Borne Infectious Diseases. In: C. Max Finlayson, Pierre Horwitz and Philip Weinstein (Ed.): *Wetlands and Human Health*. *Wetlands: Ecology, Conservation and Management*. Springer, Heidelberg, New York, London, 45–74.

Fuhrmann, S.; Stalder, M.; Winkler, M. S.; Niwagaba, C. B.; Babu, M.; Masaba, G.; Cissé, G. (2015): Microbial and chemical contamination of water, sediment and soil in the Nakivubo wetland area in Kampala, Uganda. In: *Environmental Monitoring and Assessment* 187(7), 475.

Horwitz, P.; Finlayson, C. M.; Weinstein, P. (2012): Healthy wetlands, healthy people. A review of wetlands and human health interactions. Ramsar Technical Report No. 6. Secretariat of the Ramsar Convention on Wetlands & World Health Organization. WHO, Geneva, 106 pp.

Malan, H. L.; Appleton, C. C.; Day, J. A.; Dini, J. (2009): Wetlands and invertebrate disease hosts: Are we asking for trouble? In: *Water SA* 35 (5), 753–767.

Mulatu, K.; Hunde, D.; Kissi, E. (2015): Socio-economic impacts of wetland cultivation in South-Bench, Southwest Ethiopia. In: *African Journal of Agricultural Research*, 10(8), 840–848.

Prüss-Üstün, A.; Ba, S.; Clasen, T.; Colford, J. M.; Cumming, O.; Curtis, V. et al. (2014): Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. In: *Tropical Medicine and International Health* 19 (8), 894–905.

Sakané, N.; Alvarez, M.; Becker, M.; Böhme, B.; Collins, H.; Kamiri, H.W. et al. (2011): Classification, Characterisation, and Use of Small Wetlands in East Africa. In: *Wetlands* (31), 1103–1116.

Thenya, T., 2001. Challenges of conservation of dryland shallow waters, Ewaso Narok swamp, Laikipia District, Kenya. In: *Hydrobiologia* 458, 107–119.

Carmen Anthonj

Institute for Hygiene and Public Health,
University of Bonn, Germany
carmen.anthonj@ukb.uni-bonn.de



Small scale farming and malaria in Uganda: the ambivalent role of wetlands

Introduction: Wetlands & Malaria in Uganda

Malaria, still one of the most important diseases in sub-Saharan Africa (Cormier 2011; Snowden & Bucala 2014; WHO 2015), is closely linked to wetlands. As natural breeding grounds for Anopheles mosquitoes, swamps, bogs, flood plains and humid valley bottoms play an important role in the sustaining prevalence of the disease in tropical regions of the continent (Dale & Knight 2008; Lindblade et al. 2000; Munga et al. 2006). Despite this, wetlands are also an increasingly valued economic resource for many smallholders.

In the following paragraphs the ambivalent role of wetlands on the health of wetland users will be highlighted, with a particular focus on malaria. Drawing from the preliminary results of ethnographic fieldwork in the peri-urban areas of Kampala, Uganda, it will be shown how wetlands are a crucial source of income that enables many to access the health care system. On the other hand, the risk of a malaria infection related to wetlands is clear and most people are aware of the exposure risks during agricultural work in areas dominated by water.

Against the backdrop of ongoing rapid population growth, climate change and large-scale land acquisition, wetlands play an increasing role for future food production. How people manage the health risks associated with the use of swamps and other humid areas is significant when one considers the growing importance of wetlands in East Africa.

The research area is located in the Namulonge area, at the fringes of the Ugandan capital, where although agriculture is the dominant economic activity for a large part of the population, the influence of the urban area is growing and determines the prices for land. Most people interviewed for this research cultivate crops, at least to some extent. Notably, much of the employment in the

area comes from the agricultural sector. In the Namulonge area, some of the major employers can be found in the agricultural sector, the main ones being the National Agricultural Research Organisation (NARO) / National Crops Resources Research Institute (NaCRRI) institute and the Mairye Estates flower farm located around Mairye, a village in the Namulonge area, producing mainly roses for export markets. Both are located in and around a wetland. Yet also on a smaller scale many households depend on the income derived from agricultural activities. Even in cases in which households don't have rights of disposal over land, farmers make agreements with landowners over seasonal land-use in order to gain an income. This further emphasizes the crucial relevance of wetlands to the economic income of many households. The economic and systematic benefits of wetlands are thus making mainly poor people – who do not own land – dependent on wetlands, ultimately exposing them to potentially infectious mosquito bites.

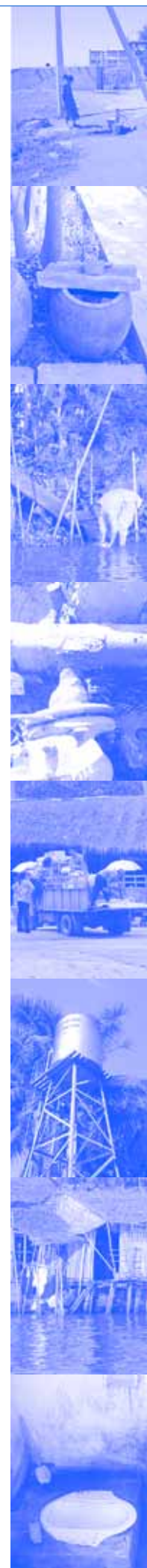
Health care in Uganda

Although limited, public health care in Uganda is free of charge. In public health centres present in most sub-counties, basic outpatient care and basic laboratory services are provided. The health centres are especially equipped to combat the most pressing diseases in the region, most importantly HIV/AIDS and malaria.

Apart from the public health care facilities, there are a number of private clinics, drug shops, medical centres and practices which are usually better-staffed and better-equipped than their public equivalents. The services offered there are, however, at a cost which puts them out of reach for many Ugandans.



Figure 1: Cabbage field of a smallholder, located in a wetland near Namulonge.
Source: Matian van Soest



Medicines for treating malaria are provided by the aforementioned public and private health care facilities. However, wetland users in central Uganda frequently make use of the so-called folk health care sector for treatment of symptoms associated with malaria. This consists of a range of semi- or non-professional health care providers that offer remedies for relief from fevers, body- and headaches, general malaise and, in some cases, even against malaria. Apart from these alternative health care services already provided by specialists, people also draw from health-related knowledge rooted in their local cultural traditions. For example, there are a number of commonly known medicinal plants that are used to treat typical symptoms of malarial infections which especially poorer households make use of.

In some cases, the therapeutic effects of certain medicinal plants are widely acknowledged and even scientifically proven. Although to this author's knowledge herbal remedies for clinical malaria are not known in central Uganda, there is a range of herbal concoctions that are effective against non-specific symptoms commonly related to malaria. Broadly speaking, however, the efficacy of available treatments is not verified and, in some instances, must be considered questionable at the least.

Whereas in theory effective malaria treatment should be available for everyone, the public health sector is a last resort for many. The long waiting hours associated with a visit to the chronically understaffed health centres are a frequently reported drawback. Patients are often asked to provide for the needed medicines themselves, due to insufficient stock on-hand. Those able to afford private health care services, either within

the professional or alternative health care sector, usually prefer to do so.

Ineffective and inadequate treatment of malaria infections can also be explained by the prevalence of diagnosis of any feverish ailment with the term malaria. The English term malaria is frequently used to describe feverish diseases in general. As long as a patient has not been tested for antibodies, malaria can have a lot of causes. However, unless tested, malaria remains a non-specific set of symptoms whose treatments may not address the underlying cause.

Conclusion: two-sided relationship between malaria and wetlands

The pursuit of health in central Uganda is, to a large extent, determined by economic resources. Although basic health care is available for free, much of the treatment decisions are based on financial considerations. What type of health care one can afford, if one's malaria status can be tested or whether one relies on the healing powers of unspecified herbal concoctions, are questions whose answers are largely defined by patient and household financial income. This applies especially to the poorest members of the society who rely on agricultural activities in order to earn an income.

Wetlands are an important resource for smallholders and are likely to gain significance in the coming decades. This holds true especially in the urban catchment zones of central Uganda, where access to arable land is increasingly contested.

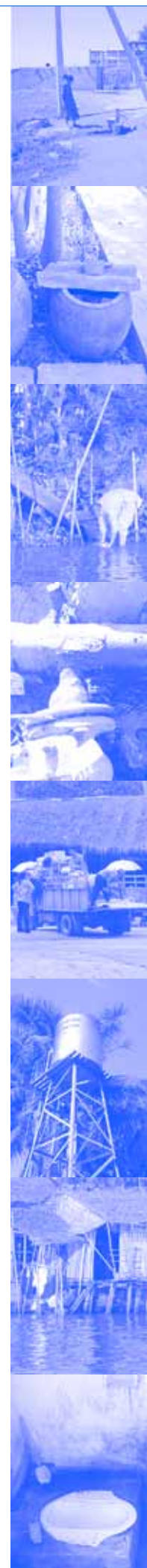
Whereas wetlands guarantee access to health care in the form of providing medically useful plants and an



Figure 2: Showcase of a self-proclaimed doctor in a village near Namulonge, displaying a variety of homemade herbal concoctions. The bottle labels contain an advice to refer to a hospital in case the symptoms persist. Source: Matian van Soest



Figure 3: Showcase of a private drug shop. Note the poster above the display, advising parents to have their feverish children tested for a possible malaria infection at a health facility, instead of applying self-medication. Source: Matian van Soest



income source, they also put users at risk. The relation between marshlands and human health is thus twofold: on the one hand, the potential economic income that can be derived from wetlands opens the door to professional health care, while on the other hand, the use of wetlands exposes smallholders to water-related health threats like malaria.

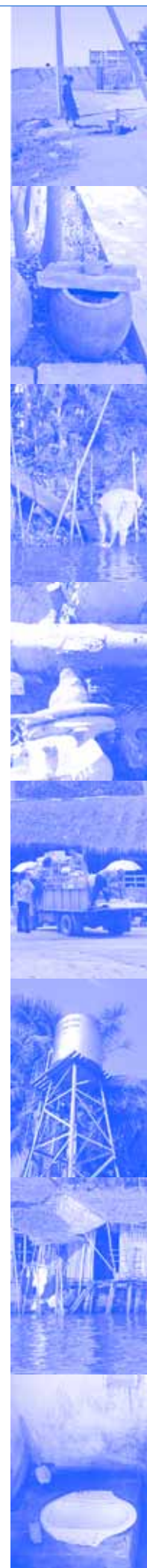
With regards to the planning and the implementation of effective malaria control programmes, it is crucial to specifically target smallholders and wetland users. Agricultural exploitation and work in wetlands is likely to increase in the coming years and, along with it, exposure to malaria. Wetland users as a target group might be the key entry-point for programmes aiming at pushing back the malaria prevalence in the region.

References

- Cormier, L. A. (2011): The Ten-Thousand Year Fever: *Rethinking Human and Wild Primate Malaria*. Walnut Creek, CA: Left Coast Press.
- Cousins, B. (2011): What is a 'Smallholder'? Class Analytic Perspectives on Small-Scale Farming and Agrarian Reform in South Africa. In: P. Hebnick (Ed.): *Reforming Land and Resource Use in South Africa: Impact on Livelihoods*. London: Routledge: 86-111.
- Dale, P. E. R. & Knight, J. M. (2008): Wetlands and Mosquitoes: A Review. In: *Wetlands Ecology Management* 16 (4): 255-276.
- Dilger, H.; Kane, A. & Langwick, S.A. (Eds.). (2012): *Medicine, Mobility, and Power in Global Africa: Transnational Health and Healing*. Bloomington: Indiana University Press.
- Ernst, W. (Ed.). (2014): *Plural Medicine, Tradition and Modernity, 1800-2000*. London: Routledge.
- Heggenhougen, H. K.; Hackethal, V. & Vivek, P. (2003): The Behavioural and Social Aspects of Malaria and its Control: *An Introduction and Annotated Bibliography*. TDR, World Health Organization.
- Kitua, A. Y. & Hamisi, M. M. (2004): Malaria Control in Africa and the Role of Traditional Medicine. In: M. Willcox; G. Bodeker & Rasoanaivo, P. (Eds.): *Traditional Medicinal Plants and Malaria*. London: CRC.
- Lindblade, K. A., Walker, E. D., Onapa, A. W., Katungu, J. & Wilson, M. L. (2000): Land Use Change Alters Malaria Transmission Parameters by Modifying Temperature in a Highland Area of Uganda. In: *Tropical Medicine & International Health* 5 (4): 263-274.
- Little, P. D. & M. M. Horowitz (1987): Subsistence Crops are Cash Crops: Some Comments with Reference to Eastern Africa. In: *Human Organization* 46 (3): 254-258.
- Munga, S.; Minakawa, N.; Zhou, G.; Mushinzimana, E.; Barrack, O.-O. J.; Githeko, A. K. & Yan, G. (2006): Association Between Land Cover and Habitat Productivity of Malaria Vectors in Western Kenyan Highlands. In: *The American Journal of Tropical Medicine and Hygiene* 74 (1): 69-75.
- Peters, P. (2006): Rural Income and Poverty in a Time of Radical Change in Malawi. In: *Journal of Development Studies* 42 (2): 322-345.
- Snowden, F. M. & Bucala, R. (2014): Introduction. In: F. M. Snowden & R. Bucala (Eds.): *Global Challenge of Malaria: Past Lessons and Future Prospects*. New Jersey and Singapore: World Scientific Publishing Company: Vii-xi.
- World Health Organization (2015): World Malaria Report 2015. [accessed: 2016 January 23]: <http://www.who.int/malaria/publications/world-malaria-report-2015/report/en/>

Matian van Soest, M.A.

Department of Anthropology
University of Cologne, Germany
mvansoes@smail.uni-koeln.de



EUROPE

Events on Water, Health and Risk Communication

June

IWA Specialist Belgrade Groundwater Conference 2016

9 – 11 June

Belgrade, Serbia

<http://www.jceni.org/en/activities/conferences/iwa-specialist-belgrade-groundwater-conference-2016.html>

The 13th IWA Leading Edge Conference on Water and Wastewater Technologies

13 - 16 June

Jerez de la Frontera, Spain

<http://www.let2016.org/>

Kampala WASH symposium and 21st SuSanA Meeting

20 – 23 June

Kampala, Uganda

<http://www.kampalawashsymposium.org/>

3rd IWA Specialized Conference “Ecotechnologies for Wastewater Treatment”

27 – 30 June

Cambridge, UK

<http://www.ecostp2016.com/>

July

Singapore International Water Week

10-14 July

Singapore

<http://www.siww.com.sg/>

39th WEDC International Conference

11 – 15 July

Kumasi, Ghana

<http://wedc.lboro.ac.uk/conference/>

August

Stockholm World Water Week 2016

28 August - 2 September

Stockholm, Sweden

<http://www.worldwaterweek.org/>

September

Wetland Systems for Water Pollution Control

4 – 8 September

Gdansk, Poland

<http://icws2016.org/>

13th IWA Specialized Conference on Small Water and Wastewater Systems & together with the 5th IWA Specialized Conference on Resources-Oriented Sanitation

14-16 September

Athens, Greece

<http://www.swws2016.gr/>

October

World Water Congress & Exhibition 2016

9-14 October

Brisbane, Queensland, Australia

<http://www.iwa-network.org/event/world-water-congress-exhibition-2016/>

Water and Health Conference

10-14 October

Chapel Hill, USA

<http://waterinstitute.unc.edu/conferences/waterandhealth2016/>

European Waste Water Conference & Exhibition 2016

11-12 October

Manchester, UK

<http://ewwmconference.com/>

IWA Regional Conference on Diffuse Pollution and Catchment Management

23 – 27 October

Dublin, Ireland

<http://www.dpcm2016.com/ehome/index.php?eventid=135732&>

Imprint

Publisher:

WHO Collaborating Centre for Health Promoting Water Management and Risk Communication
IHPH - Institute for Hygiene and Public Health
University of Bonn
Sigmund-Freud-Str. 25
53105 Bonn, Germany
phone: +49 (0)228 - 287 19515
fax: +49 (0)228 - 287 19516

Editors:

Dr. Andrea Rechenburg,
Carmen Anthonj, Christian Timm,
Prof. Dr. Thomas Kistemann,
Prof. Dr. Martin Exner

English copy editor:

Dr. Jennifer Lew-Schneider

Layout:

Farah-Saad Alhyalie

Contact:

whocc@ukb.uni-bonn.de
ISSN: 2191-9674

Contributions reflect the opinion of the authors and are not necessarily in correspondence with the position of the WHOCC.

