



# WATER & RISK

Dear Reader,

We hope you enjoy reading this newsletter.

That's all!

Done!

Hmmm, you may ask yourself, what's going on here?

That's all? Where is the rest? This is not an editorial.

Well, yes, you're right. That would not be an editorial.

That would be rather a polite phrase inviting you to read this year's summer issue of our newsletter. Okay, so let's put some more effort into raising interest in what is inside this issue. Do you know what a Mongolian ger is? How is this related to water and risk? Why are Germans working on gers? Want to know more? Start with our first article, which presents an overview of the IWRM MoMo project, which addresses water-related challenges in Darkhan.

And what happens if an African Institute for Statistics sends out a staff member to train in Europe? In the case presented here, we got a Cameroon-German project on groundwater quality up and running and started a new cooperative venture.

Just because people met, talked to each other and acknowledged that they would like to work together in a field of interest. You might add that it isn't that easy: you meet and the project runs, and I agree. You're right.

You need to move from an idea to a proposal, find some funding, cope with all the administration bureaucracy, deal with people who sometimes look at researchers as if they were aliens, and then, finally, you can start working. And of course you need to take care that the new cooperation is cultivated and can grow. You need to spend time and effort on it, or you will never leave the fledgling stages. Sounds tough? Come on, let's look at the great opportunity new cooperative projects offer. We meet new people, exchange ideas, experience different cultures, expand our horizon and have fun.

It resembles the Olympics, where athletes from around the world meet and compete for excellence. I hope that you enjoy viewing the Olympic games during the next few weeks and take a little bit of the Olympic spirit to your daily work.



Andrea Rechenburg  
WHO CC for Health Promoting  
Water Management & Risk Communication

## Towards an integrated concept for monitoring and improvements in water supply, sanitation and hygiene (WASH) in urban Mongolia

### Introduction

With a population density of only around 1.7 inhabitants/km<sup>2</sup> (National Statistical Office of Mongolia 2010), Mongolia is the world's most sparsely settled country. However, the combination of a highly continental climate, growing competition for water from the agricultural, mining and urban sector and the very uneven distribution of the population result in major water-related challenges. These include water scarcity and a degradation of water quality in some parts of the country. Natural limitations in water availability are exacerbated by outdated, dysfunctional or non-existent water supply and wastewater disposal infrastructures (Karthé et al. 2011). The rapid socio-economic development that Mongolia is currently experiencing is matched by increasing water consumption. At the same time, the Mongolian government increasingly recognizes and addresses the need for new water management strategies.

In 2000, the Mongolian government committed itself to achieving the Millennium Development Goals. With respect to water and sanitation, the plans are to achieve coverage rates of 80% for 'improved' drinking water sources and 70% for 'improved' sanitation facilities (UNDP 2010). Current data suggest, however, that these goals may not be met, particularly in rural and peri-urban 'ger' areas (Sigel 2012; UNDP 2010). Ger areas are low-income, somewhat informal settlements, where people live in gers – the traditional Mongolian felt tent – and/or in simple, detached houses. Such a situation is conducive to outbreaks of waterborne diseases; however, empirical data on microbiological water quality and the incidence of waterborne diseases is very rare.

IWRM MoMo (Integrated Water Resources Management – Model Region Mongolia), a joint German-Mongolian research and development project funded by the German Federal Ministry of Education and Research, addresses water-related challenges in the catchment of the Kharaa River. The project's interdisciplinary and trans-sectoral approach includes both research on the links between water and health, as well as actual interventions, which are evidently necessary (even though empirical data on waterborne diseases are at present almost non-existent).



### Water Supply, Sanitation and Health in Darkhan, Mongolia

With a population of about 74,000 (Darkhan-Uul Aimag 2009), Darkhan is the second-largest city in Mongolia. Parts of the city are located in the flat floodplains downstream of the Kharaa River; others extend into the open steppe and onto surrounding mountain slopes. In the early 1960s, Darkhan was founded as an industrial city, with relatively uniform apartment blocks characterizing large parts of the central city. A considerable proportion of the city's population still pursues primary-sector activities either for self-consumption or sale, including the semi-nomads who periodically leave and return to the city. Small-scale agriculture and animal husbandry are present in the peri-urban ger areas surrounding the modern city.

Darkhan's centralized drinking water supply system became operational in the 1960s and relies entirely on groundwater abstractions from 18 wells located along the Kharaa up to 8 km upstream from the city. One major problem is leakage, which accounts for about 40% of the water supplied (MoMo Consortium 2009). The length of the distribution network (245 km) and its poor condition also mean that there may be undesired inflows into the system, particularly when the water pressure is low. While the local water supply company USAG Darkhan monitors several quality parameters before the water enters the distribution system, there is practically no quality monitoring of the water actually reaching the consumers.

In Darkhan, roughly half of the population live in ger areas, without direct connection to the city's centralized water supply and sanitation system. Instead, local residents rely either on shallow wells or buy their wa-

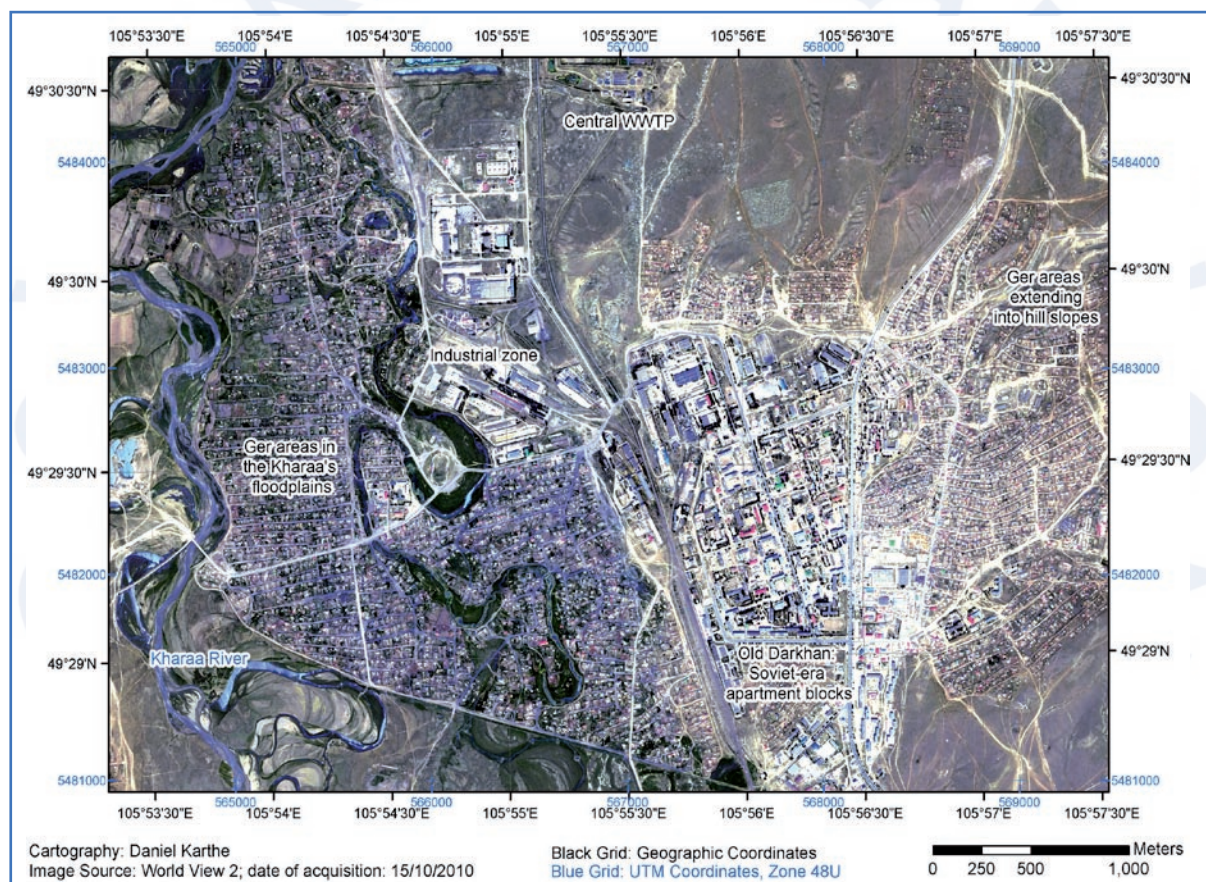


Figure 1: Satellite image of Darkhan

The heterogeneous structure of the city and the highly continental climate, which is characterized by warm summers but very cold winters with temperatures regularly falling to -40°C and below and an annual precipitation of only around 300mm, are major challenges for urban water management. These conditions are however rather typical of the situation in urban Mongolia. In Darkhan, roughly half of the population lives in solid houses, often large apartment blocks built during socialist times, which are typically connected to a centralized water supply and waste water disposal system. Cold and warm water are supplied through different distribution systems, and only cold water is purified for human consumption. The other half of the urban population lives in ger areas, where centralized water infrastructure is absent.

ter from water kiosks (see figures 2 and 3). Some of the city's water kiosks are connected to the centralized supply system, while others are supplied by trucks (MoMo Consortium 2009). The water supply pattern in the ger districts results in two key problems: underconsumption, which may be explained by affordability problems and difficult transportation (Gawel et al. 2012), and serious health risks. The morbidity pattern in urban ger districts typically reveals high rates of (potentially) waterborne diseases (Basandorj & Altanzagas 2007; City of Ulaanbaatar 2006). It is believed that high incidence rates of hepatitis A, particularly among children, are linked to water. However, since facilities for virological testing of blood, stools or water are almost non-existent in Mongolia, the link between water and (assumed) cases of hepatitis A



is currently only hypothetical (personal communication with Dr. Davaajav Abmed and Dr. B. Darmaa, Center of Infectious Diseases, Ulan Bator). Official data, including data for Darkhan, are scarce. The ger areas located in the floodplain close to the river are almost certainly exposed to high risks, as families often use private wells for the abstraction of shallow groundwater. The quality of this water is not monitored, but the likelihood of contamination from unsealed pit latrines and animal excreta is considerable (Sigel 2012).

As there are several indications of water-associated health problems (proximity of water sources and human/animal excreta; problems reported by hospitals, health authorities and leading medical scientists) but no reliable data which would allow for a scientific assessment of the situation the project, which will be carried out in conjunction with Mongolian partners, plans to investigate both the quality of the water used and the prevalence of



Figure 2: Water kiosk in Darkhan

Photo: Jürgen Stäudel



Figure 3: Shallow well surrounded by pigs

Photo: Daniel Karthe

waterborne diseases. Since there are various reports of a considerable rise in hepatitis A (and potentially hepatitis E) cases, microbiological investigations will focus on both bacterial and viral pathogens. Population-based serological surveillance has to be performed to study the epidemiology of these diseases in defined areas. In a second step we will determine the waterborne pathogen contamination level of the various water sources in the defined areas. Environmental surveillance and molecular characterization of the pathogens detected will help to link water contamination with disease outbreaks. Point of care testing of patient samples, as well as on-site testing of environmental samples, will improve waterborne pathogen surveillance even in remote areas. Recently developed molecular pathogen detection based on isothermal rapid gene amplification will be used to achieve this goal (Aw & Gin 2010; Aw & Gin 2011; Klevens et al. 2010; Aw & Rose 2011; Euler et al. 2012).

Chemical water contamination is also an issue in the study region and is typically related to waste water from mining and industry. Gold mines regularly use mercury or cyanide and accidents both at mines and production facilities have in the past led to ground and surface water contamination. Chromium released from tanneries may also be a problem. Moreover, elevated levels of arsenic have recently been detected in several localities and are currently under investigation.

## Necessary Interventions and Contribution of the IWRM MoMo Project

The IWRM MoMo project not only investigates the scientific basis of an Integrated Water Resources Management in the study region, but also addresses key challenges in capacity development and technical measures. These include the detection of leaks in the city's water distribution system, an innovative sanitation system for ger areas and pilot solutions for a future overhaul of the city's central waste water treatment plant.

### Drinking Water Supply

As much of Darkhan's drinking water supply distribution system was built at least 4 to 4.5 m below the ground because of low winter temperatures, the localization of leaks is a rather difficult task. A monitoring and leak detec-

tion system developed by Fraunhofer AST relies on combined multi-parameter sensors (pressure, flow, noise) at selected nodes in the supply network to estimate and to simulate the position of the leaks by online measurement of different network parameters. Network inflow from tanks and network outflow (consumer demands, leakage) produces a typical pattern of dynamic pressure on each network node caused by the head loss in the pipes. Since water demand follows a typical pattern during the day and leak flow depends on the network's pressure, it is possible to estimate the approximate position of leaks by using evolutionary optimization algorithms in combination with a hydraulic simulation (Scharaw & Westerhoff 2011).

### Sanitation System for Ger Areas

An integrated sanitation system combining existing infrastructures with innovative sanitation concepts and technologies was developed and adapted to the Mongolian context. Prior to any implementation activities, a case study on participatory sanitation planning was conducted, taking into account the needs and demand of the local population and other relevant stakeholders. During the stakeholder workshop for the identification of technical options, a urine-diversion dry toilet was chosen by the local residents as their preferred solution.

In accordance with the National Water Programme (Parliament of Mongolia 2010), which states the need for





Figure 4: The iPIT® toilet system

Photo: Daniel Karthe

advanced and environmental friendly (biological and dry) toilet systems, the project team developed an innovative type of separation dry toilet, which has been registered under the trademark iPIT®. At 12 Mongolian khashas (private estates), iPIT® toilet systems were installed and are currently being tested, analyzed and optimized. Feces and urine are collected in two separate containers. A local service company regularly exchanges the containers, transports them to the city’s central WWTP and provides maintenance services, thus enhancing the users’ convenience and resulting in very high levels of acceptance among the local population. Safe and value-added reuse of the human excreta in combined treatment with excess sludge from the existing conventional wastewater treatment in a biogas plant is planned to be part of the sanitation system. Urine is currently stored and will be used as high-value fertilizer by local farmers and the University of Agriculture in Darkhan. After additional treatment steps,

the stabilized sludge from the biogas reactor could be used as a high-quality soil conditioner for local agriculture, where it is urgently needed due to ongoing extensive soil degradation in the region.

### Central Waste Water Treatment Plant

Darkhan’s central waste water treatment plant was commissioned in 1968. It was designed mainly to reduce COD, and equipped for mechanical, biological and chemical sewage treatment. About 40,000 out of 74,000 inhabitants are connected to the waste water treatment plant, which currently uses only one third of its capacity, mainly because equipment has become dysfunctional over time. Because of low winter temperatures, some processes (mainly biological treatment) become impossible (MoMo Consortium 2009; Hofmann et al. 2011) and most pipes were placed deep in the ground, making such components difficult to repair and to replace. The installed pumps and air compressor system for biological and sludge processes are more than 40 years old and consume a lot of energy. Therefore, USAG spends more than 50% of their revenue on energy. Prior to an overhaul of the WWTP, model-based simulation and optimization tools are applied to minimize the plant’s energy consumption. A pilot WWTP using SBR technology was built and inaugurated in 2011 and has since been successfully tested. After completion of the pilot phase, it will serve as a model for a complete overhaul of the existing WWTP.

### WASH as an integral part of IWRM

The IWRM MoMo project ultimately aims at the conceptualization and implementation of an integrated water resources management strategy for the Kharaa River



Figure 5: Central WWTP in Darkhan

Photo: Jürgen Stäudel



Basin in Mongolia. In order to achieve the sustainable management of water resources in the region, ecological goals stand side by side with the interests of different water users. Improvements in the water supply and the provision of adequate sanitation facilities are not only meaningful from ecological and economical perspectives (minimization of water wastage and environmental contamination as well as intelligent reuse of human excreta), but also from a public health perspective. Because of their importance, related activities play a central role in the IWRM context.

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## Groundwater Quality and Health in Yaoundé, Cameroon

The German Federal Ministry of Economic Cooperation and Development (BMZ) funded a geo-studies specialists fund project (GeoSFF) which was carried out by the Federal Institute for Geosciences and Natural Resources (BGR), together with their partner, the National Institute of Statistics (INS) in Yaoundé, the capital of Cameroon. The Institute for Hygiene and Public Health (IHPH) of the University of Bonn and the Waste Water Research Unit (WWRU) of the University of Yaoundé I are also involved. The project idea was developed by INS during a 4-month GIS training period at the BGR in 2010. She is responsible for setting up a pilot geographic information system (GIS) infrastructure within the INS „Cartographie et Statistiques de l'Environnement“ unit.

Following a joint excursion considering ground water and sanitation issues in socially diverse neighborhoods of



Figure 1: Excursion – Stream a few meters downstream of an unamended spring – loaded with sewage. Photo: Robert Kringel

Yaoundé, a project opening workshop with stakeholders representing the city of Yaoundé, the Ministry of Health (MINSANTE), the Ministry of Energy and Water (MINEE) and the Ministry of the Economy, Planning and Regional Development (MINEPAT), the water supply company, the German Society for International Cooperation (GIZ) and the German Embassy took place in December 2012 in Yaoundé.

Following this the BGR started work on the development of the project infrastructure based on the concept of „Free and Open Source Software for Geographic Information Systems“ (FOSSGIS). This consists of the desktop-GIS QGIS, the database server PostgreSQL, in conjunction with PostGIS, and the software R® for statistical analysis and graphical visualization. This environment is



Figure 2: Participants of the workshop held at Monastère de Mont Fébé Photo: BGR

freely available, powerful, scalable, easily transferable and royalty-free for common system architectures. Personalized customizations or enhancements are possible at any time and remain with the user. One requirement of the INS was to have Open Source Software (OSS) installed and this is used productively by them at the server level.

At the same time, a water sampling campaign in the city of Yaoundé was conducted. This took place from 23.03 to 13.04.2012 as a combined (ground) water sampling campaign (led by BGR) and a parallel microbiological analysis campaign (led by the IHPH). The INS and the WWRU arranged logistical support. The WWRU at the Faculty of Science, University of Yaoundé I, provided the necessary laboratory infrastructure. Students from the research laboratory supported the campaign as assistants. The fieldwork was preceded by two days of theoretical and practical training, followed by a joint field exercise, which was attended by students, stakeholders and the other partners. Thereafter, two field teams recorded 113 (ground) water supply points in the city and then took a total of 57 qualified samples of ground and surface water. Forty-eight microbial and inorganic parallel sample analysis was carried out under contracts awarded by two Cameroonian analytical laboratories. Comparison and control analysis (inorganic) of these samples was also performed at the water analysis laboratories of BGR, as was the determination of volatile organic constituents (VOC, BTEX).



Figure 3: Sampling an amended and well maintained spring in Bastos, Yaoundé. Photo: Robert Kringel



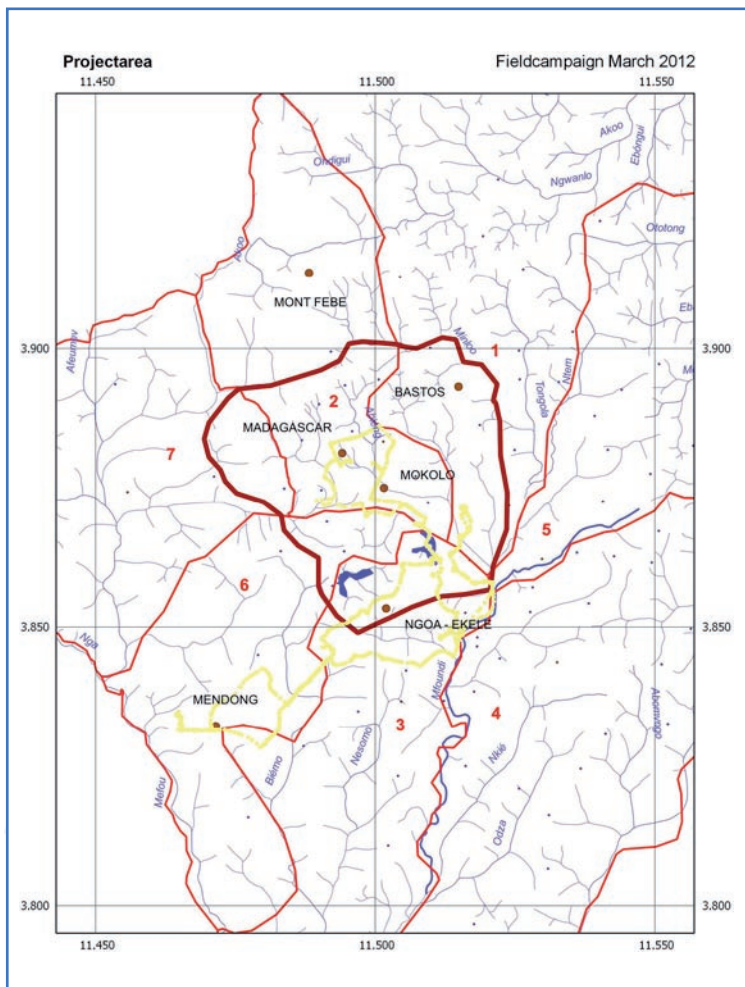


Figure 5: Project area in the city of Yaoundé. Topographic source: www.openstreetmap.org

The field campaign of BGR, IHPH and WWRU was followed by a project-specific, health survey of about 1,200 households in the project area and in a comparable area of the city that represented a different socio-economic structure. It is expected that the results will be used to reveal relationships between the (ground)water quality (microbiological, hydrochemical) and public health, as shallow groundwater is the major water source for 60% of the city population. The questionnaire that was compiled covered the areas of „Water, Sanitation and Hygiene” (WaSH). Starting mid-July 2012, GIS training of INS will take place at BGR on the basis of cooperatively collected geo-referenced data. Afterwards the analysis of the research results obtained so far will be continued. The final results of the work will be presented to Cameroonian stakeholders in autumn 2012.

Following the initial cooperation of the German and Cameroonian partners, a research proposal was developed to strengthen the collaboration. The aim of this pilot project is a more in-depth quantitative, statistic and spatial (GIS) analysis of the relationship between the contamination of the urban ground water, hygiene and the health status of the population. The necessary methodologies and technologies complement and support the efforts of the Cameroonian partners to improve the basic planning and living conditions. At the same time, they promote capacity building at a university level, in this case in wastewater biology, hydrology and sanitation in the University of Yaoundé I.

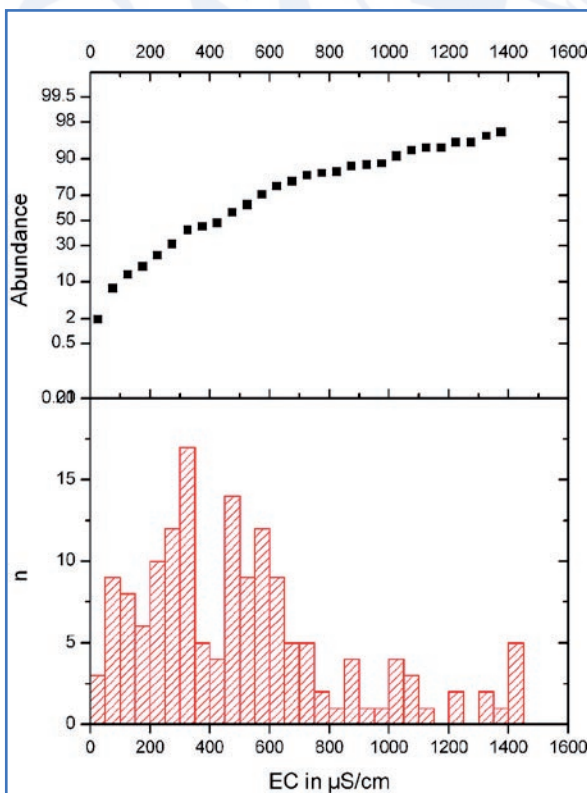


Figure 6: Distribution and range of electrical conductivity of groundwater and surface water (n = 106)

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## Events on Water, Health and Risk Communication:

### August

Mole XXIII Conference  
7-11 August  
Tamale, Ghana  
<http://www.moleconference.org/>

4th International Dry Toilet Conference  
22-25 August  
Tampere, Finland  
<http://www.drytoilet.org/dt2012/>

World Water Week in Stockholm  
26-31 August  
Stockholm, Sweden  
<http://www.worldwaterweek.org/>

### September

IWA World Water Congress & Exhibition  
16-21 September  
Busan, Korea,  
<http://www.iwa2012busan.org/>

### October

6th International Conference on Flotation in Water and Wastewater Systems  
29 October - 1 November  
New York City, USA  
<http://www.flotation2012.org/>

Faecal Sludge Management  
29-31 October  
Durban, South Africa  
<http://www.wrc.org.za/Lists/Events/DispForm.aspx?ID=200>

Water and Health Conference: Science, Policy and Innovation  
29 October- 2 November  
Chapel Hill, USA  
<http://whconference.unc.edu/>

### November

II ECOSANLAC: Resource Oriented Sanitation in Latin America  
4-7 November  
Vitória, Brazil  
<http://www.sei-international.org/-sei-events/details/301-ecosanlac-ii-resource-oriented-sanitation-in-latin-america>

International Conference on Fresh Water Governance for Sustainable Development  
5-7 November  
Drakensberg, South Africa  
<http://www.wrc.org.za/freshwater/Pages/default.aspx>

Tapping the Turn: Water's Social Dimensions  
Canberra, Australia  
15-16 November  
<http://tappingtheturn.org/>

Water Safety Conference  
13-15 November  
Kampala, Uganda  
Website: [www.iwa-watersafety2012.org](http://www.iwa-watersafety2012.org)

5th Water Contamination Emergencies International Conference  
19-21 November  
Mülheim an der Ruhr, Germany  
<http://www.wcec5.eu/>

Conference on Decentralised Wastewater Management in Asia - Meeting Urban Sanitation Challenges at Scale  
20-23 November  
Nagpur, India  
<http://www.iwadewats-nagpur.com/>

IWA Disinfection and Inactivation for Water, Wastewater and Sludge Conference  
26-29 November  
Mexico City, Mexico  
<http://eventos.iingen.unam.mx/DisinfConfMex2012/>

### December

12th World Toilet Summit  
3-6 December  
Durban, South Africa  
<http://www.world-toilet-summit-2012.co.za/>

4th IWA Asia-Pacific YWP 2012 Conference  
7-10 December  
Tokyo, Japan  
<http://www.ce.t.kanazawa-u.ac.jp/~honda/apywp2012/>

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