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WHO Collaborating Centre for Health Promoting
Water Management and Risk Communication
University of Bonn - IHPH Institute for Hygiene and Public Health

WATER & RISK

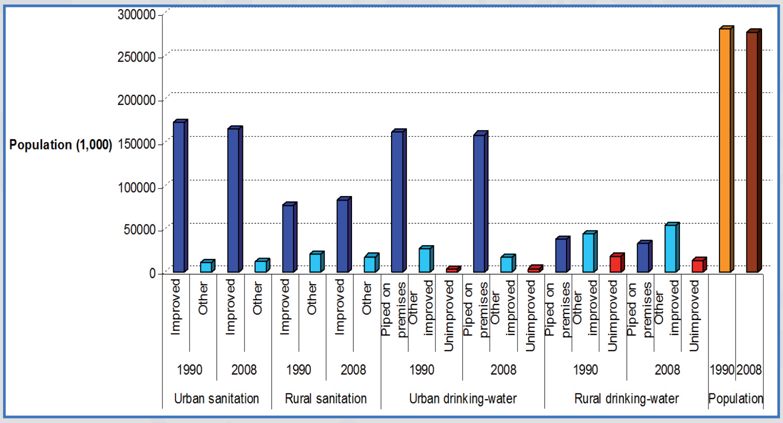
Editorial

Dear Readers,

The present volume of Water and Risk addresses issues that are well known, but remain unresolved, in addition to emerging issues.

Perhaps the oldest challenge in preventive health care is to achieve universal access to safe water and hygienic sanitation. Although most of the people in Western Europe have access to a continuous supply of safe water and hygienic disposal of waste in their homes, this is not the case for countries in the eastern part of the European region, where there is still a clear gap in physical access between urban and rural areas.

UNGA Resolution 64/292 recognizing the basic human right to water clearly distinguished four criteria that need to be fulfilled: physical availability, safety, economic accessibility and organoleptic acceptability. Resolution 15/L.14 of the Human Rights Council called on States to ensure the progressive realization of this human right.



Source: WHO/UNICEF Joint Monitoring Programme, 2011

The Protocol on Water and Health is a unique European instrument linking sustainable use of water resources with the fight against water-related diseases. It came into force on 4 August, 2005 and currently benefits a population larger than that of the European Union, spread over twenty-four ratifying countries. Under the terms of the Protocol, countries set and report progress towards targets including universal access to safe water and hygienic sanitation. Furthermore, parties pay special attention to physical access in rural areas, under a programme led inter alia by the German Federal Environment Agency, UBA and develop best practice guidance on ensuring equitable access to safe water and hygienic sanitation, including access for the lowest income groups, in a programme led by France.

These activities are closely coordinated with global WHO programmes, in particular the WHO/UNICEF Joint Monitoring Programme, which will, for the first time, assess physical access by income category in its 2012 report, and the UN Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS).

The Protocol on Water and Health also pays special attention to the issue of safe recreational waters, in particular enclosed bathing environments such as swimming pools and spas. Following the very successful 4th International Conference on Swimming Pools and Spas (Porto, Portugal, March 2011), consultations are currently under way to strengthen existing guidelines by addressing new areas such as occupational health aspects for workers in an enclosed recreational water environment, health benefits of the use of recreational waters, and others. It is expected that this work, starting in the European region, will ultimately feed into the update of the global WHO recommendations for safe recreational water environments.

The WHO Collaborating Centre for Health Promoting Water Management and Risk Communication has played a key role in the development of the Protocol on Water and Health, and continues to support the work of the WHO, and we look forward to continuing mutually supportive and coordinated action in the future.

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Ten years of collaboration with the WHO for health promoting water management

The idea to designate the Institute for Hygiene and Public Health (IHPH) as a WHO collaborating centre (WHO CC) was born in 1999, and it took roughly two years to finish the preparatory phase. Many institutions and personalities had to be informed, inspired and convinced to make the idea take off. Installing a university institute as a WHO CC involves balancing the triangle of interests made up of the World Health Organisation, the national government and the university. Moreover, for the WHO it is both a headquarters and a regional office, for the government it involves the Ministry of Health (MoH) and the Ministry of Environment (MoE), and for the university it concerns the rector's office and the faculty of medicine. We have good cause to be very grateful to all those who emphatically supported our request, who helped us develop solutions for problems and find a way through the formalities involved, who speeded up processes which normally refuse to be accelerated, and who strongly supported the new WHO CC through their personal commitment. In February 2001, the terms of reference were discussed with Dr. Jamie Bartram, then programme manager for water, sanitation & health (WSH) at WHO headquarters in Geneva. A couple of weeks later we received the designation document and became a member of the global family of collaborating centres.

What is a WHO Collaborating Centre?

The idea of using national institutions for international purposes dates back to the days of the League of Nations, when national laboratories were first designated as reference centres for the standardization of biological products. As soon as the WHO was established, it appointed more reference centres, starting in 1947 with the World Influenza Centre in London for worldwide epidemiological surveillance.

As early as 1949, the Second World Health Assembly laid down the policy (which has been constantly followed since) that the Organization should not consider „the establishment, under its own auspices, of international research institutions“ and that „research in the field of health is best advanced by assisting, coordinating and making use of the activities of existing institutions“. All WHO CCs have been designated under that policy, which has undoubtedly enhanced national participation in the Organization's activities. The WHO CCs are an essential and cost-effective cooperation mechanism, which enables the Organization to fulfil its mandated activities and to harness resources far exceeding its own.

Currently there are more than 800 WHO CCs in over 80 Member States, working with the WHO in areas such as nursing, occupational health, communicable diseases, nutrition, mental health, chronic diseases, health technologies and water, sanitation & health. From a small number in the 1950s and 1960s, the number of WHO CCs peaked in 1999. Over the last decade the number has decreased again, as nearly 40 percent of existing CCs have not been redesignated. One third of the centres are situated in Europe, 31 of which are based in Germany. Only twelve are hosted by a university. Worldwide, 13 centres specialize in water, sanitation and health, seven of them in Europe (see http://www.ihph.de/whoccmap.php).

By definition, a WHO CC is an institution designated by the Director-General of the WHO to form part of an inter-institutional collaborative network set up by the WHO in support of its programmes at the country, intercountry, regional, interregional and global levels, as appropriate. But there is more to it than that. In line with the WHO policy and strategy of technical cooperation, a WHO CC must also participate in the strengthening of country resources, in terms of information, services, research and training, in support of national health development.

Designation is made with the agreement of the head of the establishment to which the institution is attached, and after consultation with the national government. It is independent of the financial support being given to the institution by the WHO.

The functions of the WHO CC are manifold, and may include:

- Collection, collation and dissemination of information.
- Standardization of terminology and nomenclature, of technology, of diagnostic, therapeutic and prophylactic substances and of methods and procedures.
- Development and application of appropriate technology.
- Provision of reference substances and other services.
- Participation in collaborative research, as well as promotion of the application of the results of research.
- Training, including research training.
- Coordination of activities carried out by several institutions on a given subject.
- The main role of the WHO CCs is to provide strategic support to the WHO to meet two main needs:
- Implementing WHO mandated work and programme objectives.
- Developing and strengthening institutional capacity in countries and regions.

In each WHO regional office, as at WHO headquarters, focal points are designated to manage and coordinate statutory information and procedures for WHO CCs. Particular attention is paid to the joint preparation of the centre's terms of reference and work plans. The work plan comprises clearly defined objectives and expected results, explicitly related to WHO activities as set out in its programme budget. A final evaluation takes place at the end of every four-year designation period. It includes an assessment of WHO support for, and actual use of, collaboration with the centre.

In 2000, the WHO Executive Board encouraged collaborating centres to develop working relations with other centres and national institutions recognized by the WHO, in particular by setting up or joining collaborative networks with the support of the WHO. To date, eleven such networks have been established. A network on water, sanitation and health has not yet been founded, and it would be worthwhile considering combining the 13 existing WHO CCs in this area to create such a network.

Figure 1: Side building of the Institute for Hygiene and Public Health with the office of the WHO CC Bonn

Maintenance and staff of the WHO CC functionalities

The IHPH as a whole has been designated as a collaborating centre. From the very beginning it was clear that structures needed to be established to ensure continuous and smooth communication and cooperation between IHPH, the university and the WHO. This task was committed to the Medical Geography & Public Health division of the institute. Due to generous support provided by the German MoH, the university and the university clinics, the IHPH was able to establish an operational unit to coordinate, manage and also accomplish the institute's tasks as a collaborating centre.

The staffing of the operational unit is characterized by both continuity and change. Continuity is achieved as most of the personnel stay in their posts for several years, and change is seen in a way which is typical and, to some extent, necessary in an academic institution: many use their employment in the centre to aid them in obtaining scientific qualifications, graduating and finishing doctoral theses, and after some years as a postgraduate or postdoc, making their next career step inside or outside the academic world. The working experience in an international context proves to be an interesting qualification for potential employers. During the last ten years the centre has been executively managed by Dr. Friederike Dangendorf† (2001-2004), Dr. Susanne Herbst (2004-2009), and Dr Andrea Rechenburg (since 2009).

Figure 2: Institute for Hygiene and Public Health Staff 2011

Terms of reference

The terms of reference define the framework of the work to be undertaken by a collaborating centre. The terms of reference of the Bonn WHO CC have not been changed significantly during the last ten years and two redesignations, and are as follows:

1. Disease burden and surveillance: to harmonize assessments of water-related disease burden and surveil lance, including GIS-based approaches.
2. Risk assessment: to provide environmental information and methods for health risk assessment, including GIS-based approaches.
3. Risk management: To elaborate holistic water management concepts including GIS and HACCP.
4. Communication of health risks: to regularly update and evaluate recent knowledge, experiences and recommendations on risk communication in the field of environment and health.
5. Technical guidance documentation: to lead and coordinate the preparation of technical guidelines in selected topic areas.
6. Dissemination of information on health risks: to produce and disseminate guidance documents, teaching aids and awareness-raising material for technical staff, policy-makers, planners and the general public on the health-significant aspects of water management and risk communication.
7. Training: to organize group training on health promoting water management and risk communication, particularly addressing the needs of health & water agencies in less developed countries.
8. To liaise with WHO regional & country offices, particularly the European Centre for Environment & Health (ECEH), and other WHO CCs, in joint scientific assessment, research and technical cooperation programmes at regional, country and local levels.
9. To support fundraising activities together with partner institutions for projects in which the CC is actively involved; the scope of the activities targets national (German) or EU donor institutions.

Examples of work conducted with reference to the terms of reference

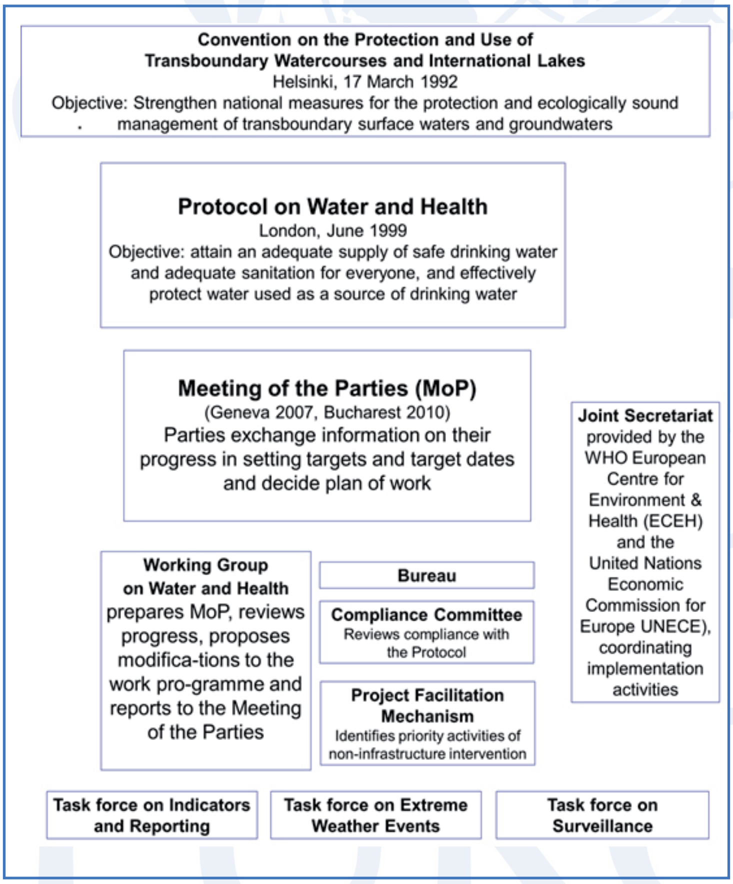

Figure 3: Scheme of the Protocol on Water and Health

I. A major part of the centre's work is linked to the UNECE / WHO EURO Protocol on Water and Health to the 1992 Water Convention (Fig. 3). The Protocol aims to protect human health and well-being through better water management, including the protection of water ecosystems, and by preventing, controlling and reducing water-related diseases in Europe. The Protocol is the first international legally binding agreement of its kind adopted specifically to attain an adequate supply of safe drinking water and adequate sanitation for everyone, and effectively protect water used as a source of drinking water. The Protocol was adopted in 1999 and came into force in 2005, becoming legally binding for the ratifying countries. So far, 36 countries have signed and 24 have ratified it. Since 2002, staff of the WHO CC have attended many meetings of the bureau, the working group, the task forces and of the project facilitation mechanism under the Protocol, and served, inter alia, as chairperson, expert, observer and rapporteur. These were undertaken with the WHO CC acting as a consultant for WHO EURO, but also as a representative for Germany, either governmentally mandated or to support the national delegation.

II. In 2002, the first country mission led the WHO CC to Turkmenistan (Fig. 4). Further to the decision of WHO EURO to support the Central Asian Republics in their fight against gastrointestinal diseases caused by deficient water supply structures through a special Public Health Initiative (PHI), the WHO CC was invited to a consultative meeting on the investigation of gastrointestinal diseases and water supply structures in the Central Asian Republics (CAR). One outcome of the meeting was the establishment of a surveillance training programme for water and health experts of the Central Asian countries. Subsequently the WHO CC was contracted to host a training course on the „Surveillance of water-related diseases", that took place in Bonn in June 2003 (Fig. 5), within the framework of the WHO Public Health Initiative. This course, with participants from five Central Asian Republics and from the Russian Federation, focused on the aims and strategies of standardized and GIS-supported surveillance. This event was also organized to support progress in the ratification of the Protocol on Water and Health. The outcomes of the training course were edited and prepared for publication as a document entitled „Basic guidance on waterborne disease surveillance" by WHO Europe. Finally, the 2nd Meeting of the Parties to the UNECE/ WHO EURO Protocol on Water and Health (Bucharest, November 2010) adopted a policy and published technical guidance on water-related disease surveillance, which form the end product of the project (Fig. 6). The guidance provides explanations of legal obligations with regard to disease surveillance under the Protocol and other international frameworks, and advises on how to set up and maintain an effective and efficient disease surveillance system, coupled with illustrative examples of good practices in the pan-European region.

Figure 4: Country mission: Communication of health risks, training (Ashgabat, Turkmenistan 2002)

Figure 6: 2nd Meeting of the Parties (Bucharest, Romania 2010)

III. In December 2007, the WHO CC held a training course on the Water Safety Plan concept in Moscow. The workshop was organised within the framework of the 2006-07 Biennial Collaborative Agreement (BCA) of the WHO with the Ministry of Health and Social Development of the Russian Federation (Fig. 7). The workshop was attended by 30 senior experts from Russian institutions in the fields of hygiene, public health, water supply and monitoring, as well as representatives of consumers' rights groups. The conclusions drawn by the participants showed that parts of the Water Safety Plan concept had already been implemented in the Russian Federation, albeit under different names. It was also stressed that the modernisation of the water supply facilities and the corresponding infrastructure that is anyway necessary

Figure 5: Preparing a guidance document on surveillance, outbreak detection and contingency planning (Bonn, Germany 2003)

Figure 7: Training Russian experts in the implementation of Water Safety Plans (Moscow, Russia 2007)

provide a good opportunity for the application of the Water Safety Plan concept.

IV. On behalf of the European Centre for Environment and Health (ECEH), in Rome, a Web-GIS application called the "Atlas of Water and Health" was developed, containing key relevant information on water and health in Europe (see http://www.waterandhealth.eu/). The data included are essential in the context of the Protocol on Water and Health. The atlas serves as a basis for the collection and evaluation of data from the countries of the WHO European Region. It integrates country profiles for European member states that bring together information on water and health. The first edition of the atlas has been online since March 2010 and features two applets (maps and fact sheets) for the compilation, presentation and communication of country data. The map applet can be used to produce thematic maps (Fig. 8) relating to water resources, drinking water and sanitation coverage, as well as the mortality and morbidity of water-related diseases.

The fact sheet applet can be used to generate country fact sheets on water resources, water supply and sanitation, as well as water-related diseases and thematic fact sheets on selected themes, which provide data for all the countries of the WHO European Region. The further development of the atlas will include a continuous update, i.e. the collection and integration of current data from the countries of the WHO European Region from existing databases (JMP, HFA-DB, CISID, WaterWiki) and the continuous maintenance and update of the technical back-end. In July 2010 a print function for the fact sheets was implemented.

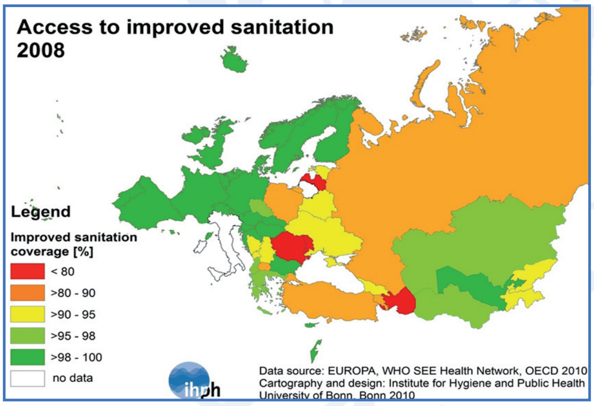

Figure 8 : Map produced with the Atlas of Water and Health

Water, sanitation and health: a persisting global challenge

Water has a central role in societies. Historically, health, wealth, and economic development have always greatly benefited from water availability and an effective management of the water supply. Water scarcity and insecurity can also hit developed societies, but they are much less vulnerable. Proper management of vital water resources has always led to developments and improvements in health. Effectively managed water supplies and resource-protection systems generate the indispensable basis for agricultural and industrial production. Urban and rural development has thrived where water sources have been effectively managed.

In many growing European cities this process started as early as the 15th and 16th centuries. As a consequence of a safer and better managed water system, farming and industrial development expanded, food supply increased and became more reliable and healthy, a number of major diseases no longer posed a serious threat to health, life expectancy increased substantially, and infant mortality in particular decreased dramatically. Industrial development and wealth have depended on a safe, reliable and well-managed water supply. This has been demonstrated to be the single most effective investment in economic and social development, and no other aspect of socioeconomic development has been as incredibly cost-effective in relation to the wealth created. Over a wide range of income distributions, rich and poor countries alike have to invest less than 1 percent of the average income to ensure an excellent water supply and resource management.

In the late 19th century, impressed by the beneficial effects of a clean water supply on mortality, a German sanitary engineer (Johann Julius Reincke) and an American sanitary engineer (Hiram F. Mills) independently found that for every death from waterborne diseases that was prevented, additional infant deaths and deaths from pulmonary tuberculosis and pneumonia were averted. This curiosity came to be called the Mills-Reincke phenomenon (Fig. 9). A recent analysis of several U.S. cities for the period from 1900 to 1936 has conservatively estimated that, for one diarrhoea death avoided, three other deaths were averted by clean water supply systems. The explanations behind the Mills-Reincke phenomenon have remained enigmatic. Contemporaries considered two alternatives: (a) that the 'other' category

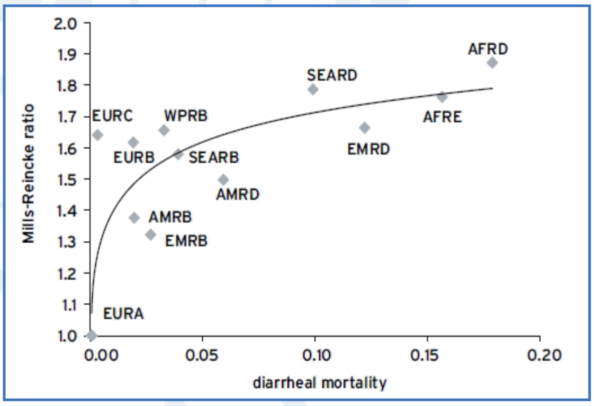

Figure 9: Mills-Reincke phenomenon

WPRB (Western Pacific subregion with low child and low adult mortality); **SEARD** (Southeast Asian subregion with high child and high adult mortality); **SEARB** (Southeast Asian subregion with low child and low adult mortality); **EMRD** (Eastern Mediterranean subregion with high child and high adult mortality); **EMRB** (Eastern Mediterranean subregion with low child and low adult mortality); **AMRD** (subregion of the Americas with high child and high adult mortality); **AMRB** (subregion of the Americas with low child and low adult mortality); **AFRE** (African subregion with high child and very high adult mortality); **AFRD** (African subregion with high child and high adult mortality); **EURA** (Europe subregion with very low child and very low adult mortality); **EURB** (Europe subregion with low child and low adult mortality); **EURC** (Europe with low child and high adult mortality)
Source: World Bank team on the basis of Fewtrell and others 2007

would ultimately also be waterborne or (b) that clean water supply somehow enhanced vitality. Evidence to support the first explanation still has not been found, while results of current research are in line with the second explanation and bring together current competing nutrition and infection-based models to explain the dramatically lowered mortality rates in developed countries over the past century.

A large part of the world population still suffers from water scarcity, both in terms of water quantity and water quality. More than 2 billion people are affected by water shortages in over forty countries: 1.1 billion do not have sufficient drinking water and 2.4 billion have no provision for sanitation. Only half the children in the rural developing world have access to clean drinking water, and even fewer have access to sanitary waste facilities. The average person in the developing world uses 10 litres of water a day. Water is collected by an average walk of 6 kilometres, this being mostly undertaken by women and children. The outcome of this can be seen in increases in disease, poorer food security, conflicts between different users and limitations on many livelihood and productive activities. Water scarcity can have direct adverse health effects in that it restricts personal and domestic hygiene. Inadequate washing procedures and frequencies may prompt water-washed diseases, such as trachoma, relapsing fever and typhus.

According to Halfdan Mahler, a former Director-General of the World Health Organization, the number of water taps per 1,000 population will be an infinitely more meaningful health indicator than the number of hospital beds per 1,000 population. In the Millenium Declaration in September 2000, a set of urgent goals were identified, which, inter alia, cover the area of water, environment and sanitation. The major goals are:

- To halve, by 2015, the proportion of people without sustainable access to safe drinking water.
- To halve, by 2015, the proportion of people who do not have access to basic sanitation.
- To equip all schools with facilities for sanitation and hand washing by 2015.
- Some of the key strategies for meeting the water, sanitation and hygiene challenges are:
- To accelerate access to water and sanitation, with particular attention to those currently not reached in both urban and rural areas;
- To focus on essential, low-cost services.
- To encourage household water security by making enough water of adequate quality available year-round, without compromising the integrity of the environment.

However, an important lesson learned from water and sanitation programmes worldwide is that water and sanitation facilities on their own do not result in improved health. Access to improved facilities is crucial, but it is the correct use of water and sanitation facilities that leads to a reduction in disease. The Hygiene Improvement Framework, developed by the Environmental Health Project (EHP) and promoted by UNICEF, is a holistic approach that reflects this in that it combines increased access to facilities with the promotion of changes in hygiene behaviour and with supportive policies and institutions, from the village household to the office of the global policymaker.

According to the best presently available burden of disease estimates combined water and sanitation interventions can reduce diarrhoeal disease by around 35 percent (i.e. around 2 percent of the total global burden of disease). There are wider social and economic benefits and cost-effectiveness of hygiene interventions. Thus the reviews of health impact studies suggest that water supply and sanitation improvements can reduce the overall incidence of infant and child diarrhoea substantially, in the range of 15-36 percent for single or combined interventions, and also reduce total infant and child mortality

Despite substantial progress achieved in these areas throughout the last decade, much still needs to be done to increase access to safe water and sanitation facilities, to promote changes in hygiene behaviour and to develop effective measures to control water-related diseases. The Bonn WHO CC will continue its collaborative work within a European and global network of UN, governmental, research and NGO institutions, to support the WHO in achieving our common goal: an adequate supply of safe drinking water and adequate sanitation for every human being to improve global health.

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The spread of bacterial antibiotic resistance in the aquatic environment

Antibiotics are substances that kill bacteria or inhibit their growth. In 1928, Alexander Fleming discovered Penicillin, the first antibiotic. Penicillin is a substance produced by the funghi *Penicillum notatum*. Today, about 8,000 antibiotic substances are known and in Germany about 80 are used in human medicine and therapy (1-3). In Germany, antibiotics are the second most frequently prescribed class of drug (4). Every year, about 250-500t of antibiotics are prescribed (5,6). In co-evolution with antibiotic treatment, microbial pathogens have developed several resistance mechanisms against the antibiotics used. Exposure to antibiotics is known to increase resistance. In the case of bacteria, the resistance genes are either located on the bacteria chromosome or on transposable elements such as integrons, transposons or plasmids. The latter can be exchanged between different bacterial cells by horizontal gene transfer. Often, multi-resistance is caused by several resistances located within one plasmid or several plasmids located within one bacterium.

Figure 1: Discharge of treated sewage leaving the STP

Wastewater is the main path by which human antibiotics enter the environment. Only 10-23 % (amoxicillin, tetracycline) up to 85 % (sulfametaxazol) of the amount of antibiotics taken can be metabolized in the human body (7). The remainder is excreted without any biotransformation into the wastewater.

Resistant commensal and pathogenic bacteria are also excreted. In addition to this, antibiotics get into wastewater though the disposal of unused medicines in the toilet or sink.

Most studies dealing with antibiotic resistance in wastewater investigate the effect of hospital sewage effluent on the aquatic environment. However, only about 15 % of antibiotics used in human medicine are used in hospitals, whereas the other 85 % are prescribed by general practitioners. Given this conditions, municipal wastewater is thought to be more important for the spread of antibiotics in the aquatic environment. To verify this, a study was conducted in the catchment area of the river Swist in Germany.

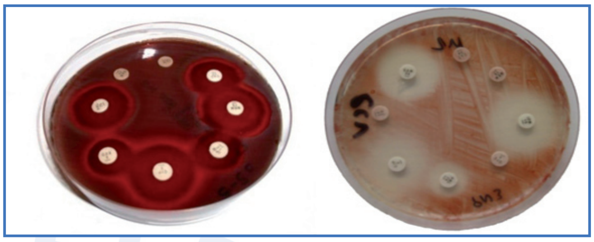

Figure 2: Antibiotic resistance tests. Bacterial growth reaching the test plates indicates resistance

Methods

The study consists of three parts representing the environment, bacteria and humans. A field study was undertaken during the hydrological year 2007/08. Water samples of the influent and effluent of a municipal sewage treatment plant (STP) were investigated, as well as the discharge system, the river Swist, upstream and downstream of the STP (Fig.1). Additionally, two tributaries without any wastewater influence were investigated in the upper reaches of the 284 km^2 catchment area. Resistant isolates were identified by bacterial growth and the size of the inhibition zones around small filters loaded with antibiotics (Fig.2). In a second step, laboratory experiments were undertaken to prove the transferability of antibiotic resistances found between different isolates. In the third socio-empirical part of the study, people from the catchment area of the STP were asked to complete questionnaires about their knowledge of antibiotics and resistances and about their risk perception and risk behaviour. Finally, data were combined in a qualitative risk assessment on the risk of infection with the resistant pathogens *Pseudomonas aeruginosa* and *Campylobacter spp.* in the catchment area.

Pathogens and environmental bacteria detected in municipal wastewater and river water

Water samples were analyzed for the occurrence of *P. aeruginosa* (8) and *Campylobacter* spp. (9, modified). Concentrations were highest in raw sewage influent and lowest in water from the tributaries. During wastewater treatment the concentration was reduced by a median of 3 log_{10}. *Rhodospirillaceae* or non-sulfur purple bacteria (10, modified) were detected in median concentrations of about 10^3 KBE/100ml at all sampling sites. Rank correlations (Kendall tau-b) show a high statistical significance ($p < 0,001$, $r > 0,65$) that an increase of pathogen concentrations is correlated with higher wastewater influence on the sampling sites.

Influence of STP effluent on bacterial resistance levels in river water

Resistance levels differ a lot. For example, the Piperacillin resistance of *Campylobacter* was nearly 90 %, but Meropeneme resistance was only <2 %. No general pattern could be observed for single antibiotics, species or sampling sites, but with regard to multi-resistances, a clear trend is detectable. The multi-resistance levels of both pathogens *P. aeruginosa* and *Campylobacter* increased from tributaries to raw sewage according to higher levels of wastewater influence (Fig. 3). In contrast, multi-resistance levels of *Rhodospirillaceae* showed the highest values in tributaries and were lower in the river downstream of the sewage plant.

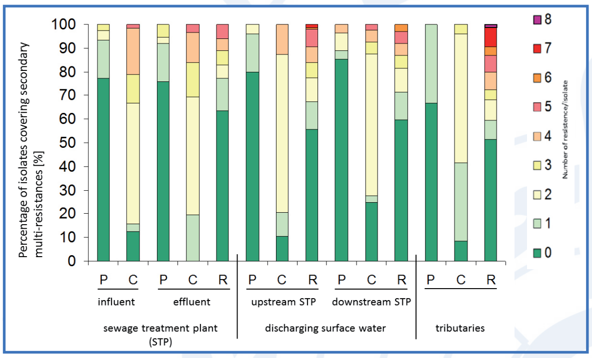

Figure3: Frequency of detected acquired multi-resistances of the bacteria isolated from different sampling sites
Tested antibiotics: Ampicilline with Sulbactam, Cephazoline, Ceftazidim, Meropenem, Imipenem, Ciprofloxacine, Ofloxacine and Piperacilline;
STP = sewage treatment plant, P = P. aeruginosa, C = Campylobacter spp., R = Rhodospirillaceae

Transfer of resistance genes between bacteria

To examine whether the resistance genes detected are located on transferable elements and if horizontal gene transfer could cause the increase in pathogen multi-resistance, isolates with different multi-resistances were chosen for filter mating tests. Out of 57 different assays (double) tested, only two *Campylobacter jejuni* were shown to transfer a Piperacillin resistance to the originally non-resistant isolates of environmental R*hodospirillaceae, Rhodobacter capsulatus* and *Rhodobacter sphaeroides*. Variations of the test assay using sterilized river water instead of filters showed lower transfer frequencies and assays in moving water as a simulation of flowing river water showed the lowest level of gene transfer.

Contribution to resistance spread by the population

The household study showed that about one third of the people in the catchment area dispose of their old unused medicines in the toilet. In particular, men, people with full-time jobs or those aged <40 years or >60 years tend to show this behavior. Knowledge of the effects and functions of antibiotics is low, e.g. about one third of people believe that they are effective in killing viruses. Women are better informed than men, as are those with a higher educational level. Compliance with prescribed therapy is also not always the case. People in full-time jobs or with higher education show more non-compliance and stop antibiotic intake early, e.g. because the health of the subject is improving.

Risk assessment

On basis of these results, the last step in this analysis was to perform a hygienic-microbiological risk assessment on the infection of people with resistant pathogens in the study area. The risk analysis includes the effects of wastewater treatment, sewage discharge into the aquatic environment, resistance levels and transmission as well as people´s knowledge, perceptions about antibiotics and resistances and their risk behavior. Additionally, volumes of water uptake, transmission routes and dose-response characteristics of the pathogens were integrated into the risk characterization. Several water use scenarios were examined. Recommendations for risk communication and risk management were produced. For *Campylobacter* spp. inter alia, the following was deduced: The volume of wastewater discharge out of the STP of the village Miel was about 828,000 m^3 in 2008, median concentrations of *Campylobacter* were 4,300 MPN/100 ml and the antibiotic resistance level in the wastewater effluent showed 69 % of *Campylobacter* isolates with at least one acquired resistance. The resulting annual microbial load that entered the aquatic environment by only one STP was $2.46*10^{13}$ KBE *Campylobacter* with acquired resistances. In the whole catchment area of the river Swist (284 m^2) there are five STPs, varying in size between 111,000-4,076,000 m^3 per year and with differences in the techniques used and the quality of the wastewater treatment.

With regard to the infection risk, a minimum ingested dose of 500 *Campylobacter jejuni* cells is necessary before symptoms occur (11, 12). According to the *Campylobacter* concentrations detected in the water samples, a person has to ingest between 54 ml (river Swist) and 50 liter (tributaries) surface water before becoming ill. During swimming for example, an adult ingests a water volume of 16 ml/h, children about 37 ml/h (13). Donovan et al. postulate a mean ingestion rate of 36 ml per day during a recreational stay, when 20 % of this time is spent in direct contact with water (14). From this, the study concludes that there is a risk of infection with campylobacteriosis within the study area. Extreme rain events may cause an increased but temporary limided risk when there is a discharge of combined sewage overflow. This untreated discharge increases contamination risk because of higher concentrations than usual and because these events are often unknown to people downstream. Although the resistance level for antibiotics such as Piperacillin, is quite high (>60 %), the resistance to the last resort antibiotic Ceftazidime which is used against Campylobacter infections, is still quite low (<1.5 %). Antibiotic therapy is therefore assessed as successful.

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Swimming pool water management

The London Olympics in 2012 together with policies to promote healthy living and exercise inevitably will increase public use of sports facilities, including swimming pools. According to one report in the UK the leisure centres and swimming pools market has grown in value by 13.6 % between 2005 and 2009, and admissions have grown by 10 % despite the recession. However, energy costs are becoming increasing important for the industry as a result of a combination of the 150 % increase in gas and electricity prices between 2004 and 2009 and the proposed introduction of a carbon trading scheme that rewards the most efficient centres.

With the cost of energy and water increasing and the promotion of the environmental agenda within the leisure industry, it is increasingly important for facilities to optimise their operations to remain economically viable. There have been a series of pool closures across the UK where the cost of running and maintaining facilities has exceeded available funding (The Telegraph, 29 February 2008). This has been most evident in deprived areas where the facilities are unable to make up the shortfall by offering other profitable services such as fitness memberships and personal training. A study carried out by Thomson et al. (2003) in Glasgow, Scotland following a community pool closure found that local residents felt that the public provision of a social space was a more significant benefit lost due to the closure. The study was conducted using a series of focus groups of adults living local to the closed pool. To provide a comparison, focus groups were also formed in a similar community that had just had a pool facility open in their locality. Both communities identified keeping young people occupied as one of the most significant benefit of the pool facility with keeping active being a secondary benefit. Swimming is one of a limited number of activities that can be enjoyed by all ages and genders at a relatively low cost. For this reason swimming pools are considered to be more valued amenity than some other local facilities. However, it is a resource that receives relatively little attention with regards to research. Current Guidelines and standards are based on laboratory studies in general with very little hard scientific evidence behind them.

Pools have become increasingly complex in terms of size, shape and 'accessories' to accommodate the needs of different user groups e.g high performance swimmers, causal swimmers, aqua sports groups etc. Moveable floors, water slides etc, result in a range of new hazards and challenges regarding management of pools taking into account safety and cost.

Many of the options available to minimise the running costs of pools require modifications to the pool or investments in alternative equipment. These include the installation of pool covers, variable speed drives on the circulation pumps and heat recovery units on the ventilation system. Although these can reduce the running costs significantly they can be extremely expensive. An alternative and cheaper option is to improve management of the pool. Operating a pool at a slightly lower temperature (for example 27°C instead of 29°C) can reduce the energy consumption of the facility significantly by reducing the energy directly used to heat the water and the amount of evaporation that takes place. A secondary effect would be to reduce the amount of ventilation required to maintain the desired humidity level. However, the reduction of temperature can cause negative feedback from the users and may not be feasible.

From discussions with regulatory authorities and swimming pool managers in the UK there appears to be a definite need to improve guidance for swimming pool operators. In order to do this it seems necessary to obtain an in-depth understanding of pool water behaviour. At the University of Surrey, UK we have begun to address this through the establishment of a series of analytical and theoretical research projects aimed at increasing our knowledge in this field. Of significance is a major engineering research project using computational fluid dynamics to model the function of swimming pools in order to look at energy efficiency. This is a four-year study and by the end we hope to be able to make recommendations to pool designers and managers about the way pool water should be managed in order to reduce costs and improve public health.

Figure1: View of an indoor swimming pool

Along the same theme we have also begun to investigate pre-swim hygiene behaviour. Bathers introduce a wide range of contaminants to the water in the form of cosmetics, dirt, sweat, urine and faecal matter. This material introduces microbial pathogens to the water which can then thrive in the warm environment. Various studies into swimming-related illnesses show that where pathogens are not actively controlled a wide spectrum of illnesses including respiratory, gastrointestinal, eye, ear, skin, and allergenic ailments are common (see Pond (2005) and WHO (2006) for review). Swimming pools provide good conditions for the survival of pathogens due to warm temperatures and therefore need to be controlled in order to protect the health of bathers. Good clarity of the water, which can be affected by pool bather hygiene, is also highly important in swimming pools to minimize injury hazards (WHO 2006).

In order to mitigate the possibility of users becoming ill through exposure to microbial pathogens, pool facilities use a disinfectant or biocide, most commonly chlorine. Contact with chlorinated pool water has been found to cause a range of symptoms amongst swimmers including runny nose, respiratory irritations, asthma and skin infections (Momas, Brette et al. 1993).

Chemical disinfectants can react with the substances shed by swimmers (eg urine) to generate a wide range of disinfection by-products. Many of these by-products, such as trihalomethanes (THMs) and chloramines have been identified as harmful to human health. G#üpk Some are naturally volatile whilst others form aerosols during water surface disturbance. Swimmers and non-swimmers are then exposed to these airborne substances. This is believed to be the reason why some symptoms are experienced by all visitors to swimming pools, regardless of whether they swim or not (PWTAG 2009).

It is therefore necessary for facilities to refresh the pool water regularly and ventilate the pool hall effectively. The process of maintaining the water quality requires the disposal of significant amounts of water. The more contaminants that are introduced into the pool the greater the concentration of disinfectant required and the greater the rate of accumulation of by-products. The amount of dilution required increases and therefore the amount of energy needed for heating and ventilation also increases. In essence the environmental impact of the pool is directly influenced by bather load. A 50m x 20m pool requires around $2000m^3$ of water with approximately a further $200m^3$ in the balance tank and associated treatment plant and requires approximately 45kwh of electricity per day to run the water plant, air plant and lighting and approximately 350kwh from the burners a day for heating. There is also an environmental consequence of discharging chlorine derivatives.

If a facility can reduce the amount of contaminants and foreign material that enters the pool they can reverse the trend and reduce the energy consumed. Other benefits to the users would be a more pleasant environment to visit with a lower risk of illness. This can be achieved in part through the use of good pre-swim hygiene and dedicated swimming clothing and equipment. Pre-swim hygiene routines, including using the toilet, removing cosmetics and showering, will reduce the amount of precursors for disinfection by-products or sources of microbial pathogens (Lakind, Richardson et al. 2010). In addition, wearing pool shoes around the pool, not urinating in the pool, not bathing if affected by diarrhea and wearing a bathing cap can help to reduce contamination. Pool managers have the important role of avoiding overcrowding of the facilities and ensuring that all technological systems function properly. Facilities would potentially be able to operate with a lower concentration of disinfectant as there are fewer microbial organisms to deactivate and less disinfectant is lost through unwanted by-product reactions. Reducing the amount of disinfectant used will reduce the cost of chemical supplies and the amount of by-products formed, leading to less water having to be replaced, thus reducing the costs associated with purchasing, heating and pumping fresh water into the system. The reduced level of disinfection by-products in the water also reduces the concentrations within the air and therefore

reduces the amount of ventilation required. This reduces the costs associated with heating fresh air to the pool hall temperature.

It is clear that the behaviour of pool users can have a significant impact on both the transmission of diseases and the running cost of a swimming pool. It is therefore desirable for facilities to improve the hygiene behaviours of their visitors to help them improve their sustainability. If programmes to improve hygiene are to be effective it is essential to both identify the particular practices that contribute to poor hygiene and thus disease transmission, and to understand the reasons for these practices.

A pilot project undertaken by the University of Surrey has shown that there is significant variation between different user groups with regards to pool hygiene behaviour. It was also observed that a significant amount of people who did use the shower only did so for a matter of seconds and failed to wet their hair, which is believed to be a significant source of pollutants. Even a short pre-swim shower has been reported to result in a significant reduction in the level contaminants introduced to the pool by bathers (Lakind, Richardson et al. 2010). Increasing the proportion of bathers using pre-swim showers could reduce the impact on the water quality and thus save energy. We are hoping to conduct a bigger survey along the same theme and try to identify through focus groups what communication measures would encourage pool users to improve their pre-swim hygiene.

Activity	Number of Bathers	Number Showered	% Showered
Public Swim	208	125	60%
Learn To Swim	85	11	13%
Swimming Club	68	39	57%
School Swim	59	45	76%
Canoe Club	20	17	85%
Aqua Classes	24	2	8%
Water Polo	24	24	100%
Total	**488**	**263**	**54%**

Figure 2: Results of a pilot scale observational study of pre-swim hygiene behaviour

There are no mandatory standards for swimming pools across Europe. Within the UK the Pool Water Treatment Advisory Group (PWTAG) was established out of the Department of Environment Committee that was in existence in the late 1970s to produce guides for pool operators. The PWTAG, now an independent limited company, recognises the need for advice and guidance in this field and have recently published the second edition of Swimming Pool Water: Treatment and quality standards for pools and spas.

The Health and Safety Executive published its second edition of Managing health and safety in swimming pools' in 2003; and the Health Protection Agency, published 'Management of Spa Pools: Controlling the risk of infection' in 2006. It is clear from these publications that there is a demand for guidance.

On a global level, the World Health Organization published in 2006 Guidelines for safe recreational water environments, volume 2, swimming pools and similar environments (WHO, 2006). This provides a referenced review and assessment of health hazards associated with recreational waters of this type, their monitoring and assessment; and activities available for their control through education of users, good design and construction, and good operation and management. The Guidelines, due to be revised, provide specific guideline values and good practice. They address a wide range of hazards, including water quality, air quality, management of facilities and hazards leading to drowning and injury. However, the evidence that exists to date underpinning the Guidelines primarily comes from outbreak data and laboratory studies rather than from targeted research carried out on actual pools.

Water Safety Plans have become established as a valuable management approach to the risk assessment of drinking-water. It is suggested that recreational waters including swimming pools could also benefit from this approach.

The authors are keen to collaborate with other interested research groups in this field.

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Universal Access to Water and Sanitation

„Access to safe water is a fundamental human need and therefore a basic human right."
Kofi Annan, United Nations Secretary General

The Millennium Development Goals (MDG) established in 2005 aim to reduce by half the population without access to an improved water supply and without adequate sanitation by 2015. Although many parts of the world have shown a tremendous increase in the provision of clean water supplies and many countries are on track and will reach the MDG on improved water supply, access to sanitation is still a significant problem. It is widely recognized by governmental organizations, as well as non-governmental organizations, that countries will often fail to achieve MDG Goal 7 target 7c. Without a significant acceleration in progress, the sanitation target will be missed by 700 million people, most of whom live in Southern Asia and Sub-Saharan Africa. The JMP report also stresses the disparity in access to water and sanitation between rural and urban dwellers and emphasizes that more effort is still needed to reach the poorest people. One billion people still practice open defecation. Recent developments should however be highlighted.

- In 2005, 87 % of the global population had access to a source of 'improved' drinking water, and it is now estimated that by 2015, this will be over 90 %.
- In Northern Africa, Latin America, the Caribbean and West Asia, coverage levels are already over 90 percent.
- In sub-Saharan Africa there has been an increase in coverage of 9 percent, but this progress has fallen short of that needed to achieve the MDG by 2015. Obstacles to accelerating progress in this region include political instability, population growth and the low priority given to water services in national budget allocations

Source: http://whqlibdoc.who.int/publications/2008/9789241563673_eng.pdf

In August 2010 the UN General Assembly adopted Resolution A/RES/64/292 "The human right to water and sanitation". This resolution is binding to all members of the General Assembly. Within the resolution, the General Assembly

"Recognizes the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights".

It also "Calls upon States and international organizations to provide financial resources, capacity-building and technology transfer, through international assistance and cooperation, in particular to developing countries, in order to scale up efforts to provide safe, clean, accessible and affordable drinking water and sanitation for all". By its adoption, Resolution A/RES/64/292 became part of international law and is legally binding upon Member States.

Within resolution A/RES/64/292 a link is also made to the Human Rights Council. The independent expert on human rights obligations related to access to safe drinking water and sanitation is requested to submit an annual report for the General Assembly addressing the principal challenges related to the realization of the human right to safe and clean drinking water and sanitation and their impact on the achievement of the Millennium Development Goals.

Following the key development of the adoption of resolution A/RES/64/292 by the General Assembly, the UN Human Rights Council adopted by consensus the Resolution on Human Rights and Access to Safe Water and Sanitation (Resolution A/HRC/15/L.14) in September 2010. This resolution affirms that "the human right to safe drinking water and sanitation is derived from the right to an adequate standard of living and inextricably related to the right to the highest attainable standard of physical and mental health, as well as the right to life and human dignity." All states which are party to the International Covenant on Economic, Social and Cultural Rights have the responsibility to provide safe water and sanitation to all individuals.

Compared to the MDGs, Resolution A/RES/64/292 overcomes several limitations. The Resolution on Human Rights and Access to Safe Water and Sanitation covers universal access, instead of setting the goal at halving the proportion of people without access to water and sanitation. The request for universal access also addresses the need for affordable access, a point not explicitly noted in the MDG. With respect to sanitation services, the MDGs do not consider wastewater disposal and associated risks, but rather monitor access to safe sanitation facilities. As the human rights resolution talks of "an adequate standard of living" and the "right to […] physical and mental health…" it is necessary to provide sanitary systems that are environmentally friendly and hygienic. Fulfillment of the human rights resolution also has to include the provision of hygiene promotion and education to improve the health status, an aspect that is not included in MDG Goal 7.

The MDGs do not include measures to ensure the human rights principles of accountability, non-discrimination, access to information and the right to participate. The human rights resolution can therefore supplement the MDGs by promoting processes that target the most disadvantaged groups.

Following these big forward steps, the process of acknowledging the human right to water and sanitation continued. On 24 May 2011, the 65th World Health Assembly unanimously adopted Resolution 64/24 on Drinking Water, Sanitation and Health. For the first time in 20 years, the Assembly has adopted a Resolution specifically addressing drinking water and sanitation.

This Resolution urges Member States, inter alia, to highlight the importance of safe drinking water, sanitation and hygiene as the basis for primary prevention in national public health strategies and to ensure that these strategies contribute to the achievement of the water and sanitation-related MDG target and to the progressive realization of the human right to water and

sanitation. It requests the Director-General, inter alia, to formulate a new, integrated WHO strategy for water, sanitation and health, with a focus on water quality and monitoring issues, and to increase technical assistance for enhanced drinking water quality management.

Additionally, Resolution 64/15 on Cholera: mechanism for control and prevention, drawing attention to the key role of access to clean water and adequate sanitation in cholera prevention, and Resolution 64/16 Eradication of dracunculiasis were adopted. The Director-General is requested to revitalize the Global Task Force on Cholera Control. The eradication of the Guinea worm from its last hotspots in Africa is an attainable goal. Access to safe drinking water and the use of cloth and pipe filters are critical elements of the strategy for final eradication.

Further information:

UN Resolution 64/292
http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N09/479/35/PDF/N0947935.pdf?OpenElement

UN Human Rights web page providing the resolution text in several languages
http://ap.ohchr.org/documents/dpage_e.aspx?si=A/HRC/15/L.14
http://www.righttowater.info/

World Health Assembly: Resolution WHA64.24
http://apps.who.int/gb/ebwha/pdf_files/WHA64/A64_R24-en.pdf
http://www.who.int/water_sanitation_health/highlights/wha64_resolutions/en/index.html

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Events on Water, Health and Risk Communication:

September

IWA Specialist Conference on Groundwater
8-10 September
Belgrade, Serbia
http://www.jcerni.org/activities/conferences/iwa_specialist_groundwater_conference_2011

16th international symposium on health-related water microbiology
18-23 September
Rotura, New Zealand
http://www.iwahq.org/Home/Events/IWA_events/Event_listing/2011/16th_international_symposium_on_health-related_water_microbiology

1st IWA Central Asian Regional Young Water Professionals Conference
22-24 September
Almaty, Kazakhstan
http://aquaproblems.com

5th European Water & Wastewater Management Conference & Exhibition
26-27 September
London, UK
http://www.ewwmconference.com

NGWA Focus Conference on Fractured Rock and Eastern Groundwater Regional Issues (conference #5017)
26-27 September
Burlington, USA
http://www.ngwa.org/Events-Education/conferences/5017/Pages/5017sep11.aspx

Water Reuse 2011
26-29 September 2011
Barcelona, Spain
http://www.waterbcn2011.org

October

Water and Health Conference: Where Science Meets Policy
3-7 October
Chapel Hill, USA
http://whconference.unc.edu

Global Forum on Sanitation and Hygiene
9-14 October
Mumbai, India
http://wsscc-global-forum.org

Training Workshop on Collaborative Tools to Support Science - Policy Interaction in the Field of Water Management
12 October 2011
Budapest, Hungary
http://www.psiconnect.eu

Hydro 2011
17-19 October
Prague, Czech Republic
http://www.hydropower-dams.com/hydro-2011.php?c_id=88

The global WaterHackathon event
21-23 October
http://www.waterhackathon.org/event

Biofilm Conference 2011: Processes in Biofilms
27-30 October 2011
Shanghai, China
http://www.iwabiofilm2011.com

November

Aqua Ukraine 2011
8-11 November
Kiev, Ukraine
www.iec-expo.com.ua/index.php?id=490&L=2

International Water Conference
13-17 November
Orlando, USA
http://www.eswp.com/water

WQTC11 - Water Quality Technology Conference & Exposition
Event Type: Conference/Seminar
13-17 November
Phoenix, USA
http://www.awwa.org/Conferences/wqtc.cfm?ItemNumber=32120&navItemNumber=3545&showLogin=N

Bonn 2011 Conference: The Water, Energy and Food Security Nexus
16-18 November
Bonn, Germany
http://www.water-energy-food.org/de/home.html

Re-Water
12-22 November
Braunschweig, Germany
http://www.susana.org/docs_ccbk/susana_download/1-54-10-08-19sebsflyersymposiumcallforpapers1.pdf

2nd IWA Development Congress & Exhibition
21-24 November
Kuala Lumpur, Malaysia
http://www.iwa2011kl.org

UNESCO IHP HELP Global Symposium 2011, Building Knowledge Bridges for a Sustainable Water Future
21-24 November
Panama City, Republic of Panama
http://www.helpsymposium.com/eng_inicio.html

Vietwater2011
24-26 November
Ho Chi Minh City, Vietnam
http://www.vietwater.merebo.com

14th IWRA World Water Congress
25-29 November
Porto de Galinhas/PE, Brazil
http://www.worldwatercongress.com/en/

6th Rural Water Supply Network Forum
Rural Water Supply in the 21st Century: Myths of the Past, Visions for the Future
29 November - 1 December 2011
Kampala, Uganda
http://www.rwsn.ch/events/skatevent.2011-03-07.4777359943

December

Summer School „Water and Sanitation for Urban Poor: Natural hazards, climate change, governance and human rights"
4-17 December
Nairobi, Kenya
http://www.iwmnet.eu/index.php/news/83-news/196-urban-poor

1st International Conference on Water and Society
5-7 December 2011
Las Vegas, USA
http://www.wessex.ac.uk/11-conferences/waterandsociety-2011.html

1st East Africa Young Water Professionals Conference
8-10 December
Kampala, Uganda
www.nwsc.co.ug

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