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WATER & RISK

Dear Reader,

Reading the articles in this newsletter made me remember my childhood. For many years my father took his daughters swimming at the weekend. My sisters and I learned to swim and we took our first jumps from the 1m block with him. At the swimming pool it was always nice and warm and especially in wintertime we enjoyed how the pool simulated summer. Later I went to lakes or rivers to enjoy water and exploring a beach in the summer was unbeatable. Were there risks? Of course! But as a child you often don‘t see them unless they are communicated clearly. It is easy to remember not to go swimming if the red flag is raised. It might be because of bad weather conditions, algal blooms, contamination or something else. No matter what it is, we know to just stick to the rule and lives will be saved.

We often don’t know what happens behind the scenes. How much technology is needed to make a swimming pool run and make it safe to use? What does it take to move from different sorts of data to creating a model, to a warning mechanism protecting bathers at the seaside? And if this is not enough, there are always new threats popping up. How can we predict risks from climate-associated changes? Modeling risks is becoming more complex, so we need to predict the changes, prepare for them and develop adaptation mechanisms.

Regardless, all around the globe people enjoy recreational activities involving water. Water is naturally attractive to humans, making it difficult to resist. If there is a small puddle, children will start playing in it. It’s a simple source of happiness putting a smile on their faces. There is only one limit: One needs to have a little spare time. It is still the case that many children have to fetch drinking water far from their homes. They spend hours on this hard work and have no time for leisure. Increasing access to safe drinking water for all is still a challenge. Every effort being made in this field has to be highly appreciated as it allows more people to enjoy the beautiful aspects of water.

I hope that you find some time and enjoy reading this issue of the Water & Risk Newsletter.
Best wishes for 2012

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

Dynamic Modelling of Bathing Water Quality for Early Warning

Introduction

Summer calls for families to go to the beach to enjoy the sun and the bathing water. Unfortunately, summer also sees problems with potentially noxious microorganisms. Clean beaches and bathing water are valuable assets to users enjoying aquatic recreational areas and to the tourism industry, which profits from the attractions of nice beaches and safe waters. Much is therefore done to protect our beaches and their water quality. Pollution by faecal microorganisms does, however, still pose a serious health risk to bathers and other users. Amongst the faecal organisms are pathogenic species (including bacteria and viruses), which may cause diseases such as diarrhoea and abdominal pain.

Some of these pathogens are introduced through point source pollution and diffuse loading, by discharge of human sewage, storm water runoff, waste from mammals and birds and agricultural runoff, either directly or indirectly via upstream waterways and their catchment areas. To detect the pollution, regulations throughout the world stipulate the monitoring of faecal indicator bacteria. In the EU, according to the new Bathing Water Directive, compliance necessitates measurements of E. coli and Enterococci. In addition to this, the Directive demands timely and adequate public warnings during short-term (less than 72 hour) contaminations.

As stated in Article 1 in the Directive: ’...The purpose of this (the new Bathing Water) Directive is to preserve, protect and improve the quality of the environment and to protect human health...’ (EU 2006, § 1, section 2). To protect the bathers from pollution originating from short-term pollution, the new directive introduces the concept of early warnings (fractured citation): ’…Bathing waters are to be classified as ‘sufficient/good/excellent… if – when subject to short-term pollution - adequate management measures are being taken, including surveillance, early warning systems and monitoring, with a view to preventing bathers’ exposure, by means of a warning or, where necessary, a bathing prohibition (Annex II, sections 2, 3 and 4) (EU 2006). In Denmark and Sweden, operational modelling systems are implemented and regularly used to fulfill the requirements to protect the public and disseminate warnings.

Early warnings of bathing water quality

In most urbanized areas the major threat to bathers' health is short-term pollution caused by sewage overflows in connection with heavy rainfall. E. coli, and Enterococci are traditionally used (one or both) as indicators of pollution with pathogenic microorganisms.

Worldwide, regulation requires that the quality of marine and freshwater recreational waters is checked to detect pollution with pathogenic organisms. The purpose of the monitoring is to inform users of the water quality and to assist water managers in identifying needs for measures to protect bathers and sewage water operators in planning mitigation measures.

When considering the protection of bathers, the present monitoring strategy has major shortcomings as it only provides snapshots at fixed spots in space and time. The measurements may give an overview of the general status of recreational waters – dependent on the intensity of the monitoring (how often; how many places). However, they are not applicable as a basis for early warnings advising the bathers if it is safe to go to the beach today or tomorrow. The pollution will most probably be long gone before the manager becomes aware of the event and warnings can be posted to the bathers. It may also be that a measurement immediately after rainfall indicates that the water is safe because hydrographical processes have caused a delay in polluted water reaching the beach area. The snapshot strategy does not take hydrographical and weather conditions (which have a marked influence on decay rate) into account or provide forecasts of the water quality. Therefore, traditional water quality monitoring provides information on the average quality, but does not provide any indications of the quality on an actual day.

To overcome these shortcomings, a Bathing Water Forecast System (BWF system) has been developed. The rationale behind the BWF at recreational beach areas is to provide the manager and the visitors with a continuous evaluation of today's bathing water quality as well as the consequences for the quality in the coming days (Erichsen and Rasch 2001). It is an innovative online predictive tool that facilitates timely and protective information for the beach visitors. The water managers have an efficient tool to follow developments in the water quality and obtain a solid basis for determining the need for action on both a short-term and a long-term scale.

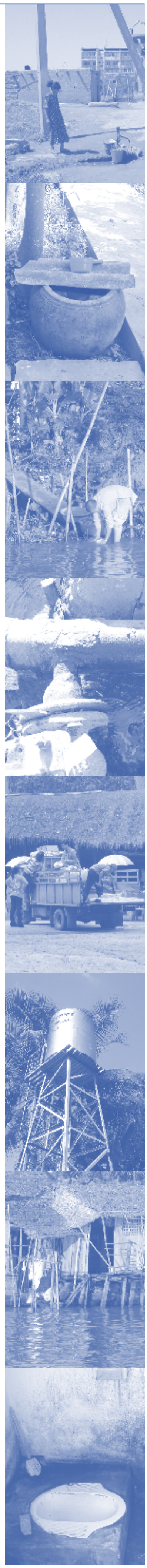
The BWF system was developed by DHI in Denmark and has been in operation since 2002 as a service within DHI's Water Forecast Service (http://www.dhigroup.com/Solutions/EcologyAndAquaculture/ForecastingForMarineWaters.aspx). The first and still an existing client was the Danish capital, Copenhagen (Erichsen et al. 2003). Since then, coverage by the BWF has been expanded to include beaches in 11 Danish and 3 Swedish municipalities. The Danish and Swedish forecasts are disseminated on two websites, one for Sweden and one for Denmark (www.hallandskusten.badvatten.se and www.oresund.badevand.dk (in Danish and Swedish, respectively)).

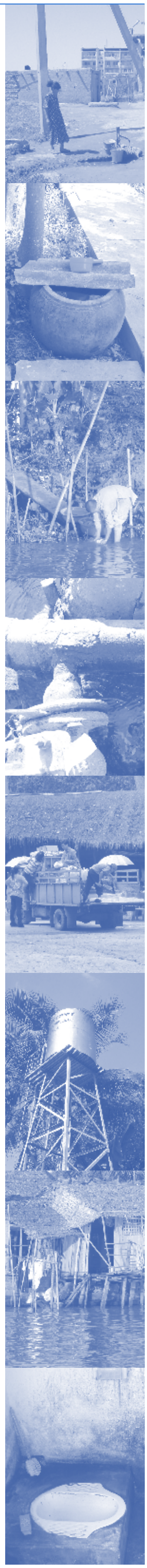
Figure 1: The English language app showing bathing and weather forecasts based on the BWF system at DHI. Upon opening the APP, the forecast for the beach closest to you is shown (view in the middle). One may also choose to see today's forecast for all beach areas (view to the right).

Furthermore, public information is also available on Windows7, Android and iPhone apps. All BWF results are published on one app, see Figure 1. The app exists in three versions; one in Danish: 'Badevand', one in Swedish: 'Battvatten' and one in English: 'Bathing water'. The English app is shown in Figure 1.

The bathing water forecast system

The bathing water forecast system was originally (Erichsen et al. 2003) developed together with, and for, the municipality of Copenhagen, the capital of Denmark. From the beginning, the system was an integrated part of a targeted investment with the purpose of opening the





harbour for swimming after more than 50 years of bathing prohibition. The Copenhagen EPA decided – based on discussions with DHI – to introduce an early warning system, because they considered it crucial to protect the public from health threats from pathogenic bacteria and because they found that traditional monitoring did not provide sufficient information on today's quality. This targeted investment and the introduction of new innovative solutions to address the safety of the daily visitors to the beach have since resulted in a Danish award for 'Good Environmental Management'. New York City has also recently acknowledged the innovative and long-term investments as Best Practice (http://www.nyc.gov/html/unccp/gprb/downloads/pdf/Copenhagen_Harbour%20Bath.pdf).

In the first version only the harbour area was covered, as the main purpose was to provide prognoses for a number of new bathing facilities in the harbour. Later the BWF was extended to cover the city's coastal beach areas and a number of neighbouring municipalities, as well as 3 Swedish municipalities.

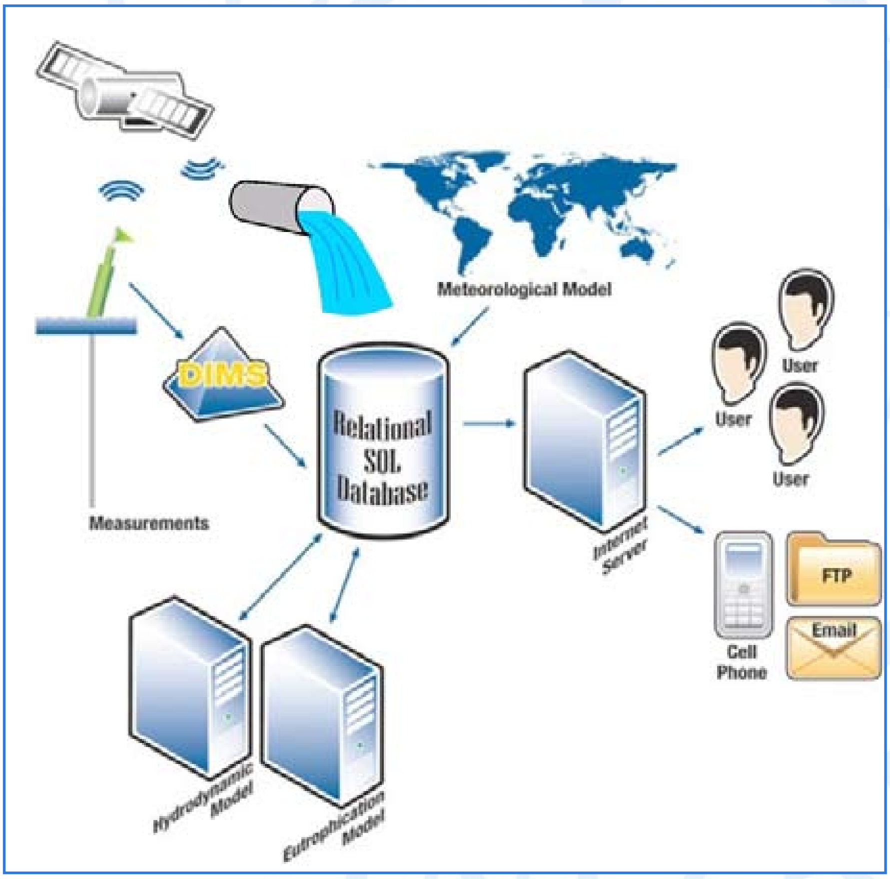


Figure 2: The infrastructure and data flow of the Danish Bathing Water Forecast System

As is often the case for bathing water around the world, the most important source of bacterial pollution in Copenhagen harbour is the combined sewer overflow (CSO). During a bathing season (May-August) Copenhagen has on average 3-5 incidences of CSOs. The CSOs occur in connection with heavy rain and thunderstorms. In some areas of the harbour the pollution originates from upstream municipalities, therefore the BWF model setup for Copenhagen recreational waters comprises both an operational 3D recipient model and an operational 1D river model transporting the upstream source inputs to the harbour area. However, in Sweden the situation is somewhat different, as in most cases the pollution occurs from separate sewer systems and diffuse loadings. The system does, however, handle both situations and provides equally valuable information to the managers.

The infrastructure, models and data

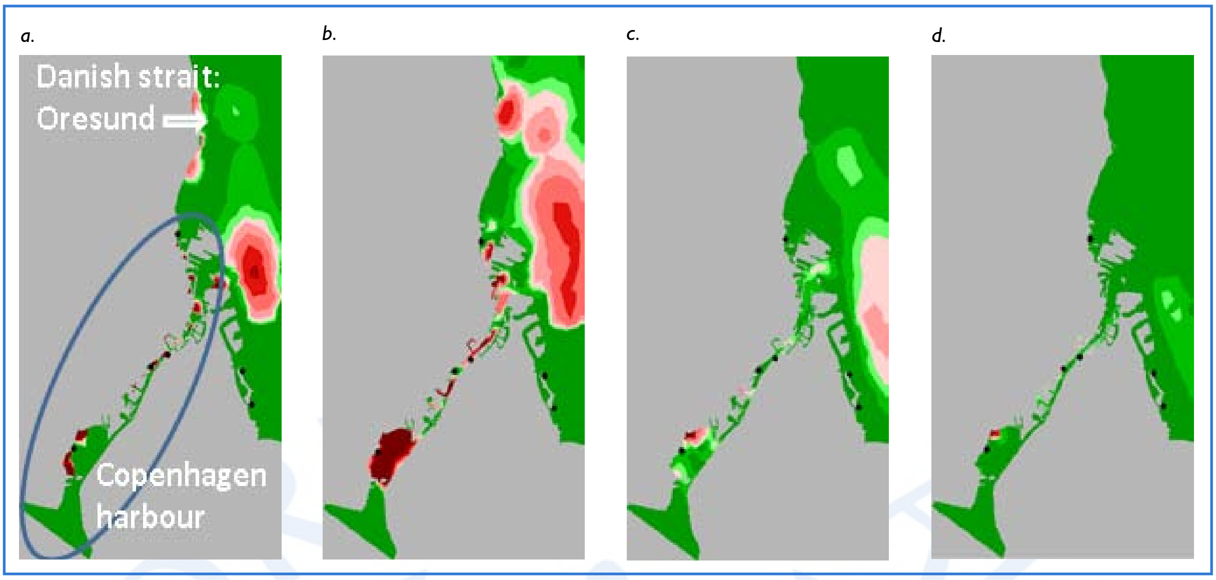
The core of the BWF system is a database and a number of hydrodynamic-ecological models (MIKE by DHI model tools: 1D, 2D and/or 3D), which simulate the physical conditions and decay of the indicator bacteria E. coli and Enterococci in real-time (today) and give forecasts for 3-4 days. The models are executed in operational mode twice a day and more frequently when there are sewage spills. The elements of the BWF and the overall data flows are shown in Figure 2.

Hydrodynamic boundary conditions are delivered online by the Water Forecast - an operational service by DHI providing daily updated data on current speed and direction, wave periods, heights and directions, salinity and temperature (Erichsen and Rasch 2001). Meteorological boundary conditions are acquired online from a weather forecast supplier. Data on sources of bacterial pollution is delivered online by the utility companies responsible for sewage and storm water discharges influencing recreational water. Additionally, DHI estimates discharges and bacterial loadings based on empirical correlations and for example, rain gauges. Finally, dissemination schemes catch/post process relevant data to provide tailor-made information to bathers and managers in various media such as the internet (basic) and optionally via emails and apps.

An example of a model forecast providing the background data for today's warning is included in Figure 3. More details about the system are given in Kaas et al. (2011).

Are we at risk?

As mentioned earlier, a lot of effort has been put into the protection of beach visitors and the bathing water directive explicitly states that one of its main purposes is to protect human health. A relevant question is, however, whether we are at risk at all? The answer to this question is yes, we are at risk. Numerous studies have documented health risks associated with swimming in faecally polluted waters. Prüss (1998) reviewed 22 studies and strongly suggested a causal dose-related relationship between gastrointestinal symptoms and recreational water quality measured by bacterial indicator counts. Similar



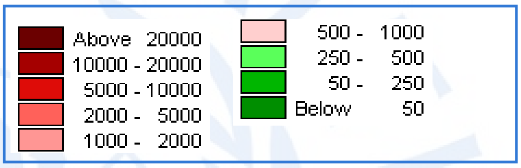


Figure 3: Time series demonstration of the development of E.coli concentrations from discharges of polluted water on the coast north of and in central Copenhagen. The event starts on 15/8-2011 at 1 am. There is an 8-hour time step between the first 3 pictures. The time step to the last picture is 24 hours. The legend gives the colour code for concentrations of E. coli (per 100 ml). Only part of the modelled area is shown.

results were also found by van Asperen et al. (1998) and Lepestreur et al. (2006) found a relationship between water quality measured using faecal streptococci content and an increased risk of respiratory illness, particularly among children aged 11 to 15 years. In addition, bathing may also lead to more serious and potentially fatal diseases especially in certain susceptible populations (Pond, 2005).

In addition to this, parts of Copenhagen were flooded as a result of a heavy thunderstorm during the night of 14 August 2010. A large amount of sewage water was flushed into the harbour and the surrounding beaches. The following morning, Copenhagen hosted a triathlon event, and despite timely warnings from the BWF, the triathlon committee decided to carry on and the athletes were allowed to start, although the swimming area was heavily affected by sewage water. This caused several participants to become ill with diarrhoea and abdominal pain.

Following this event, the Statens Serum Institut (Danish national institute for infectious diseases) carried out a cohort study among the attendees to determine the scope of the outbreak and identify possible infection sources. The study showed that many participants already became ill on the day of the competition, see Figure 4, and some were tested positive for Campylobacter spp., enterotoxigenic E. coli (ETEC), Giardia lamblia and intimin-producing E. coli (A/EEC). Additionally, a case of bloody stools was found. More details can be found on (EPI news 2010).

Conclusions and future work

The new European Bathing Water Directive emphasizes the preservation, protection and improvement of bathing water quality in order to protect human health. The literature clearly states that bathing in faecally polluted waters poses a significant health risk to bathers. This is underlined by the findings from an event in Copenhagen in August 2010 where 1700 athletes were exposed to fae-

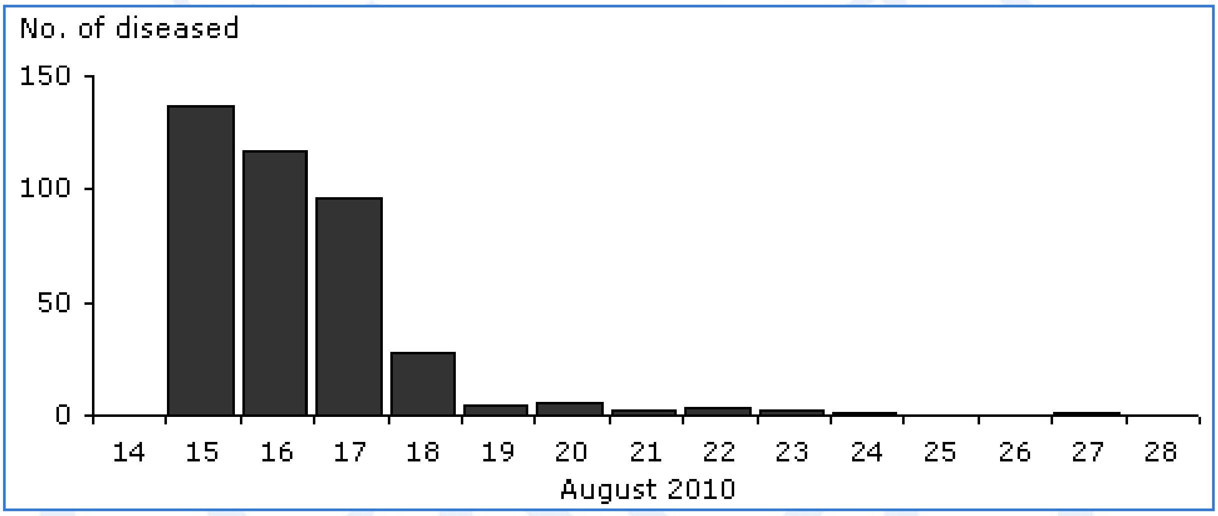
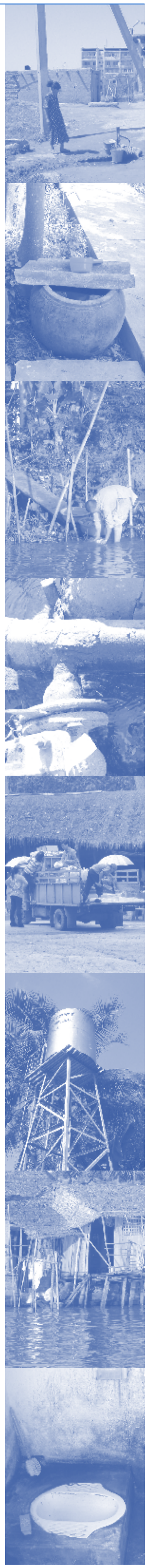


Figure 4: Disease onset for triathlon participants, August 2010 (from EPI-news 2010). *Source: Epi-News 42/43-2010*



cally polluted water.

The operational bathing water forecast systems are currently used on a daily basis as decision support for bathing water managers to secure and minimize the risk of bathers becoming ill by avoiding contact with polluted waters and at the same time maximizing the recreational use of the bathing water whenever possible – the most frequent situation.

We are presently developing a system that couples the dynamic model approach from the bathing water system with Qualitative Microbial Risk Assessment (QMRA), in order to predict the risk of becoming ill through contact with faecally contaminated water. We foresee that this tool will be able to be used worldwide to estimate the burden of disease at a local scale and to estimate the effects of interventions on public health.

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Quality control of water and air in swimming pools

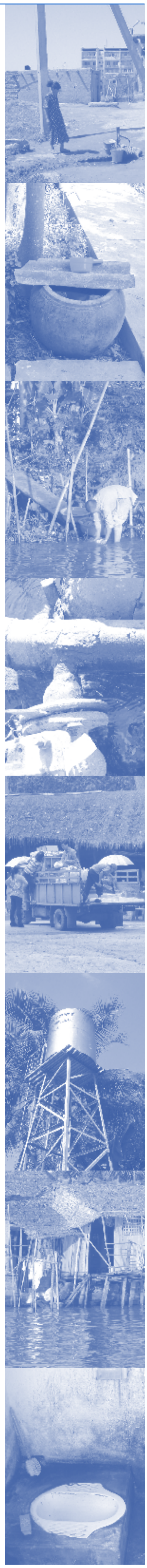
Abstract

The water and air treatment circuits in public swimming pools are controlled by the technical staff, automatic systems and by official or accredited laboratories. The controls are based on appropriate legislation and make use of the specialized experience and accumulated knowledge of several entities.

This paper presents a summary of the principles considered fundamental for the previously referred to contributions for the adequate control of swimming pools. The implementation of automatic control systems replacing manual monitoring is an interesting option, with economic benefits for operational costs.

The analytical control programme proposed in this work, or any other that may serve the same purpose, should be followed by all public swimming pools. This is essential to provide a high quality public service and also to ensure healthy competition among the providers of such services.

Key words – swimming pool, automatic control, water quality, air quality



Introduction

In every public swimming pool it is necessary to guarantee public health through the correct operation of water and air treatment systems. The adequate control of operational variables such as pH, disinfecting agent concentration in pool water, temperature, air humidity and the concentrations of the by-products of disinfection in water and air must also ensure the optimal operation of equipment, the required quality in water and air and minimization of operational costs.

Standard controls in swimming pools may include:

- Manual (immediate) controls performed by operators
- Automatic (inline) controls
- Analytical controls performed by external entities

Each type of control is important and none is dispensable. External entities verify if the swimming pool is being correctly controlled and if the legal requirements as well as the rules established by the Health Authority are being observed. Automatic controls ensure that the operational variables are within established ranges, ensuring optimal operational costs. Finally, the operator verifies whether automatic controls are operating correctly and if necessary may adjust their parameters. It is also the operator's responsibility to ensure the good operational condition of all the equipment.

A good control system implies:

- Good quality instrumentation and equipment;
- Adequate maintenance and calibration;
- Qualified staff.

The immediate control

The water and air treatment systems of a swimming pool require the supervision of one or more operators. However, with the technological means now available, supervision is not needed on a full-time basis in each swimming pool and one operator may easily supervize more than one swimming pool and rotate between the different installations.

In a public swimming pool the operator is responsible for maintaining a safe and pleasant environment for all users. The control of all equipment monitoring operating conditions is of the utmost importance and the operator is also responsible for the quality of the water and air, regardless of automatic controls that may also be available.

The operator's tasks start half an hour before the opening of the swimming pool and he must measure and register the values of the following parameters:

a) water: temperature, pH, free chlorine, total chlorine and turbidity
b) air: dry and wet bulb temperatures, that lead to the humidity value

Figure 1: Swimmingpool, "Piscina de cartes" Porto, Portugal, Photo: Porto Lazer, EEM

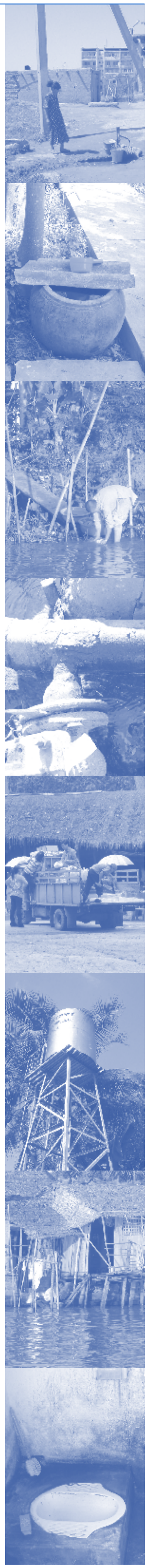
The control of these parameters must continue during the working period and must be repeated at least every four hours. All values must be registered and posted in a position visible to bathers.

The prompt measuring of water quality parameters may be performed with kits supplied by specialized companies. These give reliable and immediate results as long as their instructions are followed. In Table 1 a set of water quality parameters is presented, as well as their recommended limits.

Parameter	Units	Limit	Obs.
Free chlorine	mg/L Cl_2	0.50 to 1.2	6.9 ≤ pH ≤ 7.4
		1.0 to 2.0	7.5 ≤ pH ≤ 8.0
Total chlorine	mg/L Cl_2	Must not exceed in more than 0,50 mg /L Cl_2 of the free chlorine value	-
Bromine (b)	mg/L Br_2	2.0 to 4.0	-
Isocyanuric acid (b)	mg/L $H_3C_3N_3O_3$	≤75	-
Ozone (b)	mg/L O_3	≤0.01	
Turbidity	NTU	≤4	(a)
Temperature	ºC	≤30	-

(a) The operator may use one of the following alternative methods: 1 – To see clearly the marking lines on the bottom of the pool; 2 – To see clearly a black disk (Secchi disk) with 155 mm diameter placed in the deepest part of the pool with a minimum horizontal distance of 10 m.
(b) Test only in cases where a product that contains it is in use.

Table 1: Water quality parameters and corresponding limits for the prompt control of water treatment systems according to the requirements of the Portuguese Health Authority (DGS – 2009)



Automatic control

Nowadays the automatic control of water and air treatment systems in swimming pools is very simple. The inline measurement of operational variables, and the registration and use of control units involves a small investment when compared with the total cost of building a swimming pool complex.

For air treatment there are four compulsory rules:

1) to renew a certain amount of the swimming pool air;
2) to limit the air velocity in the swimming pool space;
3) to guarantee an established temperature value;
4) to keep the humidity values between 55 % and 75 %.

The first two rules involve the measurement of flow rates and the establishment of a correct opening position for the related valves. The last two may be satisfied by two control systems: temperature and humidity. The flow chart in Figure 2 shows schematically an air treatment system, including the measurement points.

The humidity of the swimming pool atmosphere must be measured by means of two psycrometers placed on two walls that are distant from each other and far from the air entries and exits. The psycrometers should be placed at 1.5 m above floor level so that the operator may read the values easily. Temperature and humidity sensors must be installed inside the air piping, with signal outputs between 4 and 20 mA, compatible with the corresponding recording and control systems. The humidity value of the incoming piped air determines the operation of the heat pump. The temperature signal is used by the air heating system to make the required adjustments.

The pool water treatment may also be undertaken with only a minimum contribution by the operator. The circulating water pumps operate continuously and do not require close supervision. The management of water pumps, water heating and filter washing may be done automatically. The automatic control of pH and disinfectant concentrations is also easily applied to these installations. Figure 3 shows the flowchart of the swimming pool water treatment system and indicates the measuring points for important parameters, as well as the most important measurements to be made.

Chlorine inline measurement is normally done by amperometric sensors that quantify the electric current induced by the reduction reaction of hypochlorous acid. Knowing the pH value, the free chlorine may be determined using the equilibrium constant of the acid hydrolysis. The current produced is proportional to the hypochlorous acid concentration and the signal is sent to the controller and to the registering system. The controller uses this signal to operate a dosing pump for which the flow rate is variable and depends on the difference between the established and the measured value of free chlorine.

The inline pH meter is similar to those used in a laboratory. The value may be displayed or registered and if required it may be forwarded to a pH controller. In a swimming pool the pH variation often has only a tendency to increase or decrease Therefore, only one dosing pump will be necessary with a constant flow rate. Let us consider that in a certain swimming pool, the tendency is that pH rises. If the pH set point range is settled between 7.2 and 7.6, the acidic solution pump will start working if the pH exceeds 7.6 and will stop when the value gets to 7.2.

The water temperature in the swimming pool is the variable that causes the highest number of complaints from bathers. This means that the control and management of this variable is of the utmost importance. The temperature control systems must be reliable and have fast responses to the usual unwanted variations. The management of the swimming pool is directly concerned with this problematic. The makeup water that replaces rejected water causes lowering of the swimming pool water temperature. If the

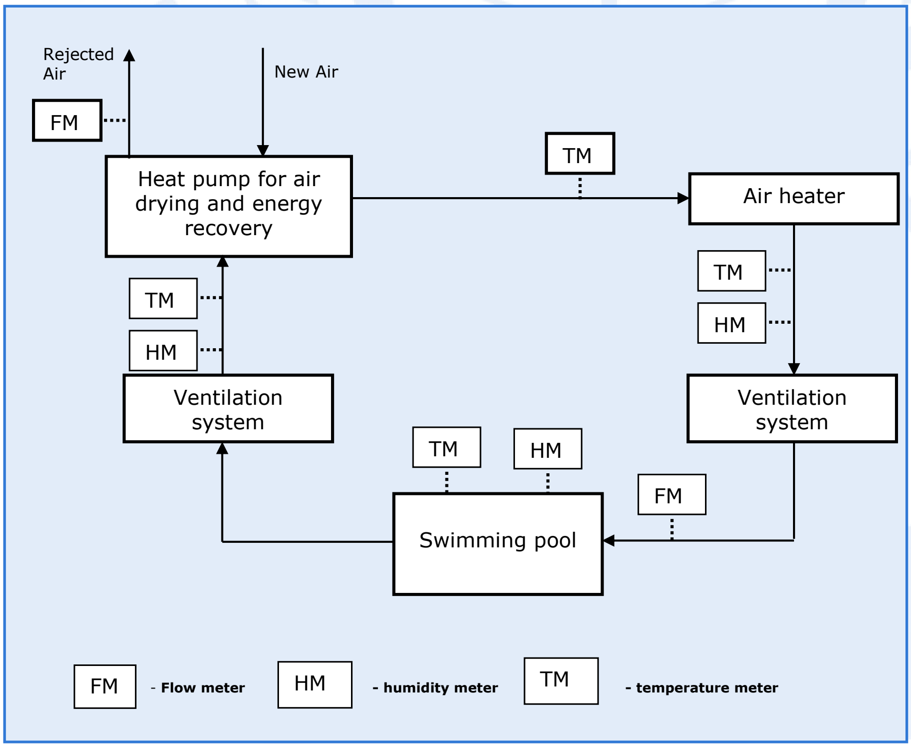
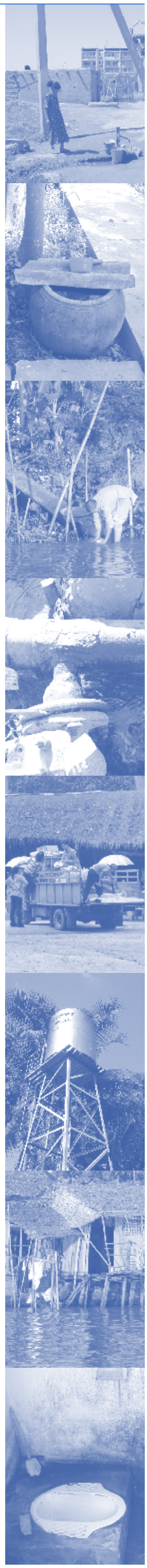


Figure 2: Flow chart of the air treatment system in a swimming pool



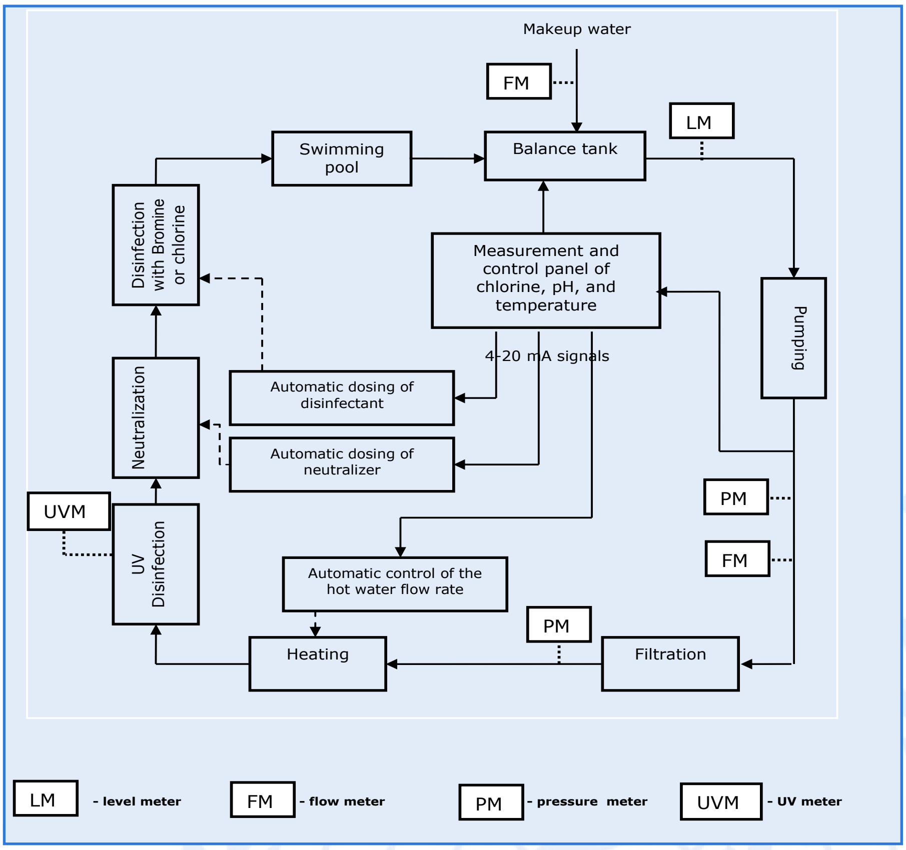
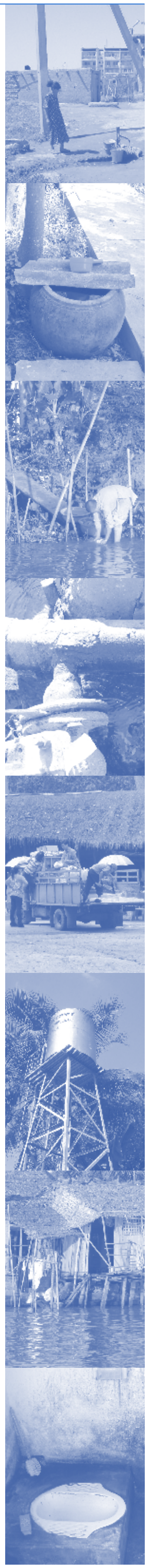


Figure 3: Flow chart of the water treatment system in a swimming pool



water heating system is not able to cope with sensible changes in water temperature, the schedule for filter washing should be programmed for a period while the swimming pool is not being used.

The variables already referred to are the most important for the automatic operation of the installation. However it is advisable to register other variables such as makeup and circulating water flow rates, pressures and ultra-violet radiation intensity (when applicable).

Control by external entities

Public swimming pools must have an external control programme performed by health authorities and by independent and reliable entities. In Portugal, health authorities periodically examine fractions of all public swimming pools. It is highly advisable that this type of control is done in all swimming pools to ensure healthy competition among them.

Portuguese law indicates that physical, chemical and bacteriological analyses must be undertaken twice a month, with no less than 10 days between analysis, by official or accredited laboratories. The reports produced must include a comment and the classification of the swimming pool water.

Parameter	Recommended value	Limit value	Periodicity
Heterotrophic plate count at 37 ºC (CFU/mL)	100 (a)	-	Each 15 days
Coliform bacteria (CFU/100 mL)	0	10	
Escherichia coli (CFU/100 mL)	-	0	
Enterococcus (CFU/100 mL)	-	0	
Pseudomonas aeruginosa (CFU/100 mL)	-	0	
Coagulase-positive *Staphylococcus* (CFU/100 mL)		0 (b)	
Staphylococcus spec. (CFU/100 mL)	≤ 20 (a)	-	
Legionella (CFU/L) (only in hydrotherapy tanks) (c)	-	*L. spp*: 10^3 *L. pneumophila*: 0	quarterly

(a) the recommended value may be exceeded once each season or calendar year
(b) 0 / 100 mL in 90% of samples. This analysis is the Public Health Unit responsibility (at the end of the season or the calendar year)
(c) if the results are systematically negative for Legionella for 6 months and if a control programme for Legionella is undertaken effectively, the Health Delegate may suspend the analysis

Table 2: Microbiological control parameters and corresponding periodicity according to the Portuguese Health Authority (DGS – 2009)

Parameters	Guideline values	Periodicity
Combined chlorine (mg/L Cl_2)	≤ 0.50	
Free chlorine (mg/L Cl_2)	0.50 – 1.2 (6.9≤pH≤7.4) 1.0 – 2.0 (7.5≤pH≤8.0)	
Cyanuric acid (mg/L $C_3H_3N_3O_3$) [(a)]	≤75	
Total bromine (mg/L Br_2) [(b)]	2.0 – 4.0	
Copper (mg/L Cu) [(c)]	2	
Turbidity (NTU)	0.5 – 4.0	Monthly
pH (Sörensen scale, 25°C)	6.9 – 8.0	
Conductivity (µS/cm 20°C)	1500	
Chlorides (mg/L Cl)	500	
Oxidability or TOC (mg/L O_2 or mg/L C)	6	
Temperature (indoor pools) (°C)	≤ 30	
Total Trihalomethanes (indoor swimming pools) (µg/L)	100	

(a) Analyse only if the water disinfecting agent is a chlorine stabilized product
(b) Analyse only if the water disinfecting agent is bromine
(c) Analyse only if copper is used in the water disinfection

Table 3: Physical and chemical control parameters for water and their corresponding periodicity according to the Portuguese Health Authority (DGS – 2009)

The same question often arises: which parameters must be controlled?

The answer is obvious:

a) parameters that are influenced by the treatment processes, such as the disinfecting agent residual, pH and temperature;
b) parameters that may reveal the contamination of the water by nitrogen and other organic compounds;
c) parameters that may affect public health.

The simplest solution, but not necessarily the best one, is to follow strictly the official requirements now in use that are presented in Tables 2 and 3. In our opinion the makeup water should also be analysed simultaneously.

The analysis reports previously referred to must be posted in a location where they are visible to all users.

Air quality control

The air quality control in swimming pools has not received appropriate attention in the past. Temperature and humidity have been the only two parameters controlled and even these have not always been well-controlled. The well-being and health of the public also depend on other variables, such as chlorine and the concentration of disinfection by-products.

For indoor swimming pools, French Health Authorities suggest the limit for trichloramine in the air as being 0,5 g/m^3.

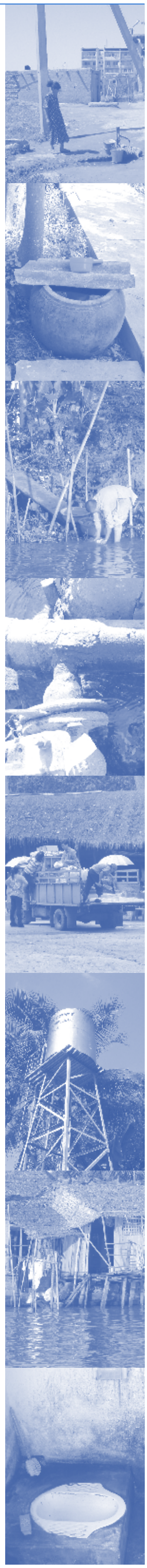
Portuguese law (Decreto-Lei nº 290/2001, partial altered by the Decreto-Lei nº 305/2007) limits the chloroform concentration for professional exposure to 10 mg/m^3 (weighted average over 8-hours). This value is hardly ever attained in the atmosphere in indoor swimming pools. OSHA (Occupational Safety and Health Administration – USA) stipulates the exposure limit for chlorine as 3 mg/m^3 and NIOSH (National Institute for Occupational Safety and Health – USA) established 1,5 mg/m^3 as the exposure limit for an 8-hour period. For ozone, OSHA fixed 0,2 mg/m^3 as the limit for the weighted-average concentration for an 8-hour exposure.

In the Portuguese law (Decreto Lei nº 79/2006) on indoor air quality requirements for service buildings, the air of indoor swimming pools, which are also included in that group, must be within the maximum reference concentrations presented in Table 4 for physical and chemical parameters. Air volume refers to temperature and pressure values of 293.15 K and 101.3 kPa respectively.

According to the same law, swimming pools must be audited every two years to verify the air quality parameters and also evaluate the hygiene conditions of the air treatment systems, including piping and filters.

Following on from Table 4, Table 5 presents proposed limits to extend air quality controls in indoor swimming pools. The proposed periodicity for those analyses is once every three months, simultaneously with a water control campaign performed by an external laboratory.

Figure 4: Analysis of a swimming pool
Photo: isep



Parameter	Unit	Maximum reference concentration
Suspended particles (PM_{10})	mg/m^3	0,15
Carbon dioxide	mg/m^3	1800
Carbon monoxide	mg/m^3	12,5
Ozone	mg/m^3	0,2
Formaldehyde	mg/m^3	0,1
Total volatile organic compounds	mg/m^3	0,6

Table 4: Physical and chemical indoor air quality requirements according to Portuguese law (Decreto-Lei nº 79/2006)

Parameter	Unit	Maximum reference concentration
Chlorine	mg/m^3	1,5
Chloroform	mg/m^3	2
Carbon dioxide	mg/m^3	1800
Ozone	mg/m^3	0,2
Trichloramine	mg/m^3	0,5
Relative humidity	%	55 to 75
Dry bulb temperature	ºC	1 ºC above the water temperature of the pool with lower temperature and with a maximum of 30ºC
Wet bulb temperature	ºC	>23

Table 5: Physical and chemical air quality requirements proposal for indoor swimming pools

Conclusions

Public swimming pools must have control procedures for water and air quality. The greater availability of technical means enables managers to make important savings in operational costs and contributes to the health protection and well-being of users.

The automatic systems simplify the control of the more important variables in the air and water treatment systems. However, they do not replace either the immediate controls to be performed by a qualified operator or the external controls undertaken by official or accredited laboratories. The customers must have easy access to the values obtained by the operator and the reports of external laboratories.

In the public interest, competent authorities must publish legal regulations for swimming pools or extend them to the existing regulation for aquatic parks. This will be an important contribution to health protection and will encourage healthy competition among the owners of public swimming pools.

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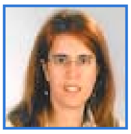

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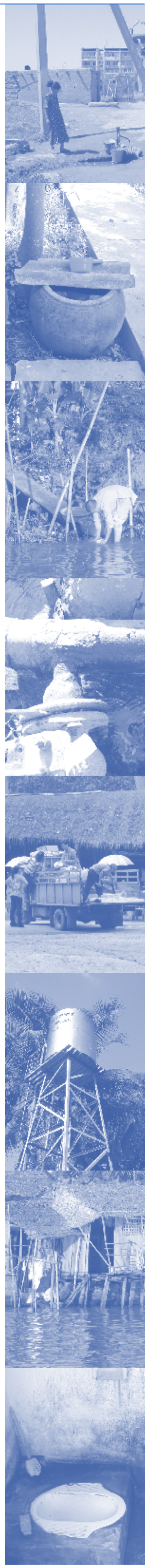


2nd Meeting of the ECDC Expert Group on Climate Change

In November the European Centre for Disease Prevention and Control (ECDC) was invited to attend the 2nd Meeting of the ECDC Expert Group on Climate Change taking place in Stockholm. 40 experts from 30 European countries and national and international organizations participated and discussed the on-going and expected impacts of climate change on diseases and mitigation and adaptation strategies. Additionally, two workshops introduced a knowledge base and a quantitative risk assessment tool.

ECDC Knowledge Base for Food and Waterborne Diseases

An ECDC knowledge base has been developed by the Institute for Hygiene and Public Health, Bonn, as a result of the ECDC tender entitled "Impact of Climate Change on Food and Waterborne (FWB) Diseases in Europe". The first part of this tender included a comprehensive review of the current state of knowledge of 6 pathogens of interest (Campylobacter, Cryptosporidium, Listeria, Salmonella, Norovirus, Vibrio non cholera) especially within the context of weather and climate change. This included a review of a huge number of papers, which could not be handled by a single reviewer within a reasonable timeframe, necessitating the establishment of a team of reviewers. This team of experts was able to inspect more than 700 scientific articles, but still has to coordinate their findings.

The knowledge base has been developed to support the reviewers and to facilitate the coordination of key findings. It does not substitute for a bibliographic management system like endnote, zotero or citavi etc, but it extends these systems 1) using a well-defined and structured thematic ontology, 2) adding a spatial ontology and 3) including options for qualitative assessment. These attributes are linked to key sentences, which are very short summaries or citations providing the key findings from an article towards the overall focus of interest. Each article may result in as many key sentences as necessary to catch all the core information relevant for a project-specific reading.

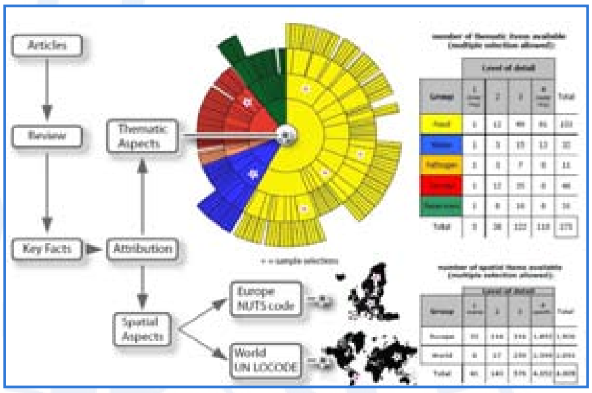


Figure 1: The structure of the interface-supported evaluation process of publications

The thematic ontology is used to add thematic attributes to a key sentence. A key sentence may be attributed to as many items from the ontology as necessary in order to describe the content of an attribute. The ontology is defined in a hierarchical way and can be used precisely towards the depth of detail which is provided by the key finding.

The predefined ontology is project-specific and does not include all possible items, but is a mirror of the overall purpose of reading, i.e. the project's intention. It can be enhanced if needed, but obviously it is necessary that all reviewers share the same understanding. Thus a publication is reduced rapidly into the core findings with respect to the project's focus. The interface of the database is available online; therefore each entry is available immediately to the complete team of reviewers. The key sentences do not prevent users from reading an article, but they do provide rapid access to the content.

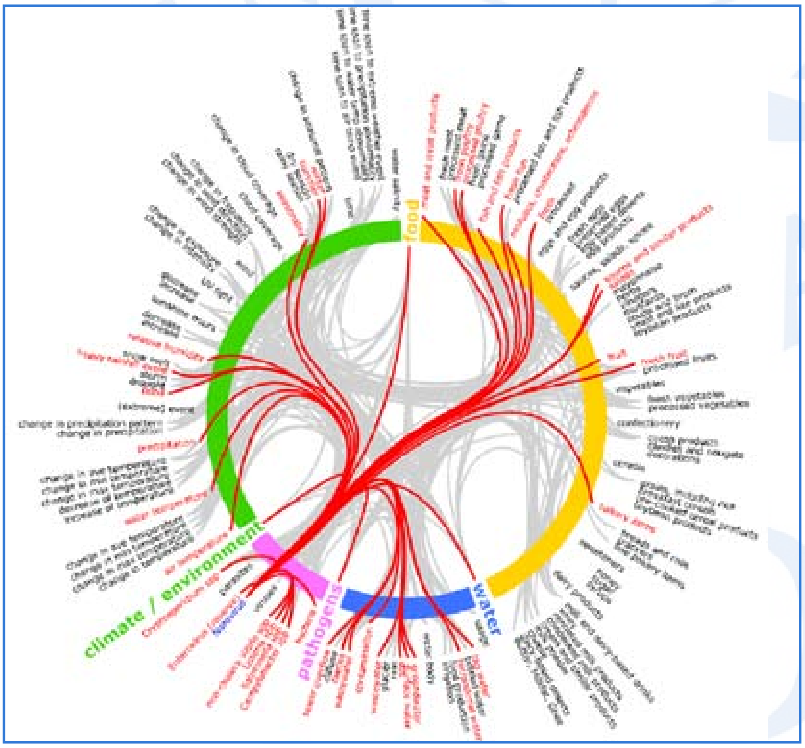


Figure 2: Sample of a meta-analysis of the knowledge base for Norovirus. For a more detailed view see the published papers cited in the text

General data retrieval opens a new perspective, especially if the ontology is applied in a combined mode. For example, it is easy to display all key findings which combine "Salmonella and Spain" or "Cryptosporium and a heavy rainfall event" or "Listeria and dairy products" or any other possible combination. The final creation of project fact sheets for each pathogen has profited from this knowledge base, which currently holds the findings of more than 700 scientific papers. Additionally, a more general approach is possible by analysing the meta information in this database, e.g. examination of a density of knowledge for different aspects of the ontology, which has been captured by the key sentences known so far.

The presentation of this concept to the audience was followed by a "hands on session", where the participants used the online database simultaneously. The positive reaction from the audience encouraged the ECDC to investigate development efforts to make this knowledge base accessible to a broader audience.

Publications

J. Semenza, J. Suk, T. Kistemann, A. Rechenburg, C. Höser, C. Schreiber, T. Frechen, S. Herbst (2011). Assessing the potential impacts of climate change on food and waterborne diseases in Europe - Development of the Climate Change Knowledge base. ECDC Technical Document (preliminary), Stockholm. Contact: Jan.Semenza@ecdc.europa.eu.

An extended description is available from the following papers:

J. Semenza, C. Höser, S. Herbst, A. Rechenburg, J. Suk, T. Frechen, T. Kistemann (2012). Knowledge Mapping for Climate Change and Food and Waterborne Diseases. Critical Reviews in Environmental Science and Technology, Volume 42, Issue 4, pages 378-411

J. Semenza, S. Herbst, A. Rechenburg, J. Suk, C. Höser, C. Schreiber , T. Kistemann. Climate change impact assessment of food and waterborne diseases. Critical Reviews in Environmental Science and Technology, Available online: 26 Jul 2011, DOI: 10.1080/10643389.2010.534706

Quantitative Microbial Risk Assessment (QMRA) Tool for Food and Waterborne Diseases

The Quantitave Risk Assessment Tool (full name: CC-MQMRA: Climate Change Modules for Quantitative Microbial Risk Assessment) has been developed during the same project as the knowledge base, but the detailed concept and programming has been provided by the subcontractor The National Institute for Public Health and the Environment (RIVM) (Jack Schijven, Martijn Bouwknegt, Ana Maria de Roda Husman). The tool was presented to the audience by Bertrand Sudre, ECDC, followed by a "hands on session".

The risk assessment tool intends to translate the details and dimensions of known processes for local experts. For a number of selected pathogens (currently: Norovirus, Campylobacter, Cryptosporidium, Vibrio and Salmonella) the examination of a number of infection pathways (drinking water, bathing water, shellfish, eggs, chicken fillet) is possible under defined climatic conditions. Each of the 13 combinations currently available is modelled by a specific selection and arrangement of modules. The modules represent steps during pathways of infection and a set of the modules is specific for a pathogen and pathway.

Each of the modules includes by definition a specific sensitivity for weather and climate. The possible weather impacts are part of the well-documented module description.

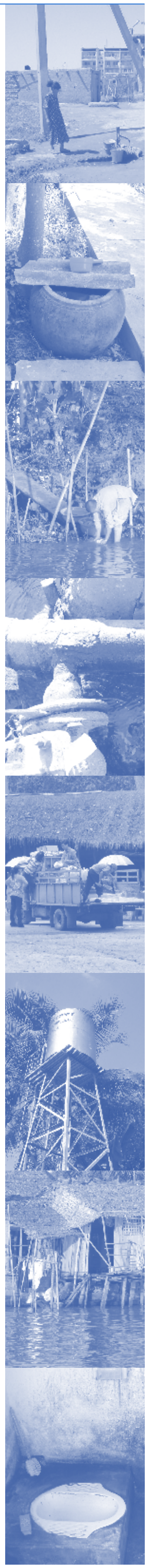
As far as this point, the process is fixed for each combination. The variable part of the modelling starts now, when the user is asked to describe a current, possibly very local, climatic setting, as well as the expected changes. Basic input includes temperature changes up to +-5°C and heavy rainfall events (up to 10 times more frequent) due to climate change conditions compared to the current situation.

After the selection of the pathogen and the infection pathway (called the "matrix"), each of the automatically provided modules of interest can be modified. In addition to the default values the manipulation adds options for more specific details like the number of sewer overflows and much more. In this way, very specific knowledge about local situations may be included and the output may generate a very specific local assessment.

Finally, the results of the QMRA are calculated with respect to the defined conditions using a Monte Carlo simulation. The settings are summarized and a final screen displays the model output, which explains the ratio of risk between future and current conditions.

The total number of optional parameters is simply overwhelming, but the very structured approach of the assessment tool clearly opens a pathway through this jungle. The conclusions and interpretation of the tool's results still need analysis. Different calculations on the same topic may change e.g. the conditions of local water treatment facilities, thus creating different output for "what if" questions. These results may be used to substantiate decisions about the most effective way to prepare for climate change scenarios from the point of view of microbial risk assessment in food and drinking water.

From our experience, the QMRA Tool is an expert system and its modelling approach is very detailed and includes a huge amount of knowledge about the impact of climate change on food and waterborne diseases. The tool is capable of adapting the general knowledge for very local situations, thus creating an interface that allows for the application of a risk assessment for local decision makers. It is necessary for the operator to take some time to understand the complete functionality, but the return on this investment is a decision support tool.



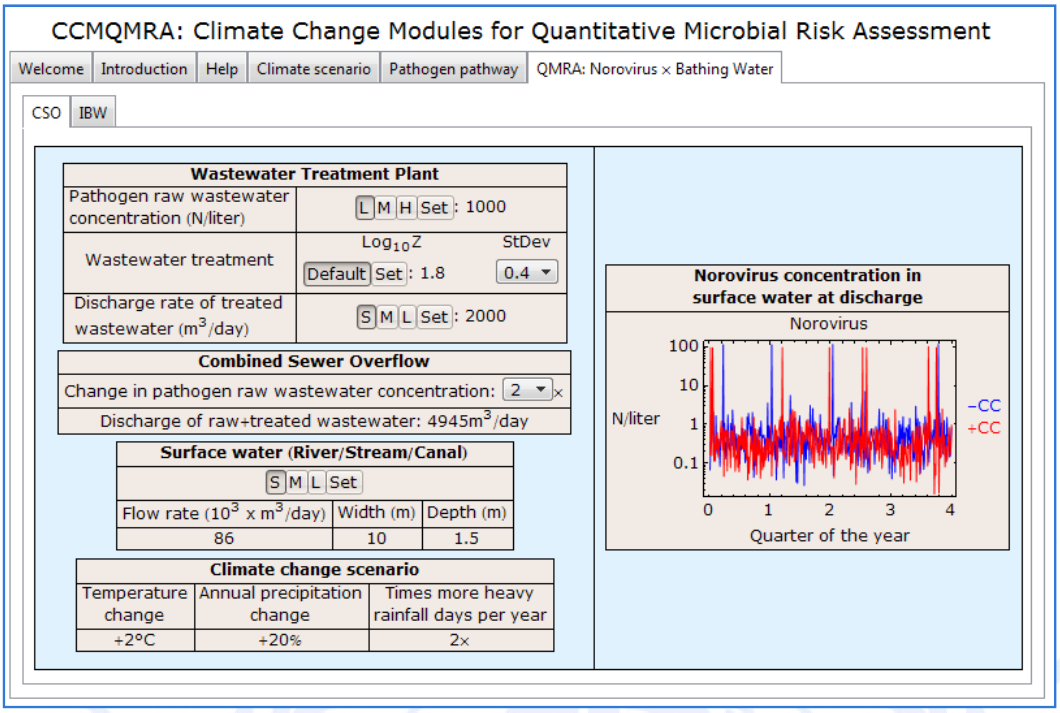


Figure 3: QMRA Screenshot: Combined sewer overflow and Norovirus

Technically the tool has been developed as an application that may be displayed using the Wolfram platform. To use the tool it is necessary to install the "Wolfram CDF player", freely available for Windows, Linux or Mac (http://www.wolfram.com/products/player/).

The tool itself is a Mathematica document (.nbp), which is currently available from ECDC. Contact: Jan.Semenza@ecdc.europa.eu.

J. Semenza, B. Sudre, J. Suk: Climate change and food and water-borne diseases: A tool for quantitative microbial risk assessment, ECDC Technical Document (preliminary), Stockholm, 2011.

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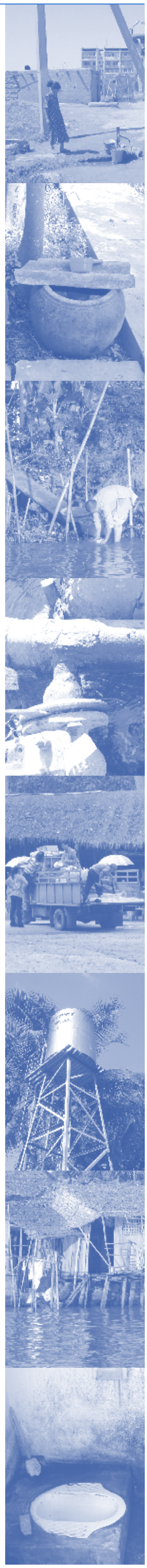

Water and Health – Where Science meets Policy"

From 3-7 October 2011, the second annual conference "Water and Health – Where Science meets Policy" took place at the University of North Carolina at Chapel Hills in the United States. More than 450 participants had the opportunity to discuss water-related research, education and outreach. A wide range of organizations were present, including the Bill & Melinda Gates Foundation, CARE, the U.S. Centers for Disease Control and Prevention, the 300in6 Initiative, the Norwegian University of Life Sciences, Save the Children, The World Bank and others.

The program covered:

- Small community water, sanitation and hygiene
- Peri-urban water, sanitation and hygiene
- Hygiene behaviors and household water treatment
- Human rights and ethics
- Freshwater availability & climate change adaptation
- Southeastern U.S. water challenges

In total there were160 presentations and 25 workshops and networking events.

During the conference week there were four keynote speeches:

- Towards the post 2015 development agenda: The importance of fully integrating human rights
  Catarina de Albuquerque (UN Special Rapporteur on the human right to safe drinking water and sanitation)
- Should The Toilet Be Reinvented?
  Frank Rijsberman (Director, Global Development Program of the Bill & Melinda Gates Foundation)
- Threats to Fresh Water: Global Lessons from Our Northeastern Corridor
  Charles J. Vörösmarty (Director, CUNY Environmental Crossroads Initiative, Professor and NOAA-CREST Distinguished Scientist)
- Reaching Scale
  Jaehyang So (Program Manager, Water and Sanitation Program, The World Bank)

Figure 1: Catarina de Albuquerque
Photo: Tom Fuldner

The workshops covered a broad range of themes, such as writing academic papers, current developments in detection methods, household water and treatment and life-cycle cost approaches. Especially for students the workshops were the ideal place to make contacts and exchange ideas and knowledge. They also offered many opportunities to learn new aspects of the field of water and health. The Annual Meeting of the International Network on Household Water Treatment and Safe Storage took place on Monday 3rd October and the following topics were discussed:

- the challenges of achieving scale in HWTS coverage
- integration with other household environmental health interventions
- monitoring & evaluation
- successes and failures in the field
- recently released WHO performance evaluation guidelines; and
- network participation in the upcoming 6th World Water Forum.

On Tuesday 4th October, the author joined the workshop entitled "Ensuring Sustainable Access to Safe Water: Best Practices for Water Projects". Water projects in practice were discussed and in addition to success stories

Figure 2: Charles J. Vörösmarty
Photo: Tom Fuldner

the pitfalls and mistakes in implementing projects were also addressed. On Thursday 6th October the workshop on "Decentralized Water, Wastewater Sanitation and Reuse: Linking the Ideal to the Practical" convened by NC State University Soil Science Department and UNC took place at the Lake Wheeler Training Center in Raleigh. At the site, research and training courses are held for students, technicians and the interested public. Demonstration plants show different types of composting facilities for solid waste management, explain local soil varieties and implications for water management and show different waste water treatment options varying from ponds, constructed wetlands and soil filters to septic tanks and small scale treatment facilities. Different irrigation systems are in place, as the reuse of wastewater in agriculture is dominating at present. Participants had the opportunity to view the wide range of the different technologies and discuss current research, outreach gaps and opportunities.

From 4th-6th October oral and poster presentations were given. The different sessions covered health, WatSan technology, social and behavioural issues, household water storage and treatment, policy, sanitation, markets and US issues. The organizer provided extra time for poster presentations during this time, enabling participants to view the broad range of research and creating lively discussions around the posters. Overall the Water and Health 2011 conference was a successful event bringing together academic research with policy and practice.

For those interested in more information, the University of North Carolina provides the conference program, workshop summaries and the keynote presentations online:

http://whconference.unc.edu/2011_archive.cfm

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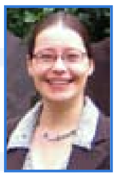


Events on Water, Health and Risk Communication:

January

The Utility Management Conference™ 2012
30 January-2 February
Miami, USA
http://www.wef.org/UtilityManagement/

February

Governance and Management of Drinking Water: Issues and Challenges
14 -15 February
Hyderabad, India
http://www.ipeindia.org

GRF One Health Summit 2012
19-23 February
Davos, Switzerland
http://www.grforum.org/pages_new.php/One-Health/1013/1/938/

16th Congress & Exhibition of the African Water Association
20-23 February
Marrakech, Morocco
http://www.afwa-hq.org

3rd IWA / WEF Wastewater Treatment Modelling Seminar 2012
26-28 February
Québec, Canada
http://www.modeleau.org/WWTmod2012/

March

6th World Water Forum
12-17 March
Marseille, France
http://www.worldwatercouncil.org/index.php?id=6th_forum_kick-off&L=0%25255D

3rd International Symposium on Water and Wastewater Technologies in Ancient Civilizations
22-24 March
Istanbul, Turkey
http://www.iwa-ww2012.org/

IWA Water Security Conference 2012
25-27 March
Sydney, Australia
http://www.watersecurity2012.com/

IWA Regional Conference on Wastewater Purification and Reuse
28-30 March
Heraklion, Greece
URL: http://www.wwpr2012.gr/index.php?lang=en

WasteECo 2012 - Cooperation for Waste Issues: International Exhibition and Conference
28-30 March
Kharkiv, Ukraine
http://waste.ua/cooperation/

April

13th UK National Young Water Professionals Conference
18-20 April
Exeter, UK
http://events.exeter.ac.uk/YWP2012/index.htm

May

IFAT ENTSORGA
7-11 May
Munich, Germany
http://www.ifat.de/en/Home

World Congress on Water, Climate and Energy
13-18-May
Dublin, Ireland
http://iwa-wcedublin.org/

Earth Summit 2012
14-16 May
Rio de Janeiro, Brazil
http://www.earthsummit2012.org

1st Bulgarian Young Water Professionals Conference 2012
17-18-May
Sofia, Bulgaria
http://2012.ywp-bulgaria.com/

International Conference on Water, Environment and Health
20-22 May
Van, Turkey
http://su-waves.com/

3rd Rainwater Harvesting Management International Conference
20-24 May
Gyeongnam, Republic of Korea
http://www.3rwhm.org/eng/index.php

June

9th IWA Leading-Edge Conference on Water and Wastewater Technologies
3-7 June
Brisbane, Australia
http://www.let2012.org/

AquaLife 2012
5-6 June
Kiel, Germany

ECWATECH-2012 - International Water Forum
5-8 June
Moscow, Russian Federation
http://www.ecwatech.com

IWA Ecotechnologies for Wastewater Treatment. Technical, Environmental and Economic Challenges
25-27-June
Santiago de Compostela, Spain
http://www.novedar.com/ecoSTP/

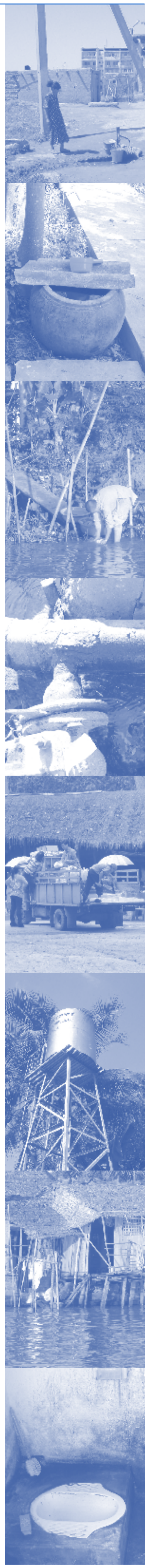
1st International Conference on Integrative Sciences and Sustainable Development of Rivers
26-28 June
Lyon, France
http://www.graie.org/ISRivers/a_index.htm

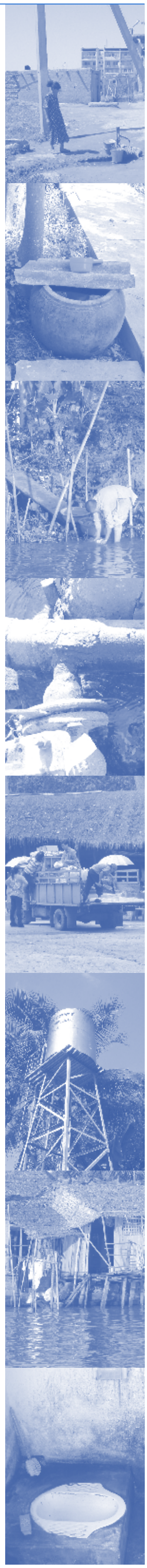
July

SIWW Water Convention
1-5 July
Singapore
http://www.siww.com.sg/water-convention

6th International Young Water Professionals Conference
10-13 July
Budapest, Hungary
http://www.iwa-ywpc.org/

12th International Conference on Modelling, Monitoring and Management of Water Pollution
10-12 July
New Forest, UK
http://www.wessex.ac.uk/12-conferences/water-pollution-2012.html





The WHO CC Bonn thanks all readers and contributors for their commitment in 2011 and sends Season's Greetings and best wishes for 2012 !

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