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WATER & RISK

Editorial

Dear colleagues,
we wish to thank the 'Water & Risk' readership for the positive and encouraging responses that we have received about the new layout of our newsletter. The editorial team has taken these comments into consideration to further improve the attractiveness, convenience, and topicality of this publication.

In the current issue, we invited our colleague Dilorom Fayzieva from the Uzbek Institute of Water Problems in Tashkent to report on water resources and their contamination as well as about human access to water and sanitation and major water-related health problems in her home country. Uzbekistan is a large and populous, but landlocked country in Central Asia and its water problems are inextricably related to the widely reported Aral Sea disaster.

The contamination of surface water bodies and, subsequently, drinking water with perfluorinated surfactants has gained much attention in Germany during the last year. With their investigations and publications, Dirk Skutlarek and Harald Färber from our institute have provoked an emotional national debate about perfluorinated surfactants and the health consequences for the population at risk, mainly in the densely populated Ruhr area. In our newsletter, they present a review of their current findings.

The newsletter is completed by short reports from four conferences, workshops and meetings: Christiane Franke visited the 'Essener Tagung' on Water, Wastewater and Waste in Aachen in March 2007; Yvonne Walz represented our WHOCC at a symposium on the occasion of the designation of the new WHOCC for Housing and Health in Stuttgart in March 2007; a workshop on infectious diseases and environmental change was held at the headquarters of the European Centre for Disease Prevention and Control in Stockholm, where our WHO CC was invited to represent views on the water-related health impact of environmental change. Finally, a brief reference is made to the International Conference 'Towards Sustainable Global Health', which was held in Bonn in May 2007.

Once again, we look forward receiving your comments and encourage you to contribute to one of the future issues of 'Water & Risk'.

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Water and Health in Uzbekistan

Water and human health are inevitably linked through both water quantity and water quality. According to the latest Human Development Report "Beyond scarcity: Power, poverty and the global water crisis", water scarcity is more a problem of allocation than of physical availability. Central Asia's water scarcity is an alarming example of man-made water problems. In much of the region water productivity is substantially lower than in other arid regions. The water used for irrigation in Uzbekistan is 30% higher than in Egypt or Pakistan owing to mismanagement and infrastructural decay. In the irrigated area of the Aral Sea Basin around 60% of the extracted irrigation water is lost due to leakages and evaporation before reaching the fields. This holds true also for Uzbekistan, where on one hand, agriculture accounts for more than a third of the country's GDP and on the other hand, water is withdrawn faster than it is replenished, resulting in water quantity problems.

Uzbekistan is a landlocked country in Central Asia. The country extends over 447,400 km² and includes the southern portion of the Aral Sea. Two thirds of the country consists of desert and about 11% of arable land; the latter mostly situated in river valleys along the course of the three main rivers. A predominantly (semi-) arid climate with long, dry, hot summers and cold to moderate winters is one of the restricting factors in agricultural production. Uzbekistan is rich in natural resources and exports gas, petroleum, heavy and precious metals.

Figure 1: Overview of water resources in Uzbekistan
Source: ESRI 2004; Cartography: Y. Walz

Figure 2: Shells on the former seabed of the Aral Sea (Aralkum) Source: S. Herbst, 2003

Figure 3: Dunes in the Aralkum Source: S. Herbst, 2003

1. Water resources in Uzbekistan

In Uzbekistan, available water resources are relatively limited. The total available and renewable water resources, including flows from other countries, amount to 50 km³ (1,968 m³/capita). Only one fifth of this water is internally produced surface water. The internal groundwater recharge amounts to only 9 km³/year. The two main surface water sources are the rivers Amu Darya and Syr Darya. The Amu Darya has the larger drainage basin, covering 227,000 km², with a total discharge of 78 km³ per year. The Syr Darya catchment stretches over 150,000 km², collecting a water volume of 36 km³ per year. The water originates predominately from melting snowfields and glaciers in the mountains of Kyrgyzstan and Tajikistan (see Figure 1).

If the water was not extracted for vast irrigation projects in the steppe, the rivers would still feed the Aral Sea. However, due to overexploitation since the 1950s, the receiving lake has almost dried up and a significant area formerly underwater now forms the 'Aralkum' desert (see Figures 2 and 3). The Amu Darya and Syr Darya are transboundary water courses, which enhances the potential for conflict over upstream management, increases water use for irrigation and hinders the achievement of quality standards for drinking and domestic purposes in downstream regions. The cultivated land is estimated at 5.2 million ha with 87% annual and 13% perennial crops. In 2003, the actual annual water use reached 56.5 km³, far more than the total available and renewable water resources of the country (irrigation 52.44 km³; industry 2.16 km³; utilities 2.16 km³) (UNDP 2007).

2. Human access to water and sanitation

Water resources are distributed unevenly throughout Uzbekistan, resulting in difficulties relating to the drinking water supply for the population in some regions (Figure 4). According to statements by the Ministry of Health of the Republic of Uzbekistan, more than one third of the country's population consumes water that does not meet the national standards and about 5 million people do not have access to safe drinking water. However, access to tap water in rural areas has increased from 51% in 1985 to 64% in 1998 (NEHAP, 1999). According to the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (2006), access to drinking water within the home has decreased 1990-2004, from 88% to 83% in urban areas and from 40% to 25% in rural regions. In 1999, about 40% of urban and 60% of rural population in Karakalpakstan used water from decentralised water sources for drinking and domestic needs (Ministry of Health of the Republic of Uzbekistan, 2003). Regarding the drinking water treatment facilities and the centralised distribution systems, it is noteworthy that existing treatment facilities do not adequately remove contaminants, resulting in some chemicals being present in almost the same concentrations both in raw and drinking water (see Figure 5).

Sewerage treatment is only available in selected towns and increased only by 0.3% per year over the three years from 1996-1998. In 1999, the overall sewerage treatment coverage was 51% (NEHAP, 1999). For the autonomous Republic of Karakalpakstan and Khorezm it was 31% and 38%, respectively. More than half of the towns and most rural settlements do not have sewerage systems at all. Here, the data from the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (2006) again differ. The access to improved sanitation increased 1990-2004, from 69% to 78% in urban regions and from 39% to 61% in rural regions. Data for connections to sewerage systems are missing.

The areas of greatest concern regarding access

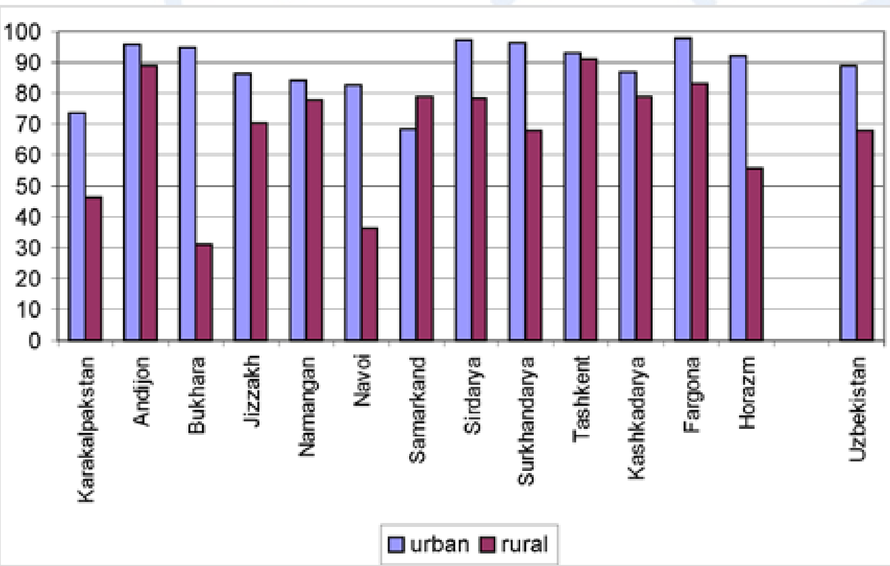


Figure 4: Provision of centralised water supply in different provinces of Uzbekistan, Source: Ministry of Health, 2003.

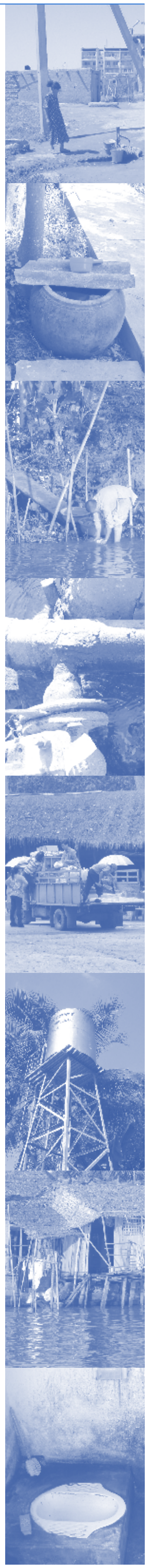


Figure 5: Sewerage treatment plant, Urgench, Khorezm, UZ Source: S. Herbst, 2003.

to safe drinking water are the autonomous Republic of Karakalpakstan, Khorezm, Bukhara, Navoi, Kashkadarya and Surkhandarya provinces (see Figure 1). Here, the freshwater resources are scarce and provision of safe drinking water is difficult. This problem is most pressing in the rural areas, where over 60% of the population do not have access to a centralized water supply system and only 2% have a centralized sewerage system.

3. Contamination of water resources in Uzbekistan

As little as 30 to 40 years ago, surface and ground water supplies were not contaminated with toxic substances and there was ample potable water for human consumption in Uzbekistan. However, there has been a rapid degradation of water supplies in terms of quality and quantity. The autonomous Republic of Karakalpakstan, and the provinces of Fergana and Navoi are the areas experiencing the most significant pressure on the environment, especially on water resources. Nowadays, there are problems with chemical and microbiological contamination, such as resistant organic pollutants and carcinogens, viruses, parasites and bacteria at the regional as well as at the transboundary level. The biggest water polluter is agriculture (see Figure 6). Large quantities of water are converted into waste water by leaching after the application of fertilisers and pesticides. The result is the depletion and deterioration of both surface and ground water in Uzbekistan. About 141 million m^3 of total sewerage of 1063 million m^3 is dumped untreated into surface waters (UNDP 2007).

Figure 6: Cotton plant Source: S. Herbst, 2003.

Open water reservoirs and shallow groundwater in rural areas are contaminated by collector-drainage water from leached fields and sewerage from farms. This leads to soil water quality deterioration due to increasing salinity and contamination with metals, nitrates, phosphates, oil products and biodegradable compounds (State Committee of Nature Protection, 2006). The contamination of 10-50 m deep wells by agro-chemicals is also common in rural areas. Scarce data obtained from the Information Bulletin of Uzbekgidrogeologia confirm that groundwater is highly polluted by agricultural activity and industrial sources. Only 65% of the approved groundwater reservoirs meet drinking water standards (NEHAP, 1999). The basins with the worst groundwater pollution are the valleys of Zaravshan and Fergana. In the Amu Darya river basin, groundwater pollution is also the result of intensive use of chemicals in agriculture and affects surface soil conditions and groundwater with salts, increased hardness, nitrates and pesticides over a wide area within the territory of the autonomous Republic of Karakalpakstan (see Figure 7).

In Fergana (Margilan, Kokand) groundwater pollution originates more from industrial sources. The industrial areas of most concern are Kokand-Kakir and Fergana-Margilan, where the level of oil products, phenols, nitrogen compounds and total dissolved solids exceeded the maximum permissible concentration (MPC) in the groundwater by a factor of 10-14. In urban water distribution systems, organic compounds, heavy metals and other chemical pollutants and biological agents such as parasites were found to exacerbate the water-quality problems. In the Navoi region, the groundwater is polluted by industrial gold processing plants, which release molybdenum, cyanides, ammonia and nitrates beyond the MPC. In Tashkent region (Pskent area), drinking water collectors were damaged as a result of underground water pollution with phosphogyps and filtering discharges of joint reservoirs from copper and lead processing plants. At a distance of 5 km from the reservoir dam, the concentration of selenium, cadmium and phosphate in the underground waters exceeded the MPC 2-8 times (NEHAP, 1999). However, in some water-carrying horizons in the valleys of the Chirchik, Akhangaran and Zarafshan rivers, improving trends in groundwater quality have been observed.

Numerous reaches of rivers in Uzbekistan are seriously polluted, including the Chirchik and Akhangaran rivers with their related watersheds in the Syr Darya basin and the Zaravshan river and other tributaries in the Amu Darya basin (see Figure 1). Much of the pollution in the surface waters of Uzbekistan originates in other countries

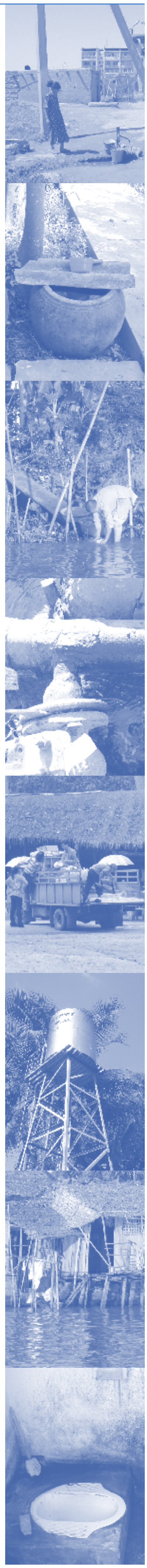


Figure 7: Amu Darya - agricultural area and saline soils
Source: S. Herbst, 2003.

and is aggravated as the rivers flow through Uzbekistan. The transboundary rivers Syr Darya and Amu Darya then carry numerous types and high quantities of pollutants to downstream countries. Ultimately, pollutants in the remaining flows of the Syr Darya and Amu Darya are deposited in the Aral Sea area.

The contamination of ambient water resources is exacerbated by a lack of appropriate sanitation facilities and sewerage treatment. Operating facilities are obsolete and in poor condition. This is also the case for drinking water distribution systems and contributes to the cross-contamination of drinking water. Drinking water distribution networks were built in the 1950s and 1960s and are often poorly maintained.

The number of tap water samples tested by the sanitary epidemiological stations and failing to meet the standards of chemical indicators has increased from 22% in 1985 to 25% in 2002. The number of samples going beyond the critical limit for bacteriological indicators decreased from 18% to 7%, but it is still high. In the Syr Darya region, microbiological tap water contamination has been revealed in 17% of the samples, in Djizak region 12%, in Tashkent and Namangan 12.8%. In surface waters, chemical pollution increased from 21% in 1985 to 30% in 2002, and bacteriological contamination from 10% to 11% of the samples (Ministry of Health of the Republic of Uzbekistan, 2003).

Bacterial and chemical contamination continues to be a problem in ambient water reservoirs used for drinking water, especially in Bukhara and Navoi regions. Overall, bacterial and chemical contamination is a serious environmental problem, which adversely impacts the health status of the population, in terms of morbidity and mortality (NEHAP, 1999). The resulting problems are most serious in the autonomous Republic of Karakalpakstan, and the provinces of Khorezm, Kashkadarya and Bukhara during the summer months, when bacterial and chemical contamination regularly exceeds standards 18-50% of the time (Ministry of Health of the Republic of Uzbekistan, 2003).

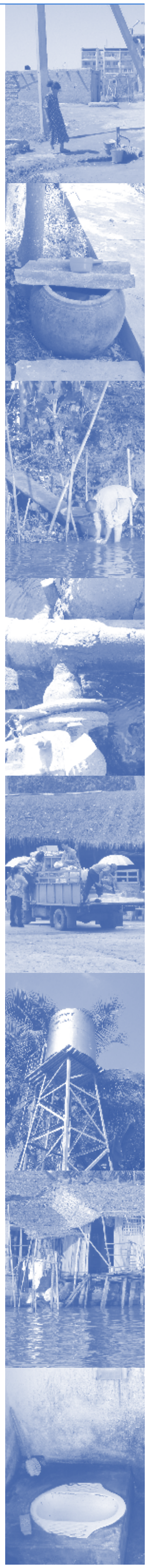
Figure 8: Well used for drinking water
Source: S. Herbst, 2003.

4. Major water-related health problems in Uzbekistan

According to the Ministry of Public Health of the Republic of Uzbekistan, water-borne infections are the most common type of infectious diseases reported in the region. Morbidity rates among the population have increased due to the use of surface water for drinking, and substandard drinking water treatment plants in built-up and rural areas have amplified the problem (see Figure 8). The lack of effective and sustainable sanitation and inadequate water management are the cause of major outbreaks and sporadic diseases that arise from the presence of infectious agents of the faecal-oral group. The role of water as a factor in the spread of faecal-orally transmitted diseases such as typhoid fever (TF), paratyphoid dysentery, enterovirus and giardia is well known.

The incidence of TF caused by Salmonella typhi was the highest during recent decades in the Republic of Uzbekistan. At present, the TF incidence rate remains at a relatively high level despite a substantial reduction by a factor of 1.3 during the last 15 years. However, an average of 1.5 per 100,000 people is still 7 times higher than the TF incidence in Russia of 0.22. A characteristic feature of the epidemic process of TF, which is a typical representative of waterborne intestinal infections, is the group (outbreak) morbidity (Mirtazaev et al., 1999). The epidemiologic outbreak examination of 100 TF pestholes conducted in unfavourable micro-areas of Uzbekistan revealed a 57% association between disease cases and water from open reservoirs. The level of water contamination was determined by analysing 349 samples from different surface waters situated in various TF affected areas. In 23 (6.6%) cases, the TF pathogenic factor was identified. TF morbidity has a pronounced seasonality due to intensive growth of the pathogen during the summer, combined with higher levels of water consumption from surface waters and increased recreational activities.

The TF rate varied greatly in different regions of the country due to a number of conditions and factors responsible for the spread of Salmonellae. A stable TF inci-



dence rate at a relatively high level is reported in different areas of Navoi, Samarkand, Namangan, Kashkadarya, Surkhandarya and Bukhara provinces. The overall high TF incidence rate was due to the extraordinarily high incidence of the disease in some micro-areas, which was caused by the contamination of surface waters. A particularly distinct TF morbidity was observed in the settlements located in the basins of transboundary rivers, such as the Zaravshan and Naryn, where surface water is still utilised for household and drinking needs. The waterborne transmission of the disease was reported in all TF outbreak sites of Navoi, Namangan and Samarkand provinces (Ministry of Health of the Republic of Uzbekistan, 2003).

In recent years, growing incidence rates of diseases concerning blood, the circulatory system, the urogenital system and nervous and digestive disturbances, were reported particularly in the Aral Sea area of Uzbekistan. Data on chemical water quality from the studied regions led to the assumption that the high incidence of these diseases is influenced by chemical substances in the drinking water. High levels of calcium in drinking water are suspected to contribute to the high prevalence of kidney stones in the Aral Sea area. Long-term ingestion of drinking water with a medium to high sodium content may impact on the cardiovascular system and lead to hypertension and other pathogenic conditions of the circulatory system. Pesticides are known to cause serious health problems such as hormonal imbalances, influencing fertility, carcinogenesis and impacting kidney function.

In the Republic of Karakalpakstan, the incidence of cholelithiasis varied from 7,225-8,286 and nefrolithiasis from 2,734-2,764 cases per year between 1994 and 1996. A statistical association between incidence rates of nefrolithiasis and the hardness of drinking water was shown for many districts in the autonomous Republic of Karakalpakstan with a correlation coefficient ranging from +0.82 to +0.98 (Iskandarova, 1999). Furthermore, the extreme environmental degradation in the autonomous Republic of Karakalpakstan, located in the inner Aral Sea area has resulted in a decline of the socio-economic status of the population and an increase in overall morbidity and infant mortality. The poor socio-economic situation accompanied by poor quality drinking water, dust loaded air and soil degradation creates unfavourable living conditions, which are suspected to influence the morbidity of malignant neoplasms and diseases of the kidney as well as of the circulatory system. However, detailed information on the complex links between socioeconomic and environmental factors, in particular, (drinking) water, and their impact on public health is still lacking. Hence, further research into the links between the environment, socioeconomic conditions and health is needed to establish an evidence based assessment for development of sustainable health policies in the Aral Sea area.

5. Conclusion

The long-term impact of inadequate water management, utilization and control at national and international levels has resulted in degraded water resources and high incidences of water-borne diseases which are seen as a threat to public health (NEHAP, 1999). Hence, measures to safeguard access to drinking water in sufficient quantities – including sustainable sanitation - are seen as the most important activities to strengthen public health.

Despite recent progress, improvements in water treatment, the availability of safe drinking water and sustainable sanitation need to be accelerated. In general, the highest health risks are associated with the use of drinking water directly from polluted rivers, canals and wells (Ministry of Health of the Republic of Uzbekistan, 2003) as is still common in rural areas of Uzbekistan. The water supply in Uzbekistan, especially in the rural areas, remains one of the foremost environmental concerns. However, even piped water, especially in summer time, does not meet drinking water standards for a number of microbiological and chemical contaminants. Due to intermittent supply, the access to water is not always sufficient even where water pipes are intact, forcing people to use alternative sources of water (UNESCO, 2000). Some projects to improve water supply in different regions of Uzbekistan are now underway. There is a need to evaluate their effectiveness for the development of locally adapted measures to further improve water supply and sanitation and as a basis for the identification of further steps in decision making on priorities for preventive public health measures.

With regard to further research, it is of the utmost importance that results aready available should be systematically summarised to enable the identification of research topics in order to meet gaps and to avoid repetition.

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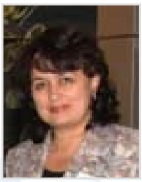

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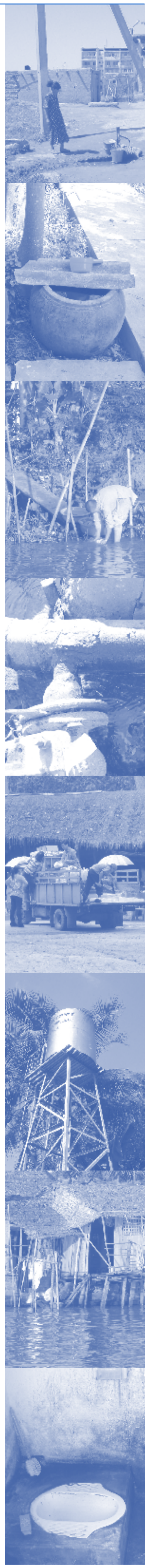


Perfluorinated surfactants in surface and drinking waters

The mismanagement of several thousand tons of sludge and waste materials contaminated with perfluorinated surfactants (PS including PFOS/PFOA) has caused the contamination of hundreds of sites such as agricultural fields, forests and grazing areas in Germany. In total ca. 1000 suspected areas are presently being evaluated for contamination.

The run-off of PS from some of these sites contaminates tributaries of the river Ruhr such as the Moehne, and results in elevated concentrations in the Ruhr and related drinking waters (Skutlarek et al, 2006). The Ruhr serves as a raw water source for the drinking water supply of ca. 5 million people.

The population in the area with the highest drinking water contamination (approximately 500 ng/L PFOA) showed five to eight times elevated PFOA concentrations in the blood after three to four years of exposure, as compared to non-affected German background contamination (Human Biomonitoring Arnsberg 2007).

Perfluorinated surfactants (PS), especially perfluorinated carboxylates and sulfonates, are special chemicals with specific technological properties. They show high thermal and chemical stability, possess a high polarity and are not biodegradable. PS are used to coat textiles, papers and carpets to achieve oil, stain and water repelling properties. Furthermore, they are employed as performance chemicals in firefighting foams and as ingredients in consumer products such as floor polishes and shampoos (Begley et al. 2005, Moody et al. 2003). The properties described above have also led to their widespread distribution. Major compounds like perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), but also components with varying chain lengths from C2 – C12, have been found in different environmental samples even in polar regions (Allsop et al. 2005, Berger et al 2004, Daughton 2004, Kannan et al. 2005).

The concentrations of perfluorinated surfactants described may not be acutely toxic, but these compounds can be enriched in humans (blood, liver), which raises the concern of long-term metabolic effects of these cellularly recognised xenobiotics (Inoue et al. 2004). Because of the multiple toxicities of PS (coupled with bioaccumulation and biomagnification in the food chain), different risk assessments on PFOS and PFOA have been undertaken (OECD 2002, Swedish Chemical Inspectorate 2006, FSA UK 2006 a, b). Recent research studies (Jernbro et al. 2006) indicate that PFOS increases the effect of genotoxic substances like cyclophosphamide in the micronucleus test, which adds a new dimension of concern to the toxicology of perfluorinated surfactants and other perfluorinated compounds.

Abbreviations:

PFBuA:	*Perfluorobutanoic acid*
PFPeA:	*Perfluoropentanoic acid*
PFHxA:	*Perfluorohexanoic acid*
PFHpA:	*Perfluoroheptanoic acid*
PFOA:	*Perfluorooctanoic acid*
PFNA:	*Perfluorononanoic acid*
PFDA:	*Perfluorodecanoic acid*
PFUnDA:	*Perfluoroundecanoic acid*
PFDoDA:	*Perfluorododecanoic acid*
PFBS:	*Perfluorobutane sulfonate potassium salt*
PFHxS:	*Perfluorohexane sulfonate potassium salt*
PFOS:	*Perfluorooctane sulfonate potassium salt*

It is assumed that the main sources of human intake of perfluorinated surfactants, especially PFOS and PFOA, are foods and beverages which are either primarily contaminated or secondarily contaminated by food packaging materials (Begley et al. 2005); however, drinking water can also contribute to the daily uptake. In recent years, several studies on detected contaminations of ground, surface and drinking waters have been published (Hansen et al. 2002, Saito et al. 2004).

In our study the concentrations of 12 different perfluorinated surfactants in German rivers (Rhine, Ruhr, Moehne and others), canals and drinking waters of the Ruhr catchment area are presented. Furthermore, the main contamination source of the river Ruhr was identified as an agricultural area on the upper reaches of the Moehne, an important tributary of the Ruhr.

Sampling:

Surface and drinking water samples were collected from rivers, canals and public buildings in several campaigns from March (Rhine) to May (Ruhr area and Moehne) 2006.

Figure 1: Sampling at the Moehne river (upper reaches)

River	Sampling site	PFBuA [ng/L]	PFPeA [ng/L]	PFHxA [ng/L]	PFHpA [ng/L]	PFOA [ng/L]	PFBS [ng/L]	PFOS [ng/L]	Σ [ng/L]
Rhine	Neuhausen (CH)	-	-	-	-	-	-	2	2
Aare (CH)	Koblenz (CH)	-	-	3	-	2	13	8	26
Rhine	Huningue (F)	-	-	2	-	2	9	12	25
Rhine	Breisach	-	-	-	-	2	46	26	74
Rhine	Ludwigshafen	-	-	-	-	2	30	5	37
Neckar	Mannheim	-	-	-	-	3	-	3	6
Main	Gustavsburg	-	-	-	-	3	-	12	15
Rhine	Mainz	2	-	2	-	3	24	12	43
Moselle	Koblenz	-	-	-	-	-	-	5	5
Rhine	Koblenz	-	-	-	-	2	19	5	26
Rhine	Bonn	-	-	-	-	2	12	5	19
Rhine	Cologne	-	-	-	-	-	2	5	7
Ruhr	Duisburg	2	18	12	-	48	9	5	94
Rhine	Duisburg	2	3	3	-	9	15	9	41
Emscher	Dinslaken	-	3	7	2	22	5	18	57
Lippe	Wesel	-	9	20	-	21	3	6	59
Rhine	Wesel	2	2	3	-	8	13	9	37

Table 1: Perfluorinated surfactant concentrations in the river Rhine and selected tributaries (mouth)

Results of surface water analyses:

In the surface waters of the river Rhine, the concentrations of PFOA ranged between below the Limit of Determination (< LOD = 2 ng/L) at Neuhausen (CH) in the upper reaches and 9 ng/L at Duisburg. PFOS was found between < LOD and 26 ng/L. The major component in the Rhine was PFBS, with concentrations ranging between < LOD and a maximum value of 46 ng/L at Breisach. The sum of all determined components was below 100 ng/L at all sampling points. Perfluorinated surfactants were found in similar concentrations in the main tributaries of the Rhine, with the exception of the Ruhr and the rivers Emscher and Lippe. In the river Ruhr (mouth at Duisburg), PFOA was recognised as the major component with 48 ng/L, followed by PFPeA (18 ng/L), PFHxA (12 ng/L), PFBS (9 ng/L) and PFOS (5ng/L) with a sum of 94 ng/L. (Table 1).

The highest concentrations in surface waters could be detected in the upper reaches of the Ruhr and the Moehne rivers (see Table 2). The river Ruhr at Meschede-Wehrstapel (Figure 2, No. 21) was contaminated with a sum value of 446 ng/L with three major components: PFPeA (167 ng/L), followed by PFOA (139 ng/L) and PFHxA (120 ng/L). We found the highest sum concentrations in the river Moehne at Heidberg (Figure 3). The sum concentration was 4385 ng/L with the major component PFOA (3640 ng/L), followed by PFHxA (247 ng/L), PFOS (193 ng/L), PFHpA (148 ng/L) and PFPeA (93 ng/L). PFBS and PFBuA were also detectable.

Lake Moehne, which has a volume of approximately 134.5 million m³, (Figure 2, No. 15) was also contaminated with perfluorinated surfactants (sum value: 822 ng/L, major component PFOA, followed by PFHxA, the other components ranged between 17 and 27 ng/L), and shows a similar pattern to the river Moehne.

By tracking the high concentrations in the upper reaches of the Moehne, we localised the main source of contamination in an agricultural area near Brilon-Scharfenberg (Figure 3, Table 3). From this area the perfluorinated compounds are washed into two small creeks, the Steinbecke (Figure 3, point B and H) and the Klossiepen (Figure 3, point D, point A was not contaminated).

The confluence of the Klossiepen with the Bermecke and the Hoebecke near the waste water treatment plant of Brilon-Scharfenberg causes the Bermecke contamination at point F in Figure 3. The authorities in charge at present assume that contaminated organic waste which was applied several years ago on this and other areas is

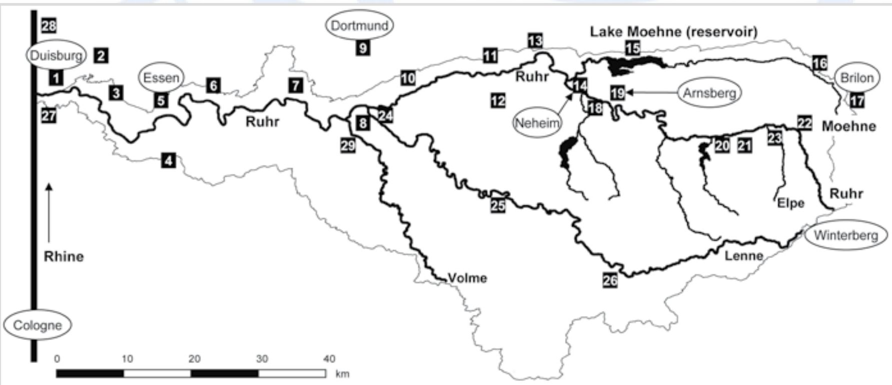
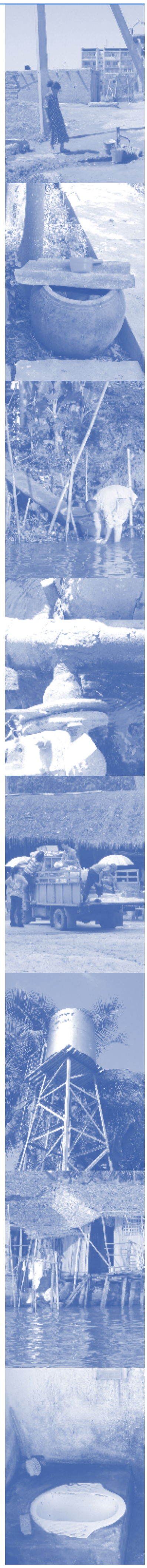


Figure 2: Sampling sites (surface water and drinking water) in the Ruhr area

No.	Sampling site (river, town)	PFBuA [ng/L]	PFPeA [ng/L]	PFHxA [ng/L]	PFHpA [ng/L]	PFOA [ng/L]	PFBS [ng/L]	PFOS [ng/L]	Σ [ng/L]
1	Ruhr (Duisburg)	2	18	12	-	48	9	5	94
3	Ruhr (Muelheim)	-	8	3	-	46	14	6	77
5	Ruhr (Essen)	-	15	12	-	51	9	7	94
6	Ruhr (Bochum)	-	7	5	-	57	12	4	85
7	Ruhr (Witten)	-	8	6	-	69	17	22	132
8	Ruhr (Hagen)	-	12	10	-	90	17	13	142
10	Ruhr (Schwerte)	10	28	25	-	177	18	14	272
18	Ruhr (Huesten)	11	50	38	-	63	8	-	170
20	Ruhr (Meschede-Wennemen)	5	31	16	-	24	4	-	80
21	Ruhr (Meschede-Wehrstapel)	14	167	120	-	139	6	-	446
22	Ruhr (Olsberg)	-	-	-	-	-	-	-	-
14	Moehne (Neheim)	18	13	33	25	647	18	14	767
15	Lake Moehne	25	24	54	27	654	22	17	822
16	Moehne (Heidberg)	21	93	247	148	3640	44	193	4385
17	Moehne (Brilon)	-	-	-	-	11	6	-	17
23	Elpe (Bestwig)	143	1638	1248	-	1168	71	-	4268

Table 2: Perfluorinated surfactant concentrations in surface water in the Ruhr area



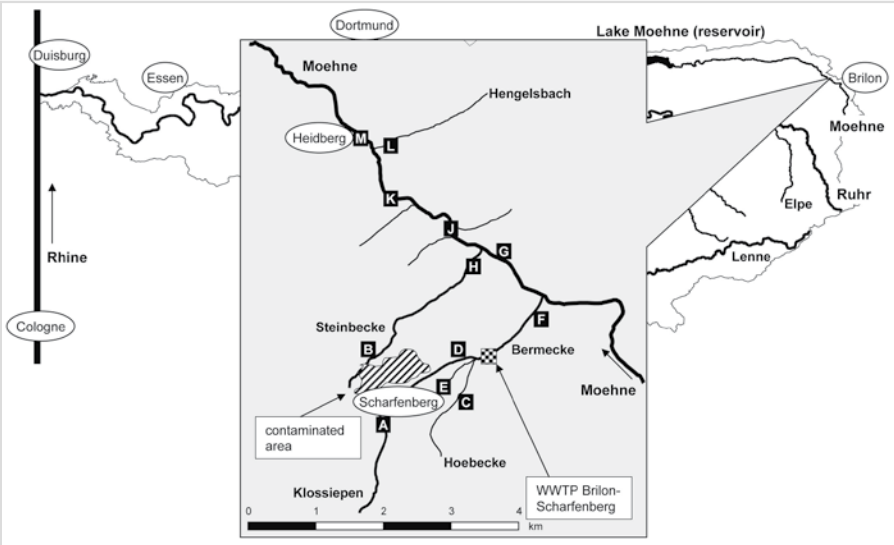


Figure 3: Sampling sites (surface water) near Brilon-Scharfenberg

responsible for the pollution. In the upper soil layers of this area, PS was found at concentrations of up to 0.676 mg/kg.

In summary, the contamination of the river Moehne occurs at the confluences with the Bermecke and the Steinbecke creeks. This leads to the consecutive pollution of Lake Moehne and the river Ruhr and of corresponding drinking waters.

Results of drinking water analyses:

With regard to the concentration of perfluorinated surfactants in drinking waters of the Ruhr and Moehne areas, the highest values were found at Neheim (Figure 2, Table 4, No. 14). The major component is PFOA with 519 ng/L. The drinking water of Neheim stems from the river Moehne, presumably after it underwent bank filtration or artificial recharge. In comparison, the surface water of the Moehne at Neheim and the corresponding drinking water of Neheim show only small differences in the concentrations of the determined analytes (sum value in Moehne river: 767 ng/L, sum value in drinking water: 598 ng/L).

Discussion, Recommendation and Outlook

Because of their persistence and mobility, and as indicated by these results, different perfluorinated surfactants are relevant potential contaminants of both surface and drinking waters. At present, these compounds and their precursors are not included in regular quality controls of either surface or drinking water or organic waste materials. The contamination stems from polluted waste materials, which were illegally applied in high tonnages on more than 1000 agricultural areas in the Ruhr watershed and in some other federal states of Germany. Whether the impurities stem from legal or illegal use of specific waste components and which components are present must still be analysed. According to official information, the contaminated material was probably produced since 2002. Further investigations have to show to what extent ground waters are already affected.

The occurrence of perfluorinated surfactants in surface and drinking waters of the Ruhr and Moehne areas causes considerable concern in view of the possible toxic effects on humans and the ecosphere. As a result of the concern over high PS concentrations in different drinking waters, particularly in Neheim, German authorities have recommended guide values for PFOA and PFOS in drinking water in a preliminary statement (Trinkwasserkommission 2006 – Drinking Water Commission 2006).

In comparison with the results of the surface waters of the river Ruhr, the corresponding drinking waters in the Ruhr area show approximately similar values (Table 5). The concentrations in both water types decrease in the flow direction of the Ruhr from east to west, which can be explained by the diluting effect of the confluence of other non- or less contaminated tributaries, like the Lenne or Volme, and other smaller tributaries.

The observed parallelism of the PS concentrations in surface and drinking waters of the Ruhr area indicate that the water treatment steps used at present do not effectively eliminate perfluorinated compounds to a sufficient extent, although approximately 50% of the waterworks on the Ruhr are equipped with activated carbon filters within their water treatment facilities. These filtering materials have to be changed every few months, depending on the quantity of drinking water produced and the PS contamination concentration of the surface water used. Furthermore it seems to be necessary to use activated carbon filtration in all waterworks on the Ruhr as a “state of the art” water treatment step.

Population at risk:

The population in the area with the highest drinking water contamination (519 ng/l PFOA in March 2006)

Table 3: Perfluorinated surfactant concentrations in the Moehne river and selected tributaries near Brilon-Scharfenberg

No.	Sampling site (river)	PFBuA [ng/L]	PFPeA [ng/L]	PFHxA [ng/L]	PFHpA [ng/L]	PFOA [ng/L]	PFBS [ng/L]	PFOS [ng/L]	Σ [ng/L]
A	Klossiepen	-	-	-	-	11	-	-	11
B	Steinbecke	500	2670	2630	621	16800	1450	5900	30571
C	Hoebecke	-	-	-	-	-	-	-	-
D	Klossiepen	9	25	73	46	1860	17	2	2032
E	Bermecke	-	-	-	-	-	-	-	-
F	Bermecke (mouth)	53	234	621	210	6530	146	507	8301
G	Moehne	12	58	152	50	1930	38	135	2375
H	Steinbecke (mouth)	200	1390	3040	989	33900	669	3160	43348
J	Moehne	33	150	393	180	7070	87	405	8318
K	Moehne	31	139	390	158	5990	79	370	7157
L	Hengelsbach	-	-	-	-	-	-	-	-
M	Moehne	25	118	358	146	5570	67	311	6595

No.	Sampling site (town)	PFBuA [ng/L]	PFPeA [ng/L]	PFHxA [ng/L]	PFHpA [ng/L]	PFOA [ng/L]	PFBS [ng/L]	PFOS [ng/L]	Σ [ng/L]
2	Oberhausen	-	6	3	-	43	16	9	77
3	Muelheim	-	3	-	-	30	18	3	54
4	Velbert	-	11	7	-	38	13	-	69
5	Essen	-	9	7	-	56	15	7	94
6	Bochum	-	8	5	-	53	14	10	90
7	Witten	-	4	4	-	49	14	12	83
8	Hagen	-	5	3	-	34	16	22	80
9	Dortmund	2	30	26	-	152	8	11	229
10	Schwerte	3	27	24	-	145	10	13	222
11	Froendenberg	3	26	21	-	143	3	6	202
12	Menden	-	35	31	2	157	6	11	242
13	Wickede	5	46	38	-	208	4	-	301
14	Neheim	11	5	22	23	519	13	5	598
19	Arnsberg	8	77	56	-	71	3	-	215
20	Meschede	6	46	22	-	22	-	-	96

Table 4: Perfluorinated surfactant concentrations in drinking water in the Ruhr area (- = not detectable)

showed five to eight times elevated PFOA concentrations in blood plasma after about three years of exposure compared to background cohorts in areas with non impacted drinking water (children 4.5-fould (median 22.1 µg/l), men 4.7-fould (median 27.4 µg/l) and women 8.4-fould (24.9 µg/l). The maximum value measured for an individual was 99.7 µg/l. The observed PS concentrations in blood are related and proportional to the individual drinking water consumption (Human Biomonitoring Arnsberg 2007).

Conclusions

The present case showed enormous shortcomings in the management of PS contaminated waste from industrial releases and also the management of PS contaminations including the security of drinking water.

The case further demonstrates that the mismanagement of one waste stream from PS- producing or PS-applying industries can contaminate hundreds of sites and the drinking water of millions of people. Therefore in addition to contaminating sites around PS production and application facilities, the waste streams of these industries can become a serious contamination pathway for human PS contamination via contaminated drinking water. Therefore the mass flow and waste management of fluorinated organics in the technosphere (perfluorinated surfactant production and application facilities) has to be severely controlled by national authorities. It must be guaranteed that the PS and PS precursor contaminated waste and waste streams (including PS containing products) are managed and finally destroyed in an environmentally sound manner. The responsibility of waste management and related damage must stay with the PS producers (strict extended producer responsibility). Regulations in this respect should be developed as soon as possible along with legal regulations/ limitations concerning the general production and use of fluorinated surfactants and their precursors. If they cannot be managed in closed cycles, this should be followed by a ban such as that relating to PFOS and its precursors.

In addition to the precursor compounds of PFOS, PFOA and other PSs discussed, fluorotelomer alcohols (FTOHs) in the environment must also be identified and levels determined, particularly in surface and drinking waters, foodstuffs, packaging material and, if necessary, in organic waste materials and organic fertilisers.

In order to protect customers and the ecosystem from these persistent and bioaccumulative toxic compounds and their precursors, the EU passed a directive (EU Directive 2006/122ECOF, 12.12.2006) concerning restrictions on marketing and use of PFOS from 27.06.2008 on.

Members of the EU parliament have also suggested restricting the use of PFOA. In January 2006, the US EPA asked different PS manufacturing and processing companies to join in the global effort to eliminate PFOA from emissions and products by 2015 (US EPA Stewardship Program 2006), as a first step.

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Table 5: PFOA and PS concentrations in surface water and related drinking water of some cities in the Ruhr/Moehne area

City (river, No. in fig.2)	**PFOA** [ng/L]		**Sum of PS** [ng/L]	
	Surface Water	**Drinking Water**	**Surface Water**	**Drinking Water**
Duisburg-Wedau (Ruhr, 28)	9	-	41	26
Muelheim (Ruhr, 3)	48	31	94	63
Essen (Ruhr, 5)	60	58	97	104
Bochum (Ruhr, 6)	58	53	91	96
Witten (Ruhr, 7)	75	50	147	91
Hagen (Ruhr, 8)	91	65	152	118
Schwerte (Ruhr, 10)	178	146	280	234
Neheim (Moehne, 14)	646	520	765	609

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ECDC Workshop on Infectious Diseases and Environmental Change

At the end of March 2007, the European Centre for Disease Prevention and Control (ECDC) organised a 2-day exploratory workshop on the public health consequences of global climate change and ecological changes in the context of communicable diseases. The meeting was held at the ECDC headquarters in Stockholm and was co-hosted by the Joint Research Centre (JRC) of the European Commission, the European Environment Agency (EEA) and the WHO Regional Office for Europe. The Bonn WHO CC was invited to represent views on the water-related health impact of environmental change.

As outlined in ECDC's First European Communicable Disease Epidemiological Report (7 June 2007, www.ecdc.europa.eu/pdf/Epi_report_2007.pdf), environmental, ecological and climate changes contribute to the emergence, perpetuation and transmission of infectious diseases. The effect of global warming on Europe in the years ahead is expected to increase this danger.

The objective of the workshop, which brought together some 30 key scientists, researchers, public health practitioners and advocates together with representatives from international organisations, was to assess the different manifestations and the extent of environmental changes in Europe. Demographic changes (international travel, global migration, overcrowding, urbanisation, etc.) and technological changes were explicitly included.

Plenary sessions provided the participants with key regional and global agency perspectives (ECDC, WHO Europe, EEA, JRC, DG Sanco), looked at global societal and environmental factors influencing disease outcomes and transmissions, and highlighted the impacts of Europe's changing ecological environment on its communicable dis-

What is the ECDC?

The European Centre for Disease Prevention and Control (ECDC; www.ecdc.europa.eu) is a relatively new EU agency that has been created to help strengthen Europe's defences against infectious diseases. It was created by the European Parliament and the Council of the European Union in the spring of 2004. At the core of its mandate, the ECDC is responsible for facilitating cooperation between national disease control agencies and other organisations and coordinating European action to meet some of the key health challenges of the 21st century. In order to achieve this mission, the ECDC works in partnership with national health protection bodies and other EU agencies to strengthen and develop continent-wide disease surveillance, early warning and response systems. By working with experts throughout Europe, the ECDC aims to pool Europe's health knowledge, so as to develop authoritative scientific opinions about the risks posed by current and emerging infectious diseases. In 2007, the centre is set to employ some 150 staff, growing to 400 over the next few years. Under the directorate of Zsuzsanna Jakab, the ECDC comprises units for scientific advice (Head: Johan Giesecke), surveillance & communication (Andrea Ammon) and preparedness & response (Denis Coulombier).

Figure 1: Since 2004, Tomtebodaskolan in Solna near Stockholm / Sweden is the headquarter building of the ECDC. Untill 1985, the building has served as a national school for blind and mentally disabled children (Kungliga blindinstitutet Tomteboda - The Royal Institute for blind men) Source: Th. Kistemann 2007

ease burden and public health systems. Within parallel working group sessions, particular emphasis was placed on identifying new or enhanced infectious disease threats from water, air and food, zoonoses, vectors and rodents. There was no doubt that, as the impact of environmental change is felt, water will be one of the utmost important transmission routes for emerging infections.

A second set of working group sessions addressed the potential and deficiencies of strategic public health measures (surveillance, research, assurance, policy). The final working group sessions addressed problems to overcome obstacles to action. Without doubt, this workshop was a first step to begin to address the challenges relating to communicable diseases resulting from environmental changes in Europe, and to begin closing the gap between researchers and concerned European agencies. In the future, environmental change will play an increasing role on the agenda of the ECDC.

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Latest facts on water, wastewater and waste – German tasks in the global topic

Following the „Advanced Sanitation" conference, the "Essener Tagung" took place between 14 - 16 March 2007. As one of the most important events on water, wastewater and waste in German-speaking Europe this resulted in about 900 professionals convening in Aachen, Germany. The majority of the participants were engineers or economists. However, planners, administrative officers and scientists from other fields were also represented. Scientists and experts from universities together with applied scientists and politicians made more than 70 presentations.

Organiser: Lehrstuhl für Siedlungswasserwirtschaft und Siedlungsabfallwirtschaft der RWTH Aachen, Forschungsinstitut für Wasser- und Abfallwirtschaft an der RWTH Aachen e.V., Institut zur Förderung der Wassergüte- und Wassermengenwirtschaft, Landesamt für Natur, Umwelt und Verbraucherschutz NRW in Abstimmung mit dem MUNLV

Water supply, wastewater management and waste management, the classic subjects of this conference, were expanded to include topics such as the water framework directive, demographic change and the scarcity of energy and its effects. Although the focus of the presentations was mainly technical and economic, health issues were also included in several sessions. Three speeches dealt with perfluorinated tensides (PFT) in the context of water supply and treatment as well as in water management and pollutants. Elimination of other organic compounds (e.g. pesticides) in wastewater and the monitoring of surface water were also foci.

Furthermore, a good comparative view was presented of the implementation of the water framework directive in different German federal states. The quality of drinking water, new technical possibilities of treatment and efficiencies in water distribution systems were also discussed from a technical point of view. A report about the first operational year of Germany's largest ultrafiltration plant for drinking water treatment was given by the Wassergewinnungs- und -aufbereitungsgesellschaft Nordeifel mbH (WAG), Roetgen, Germany. The process of ultrafiltration has demonstrated a high level of stability despite frequently changing raw water quality. No membrane defects were detected and microbial parameters were without pathological findings at any time.

The relative new phenomenon of shrinking cities in industrialised countries requires the adaptation of the water infrastructure. Mannheim, Germany, a traditional industrial location in the "Rhein-Neckar-Triangle" – and a European metropolitan area was taken as an example for analysing the consequences of change. The draining of wastewater, wastewater treatment and the elaboration of future necessary action plans were included in an exercise to evaluate precautionary measures. This was based on demographic, climatic, economic and infrastructural conditions, which influence the amount and composition of wastewater in several ways.

Furthermore, one session considered how German water professionals and the water industry could contribute to solving water supply problems in countries in transition together with low-income countries.

In conclusion, the "Essener Tagung" is not only an important meeting by engineers from the fields of water and waste management; it also offers a platform for interdisciplinary discussions and the exchange of knowledge for experts dealing with human health.

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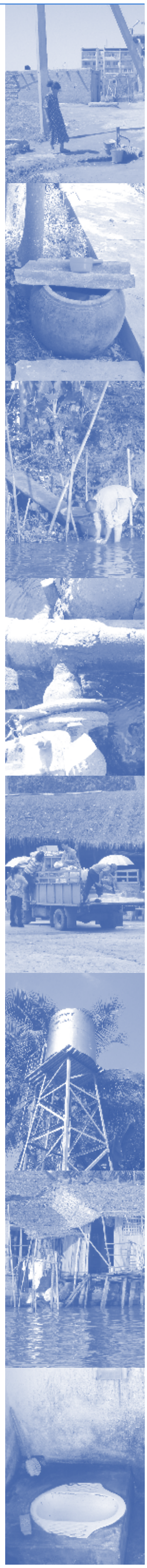

At a glance

The Health Department of Baden-Wuerttemberg has been designated a WHOCC for Housing and Health

In December 2006, the WHO Regional Office for Europe designated the health department of Baden-Wuerttemberg in Stuttgart, Germany as a WHO Collaborating Centre for Housing and Health. The task of the WHOCC is to support the implementation of scientific knowledge on housing and health, e.g. through action plans and guidelines on healthy housing. The health department will additionally perform studies on the impact of chemical or biological indoor pollutants (e.g. fine particulate, mildews, mites); on the impact of noise from traffic and neighbourhoods and on domestic accidents. A further task of the WHOCC is the organisation of trans-disciplinary workshops and training for housing and health.

On 28th March 2007, the health department of Baden-Wuerttemberg, WHOCC for Housing and Health, invited WHOCCs from Germany working on housing related issues to a meeting. The participating WHOCCs were:

- WHO Collaborating Centre for Air Quality Management & Air Pollution (Ministry of Environment, Berlin)
- WHO Collaborating Centre for Tobacco Control (German Cancer Research Centre, Heidelberg)
- WHO Collaborating Centre for Ionizing and Non-Ionizing Radiation and Health (Federal Office for Radiation Protection, Oberschleißheim)
- WHO Collaborating Centre for Health Promoting Water Management and Risk Communication (Institute for Hygiene and Public Health, University of Bonn)

All WHOCCs presented their terms of reference and current projects. Further meetings have been planned to discuss the common and synergetic topics for collaboration between the WHOCCs.

At the afternoon symposium, experts on medicine, architecture and acoustics made presentations aimed at defining strategies for the future of housing and health.

Towards Sustainable Global Health – International Conference at the International Congress Centre Bonn, Germany

From 9 to 11 May 2007, the International Conference "Towards Sustainable Global Health" was held at the International Congress Centre (IKBB) in Bonn, Germany. About 150 stakeholders, decision-makers and practitioners from the fields of politics and science, from private companies, NGOs and institutions for development, knowledge transfer and education represented their different perspectives on sustainable global health. During 5 plenary sessions and parallel sessions diverse topics regarding global health were targeted. A committee constituted by the chairs of the conference assembled to draft the "Bonn Call for Action on Promoting Sustainable Global Health", which was presented in the last plenary session and was intended to be introduced at the G8 meeting in Heiligendamm.

Events on Water, Health and Risk Communication:

July 2007:

XIIth International Medical Geography Symposium (IMGS) Changing Geographies of Public Health, 09.07. - 13.07.2007, Bonn, Germany
http://www.imgs2007.de/

August 2007:

World Water Week in Stockholm 2007 'Progress and Prospects on Water – Striving for Sustainability in a Changing World', 12.08. - 18.08.2007, Stockholm, Sweden
http://www.worldwaterweek.org/

September 2007:

International Symposium on 'New Directions in Urban Water Management', 12.09. - 14.09.2007, Paris, France
http://www.unesco.org/water/ihp/pdf/symposium_UWM07.pdf

10th IWA Specialised Conference on Large Wastewater Treatment Plants, 09.09. - 13.09.2007, Vienna, Austria
http://lwwtp07.tuwien.ac.at/conference_focus.php

October 2007:

6th IWA Specialty Conference on Wastewater Reclamation and Reuse for Sustainability, 09.10. - 12.10.2007, Antwerp, Belgium
http://www.wrrs2007.org/

November 2007:

HELP - Local Solutions to Global Water Problems : Lessons from the South, 04.11. - 09.11.2007, Pretoria, South Africa
http://www.unesco.org/water/ihp/help

2nd International Congress on Wastewater Treatment in Small Communities (SmallWat07), 11.11. - 15.11.2007, Seville, Spain
http://www.smallwat.org/index_en.html

1st International Conference on Adaptive and Integrated Water Management: Coping with Complexity and Uncertainty (CAIWA 2007), 12.11. - 15.11.2007, Basel, Switzerland
http://www.usf.uos.de/projects/caiwa/index.htm

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