Xenobiotics and urban water

R. Aartgeerts
WHO Regional Office for Europe
Email: watsan@ecr.euro.who.int
My talk today will last approximately 20 minutes. I aim to:

- Introduce the water and health portfolio of the WHO Regional Office for Europe
- Highlight the interdisciplinary approach needed for the development of a position on xenobiotics
- Introduce the work of the International Program on Chemical Safety
  http://www.inchem.org/
- Discuss the approach taken by the water supply and sanitation unit
- Summarize the long-term work of the children, environment and health program
- Indicate some cooperation possibilities
This presentation approaches the problem from the viewpoint of the WHO European Region.

[1] EUR A includes: Andorra, Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxemburg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, UK Child population 0 – 19 years 94,994,000.

EUR B includes: Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Serbia and Montenegro, Slovakia, Tajikistan, the former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan. Child population 0 -19 years 79,467,000

EUR C includes Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine, Child population 0-19 years 64,846,000


Of course, the work undertaken in this region follows the concerns expressed by the Member States and the guidance received from WHO Headquarters in Geneva.
The work related to water, sanitation and health at the WHO Regional Office for Europe falls mainly under the Protocol on Water and Health to the 1992 Convention on Protection and Use of Transboundary Watercourses and International Lakes (the Water Convention). The Protocol has been signed by 34 countries and will enter into force once 16 ratifications have been deposited with the Secretary General of the United Nations.

The Meeting of the Parties is the highest decision-making body under the Protocol. The Working Group on Water and Health meets approximately semi-annually and reviews national priorities and research programmes. Expert groups deal with specific topics such as drinking-water and recreational water quality, environmental risk assessment and others. As such there is a clear similarity between the aims of COST and the challenges faced by the Parties to the Protocol.
I now come to the interdisciplinary nature of the WHO activities needed to develop a consistent approach to xenobiotics in water, urban or otherwise.
Within WHO, three main actors could contribute to the development of such a position:

- The International Program on Chemical Safety
- The program on Water Sanitation and Health
- The Children, Environment and Health Program

In the European region, the Special Program on Environment and Health serves as focal point.
The International Program on Chemical Safety is designed as a tool for those concerned with chemical safety and the sound management of chemicals. Produced through cooperation between the International Program on Chemical Safety and the Canadian Centre for Occupational Health and Safety (CCOHS), IPCS responds to one of the Intergovernmental Forum on Chemical Safety (IFCS) priority actions to consolidate current, internationally peer-reviewed chemical safety-related publications and database records from international bodies, for public access. IPCS INCHEM contains:

- Concise International Chemical Assessment Documents (CICADS)

Concise documents that provide summaries of relevant scientific information concerning potential effects of chemicals on health and environment. Primary objective is the characterization of hazard and dose-response from exposure to a chemical.

- Environmental Health Criteria (EHC) monographs

- Health and Safety Guides (HSGs)

- International Agency for Research on Cancer (IARC) – Summaries and Evaluations

Program on the evaluation of carcinogenic risk to humans involving the production of critically evaluated monographs on individual chemicals. The program was expanded to include evaluation of carcinogenic risks associated with exposures to complex mixtures and other gases.

- International Chemical Safety Cards

- IPCS/CEC Evaluation of Antidote Series

- Joint Expert Committee on Food Additives (JECFA) – monographs and evaluations

- Joint Meeting on Pesticide Residues (JMPR) – monographs and evaluations

- Pesticide Data Sheets (PDSs)

- Poisons Information Monographs (PIMs)

- Screening Information Data Set (SIDS) for High Production Volume Chemicals
Notwithstanding the success of the ongoing work, the parent body of the IPCS, the Intergovernmental Forum on Chemical Safety (IFCS) fully acknowledges that considerable challenges remain to be done. Amongst the remaining tasks can be mentioned:

- Link between exposure and health outcome for different age groups, in different settings
- Risk assessment approaches that account for child-specific issues
- Improve understanding of foetal and early childhood exposure and toxicological impact
- Incorporate new scientific information (genomics, proteonomics)

The reference to children and prenatal stages of human development is particularly important in view of recent political statements in this area, as will be discussed later in this presentation.

Notwithstanding these remaining concerns, the work of the IPCS is already used in other programs, particularly the water, sanitation and health program.
The work done by the IPCS is one of the basic sources of information used by the water, sanitation and health program.
Guidelines for drinking-water quality

- Credible evidence of occurrence, combined with evidence of actual or potential toxicity
- Of significant international concern
- Included in the WHOPES evaluation program

The water, sanitation and health unit at WHO Geneva, supported by the regional offices of the Organization, works on aspects of water, sanitation and hygiene where the health burden is high, where interventions could make a difference and where the present state of knowledge is poor. Areas of specific interest are:
- Drinking water quality
- Bathing waters
- Water resources quality
- Water supply and sanitation monitoring
- Water, sanitation and hygiene development
- Water-related disease
- Wastewater use
- Healthcare waste
- Health in water resources development
- Emerging issues in water and infectious disease
- Household water treatment and safe storage

The work on water, sanitation and hygiene includes the different types of activity of WHO:
- Policy
- Research
- Partnership
- Databases and statistics
- Guidelines and regulatory elements
- Training materials
- Good practice and tools for disease reduction

Amongst the best known products are the Guidelines for drinking-water quality. However, it is worth noting that a number of criteria need to be met before a chemical will be taken up for inclusion in the Guidelines, as shown in the above slide. From these criteria it follows that certainly not every xenobiotic will be taken up in development of the Guidelines.
Two approaches

- Threshold chemicals: those where there is a dose below which no adverse effect will occur
- Non-threshold chemicals: mostly genotoxic carcinogens
- Currently over 200 chemicals in GDWQ

WHO GDWQ are kept up to date by a “rolling-revision”. The work involves development of addenda to be published in 2005 and 2007 with possibly one in 2008.

Derivation of chemical guideline values (Ref. GDWQ page 147)
The criteria used to decide whether a GV is established for a particular chemical constituent meeting the first set of criteria is as follows:
- There is credible evidence of the occurrence of the chemical in drinking-water, combined with evidence of actual or potential toxicity, or
- The chemical is of significant international concern, or
- The chemical is being considered for inclusion, or is included, in the WHO Pesticide Evaluation Scheme program (approval program for direct application of pesticides to drinking-water for vector control).

Two approaches are taken to the derivation of guideline values: one for “threshold chemicals” and the other for “non-threshold chemicals”.

\[
TDI = \frac{(NOAEL \ or \ LOAEL)}{UF}
\]
\[
GV = \frac{(TDI \times bw \times P)}{C}
\]
- \(bw\) = body weight
- \(P\) = fraction of the Total Daily Intake allocated to drinking-water
- \(C\) = daily drinking water consumption

These approaches lead to GV for a number of chemicals – however, they are not by themselves sufficient to completely solve a health problem, especially when water is only one of the exposure routes, and perhaps not even the most important, as the case of Pb illustrates.
Note: these are the chemicals flagged as being of particular concern to children, environment and health during the 4th Ministerial Conference on Environment and Health

Recalling the concern expressed by the IPCS on childhood exposure, it is appropriate to recollect that the Guidelines are developed giving particular concern to children. In developing the guideline values for potentially hazardous chemicals, a daily per capita consumption of 2 litres by a person weighting 60 kg was generally assumed. However, this assumption might underestimate the consumption of infants and children, who consume more fluid per unit weight than adults. The higher intakes, and hence exposure, for infants and children apply only for a limited time, but this period may coincide with greater sensitivity to some toxic agents. Where it was judged that this segment of the population was at a particular high risk from exposure to certain chemicals, the guideline value was derived on the basis of a 10-kg child consuming 1 litre per day or a 5-kg bottle-fed infant consuming 0.75 litre per day.

I’d like to draw your particular attention to lead. The first recommendation (1958) was at 0.1 mg/l for lead, which was subsequently lowered to 0.05 mg/l in the 1963 International Standards. It was again revised upwards to 0.1 in 1971 but lowered again to 0.05 in 1984. In 1993, the Guidelines proposed a health-based GV of 0.01 mg/l. Notwithstanding ever tighter GV, lead continues to exercise an appreciable health burden. This evolution shows the fluctuation of the decision-making process and the move towards ever stringent and hence protective guideline values.
The slide shows the percentage of children with blood levels above 10 micrograms per deciliter (2002). Blood levels above 10 µg/l are a serious cause for concern. and the percentage of children who would gain 1.95 or more IQ points over a lifetime if not exposed to lead. It shows that, although guideline values have been established for a considerable time in the water area, this is not sufficient to control overall health impacts.
A limited approach, in an increasingly complex environment

- WSH develops GV for appr 30 chemicals from agricultural activities …
- But over 800 pesticides are currently registered in the European Union

This presentation has till now illustrated how GV are determined for certain xenobiotic components, and how even the derivation of ever stringent GV is not sufficient to permanently address the health consequences, the matter becomes even more complex when one compares the painstaking work of GV development against the rush towards an ever more complex chemical environment.

The EU is globally largest chemical producing area in the world, with EU chemical industry grew faster than GNP in the 1990s.

The speed and complexity of the development and use of chemical products over the past few decades did not allow knowledge of environmental and health effects to keep pace. Knowledge on toxicity and ecotoxicity remains poor for many chemicals. Often in dealing with xenobiotics one is forced to work under conditions of uncertainty and precaution has to be brought into play. Although the derivation of guideline values includes elements of precaution, the mere quantity of chemicals present in our environment impose limitations to a ‘test everything’ approach. This uncertainty needs to be recognized.

Managing under conditions of uncertainty becomes unavoidable, calling for the application of precaution …

But science still has a role to play, as the example of the PCB’s shows

Source: EEA Europe’s environment: the third assessment chapter 17 Chemicals and GMOs
Paradigm shift: reaction to precaution

Modern risk factors become more complex, far reaching in geographic and temporal scale, and uncertain in their effects. Science needs to inform policy from a strategy of ‘reaction’ to a strategy of ‘precaution’.

- The PP encourages policy makers and public health professionals to consider how to account for growing complexity and uncertainty. Evidence supports that contemporary environmental health risk results from complex interactions amongst genetic, nutritional, environmental and socio-economic factors. The PP can be used to encourage research, innovation, and cross-disciplinary problem solving in the face of these complex risks.

- There is a great need to fill gaps in our knowledge, but while waiting for the gap to be filled, we must make decisions based on the best available evidence while acknowledging that uncertainty remains. Thus, there is no contradiction between pursuing scientific progress and taking precautionary action.

- Socio-economically disadvantaged countries have special environmental and health problems and need to be acknowledged.

- Flexibility is critically important, what is “acceptable” depends not only on the level of risk and the strength of the evidence, but also on the magnitude, reversibility, and distribution of the risk, the availability of opportunities to prevent risk, the public’s risk aversion, society’s culture and values, and the pros and cons of alternative.
The previous sections summarized the work of the IPCS, and went into some detail in the work done by the water, sanitation and health unit. Both stressed the need to pay special attention to children. This will be the topic of the penultimate part of this presentation.
In the European region, concerns related to health and environment are addressed through a system of Ministerial Conferences on Environment and Health, the most recent one of which was held last year in Budapest, Hungary. With a near complete presence of WHO Member States, Ministers reviewed progress made since the 1999 Conference, discussed policy making tools that would address children, environment and health, adopted a ministerial declaration, and expressed their political decisions through the adoption of a children environment and health action plan (CEHAPE). This development was endorsed by the European Union in a separate declaration, and by the WHO Regional Committee.
Ministerial declaration

- “We are increasingly concerned about the effects on children’s health of unsafe and unhealthy environments. We understand that developing organisms, especially during embryonic and fetal periods and early years of life, are often particularly susceptible, and may be more exposed than adults, to many environmental factors, such as […] chemicals, contaminated and polluted water … .
- Boys and girls may also differ in susceptibility and be differently exposed.
- Children living in the poorest countries and belonging to the most disadvantaged population groups are at the highest risk.”

The senior decision makers in our region recognized the danger posed by chemicals to the environment in general and to children in particular. Although it requires three slides, I would like you to take the time and read through them.
Ministerial declaration

- “6. We note that in the European region … about one third of the total burden of disease from birth to 18 years can be attributed to unsafe and unhealthy environments in the home and the broader community, resulting in significant social and economic loss.

- Exposure to contaminated water … can cause gastrointestinal … diseases, birth defects and neuro-developmental disorders, all of these accounting for one sixth of the total burden of disease.”
(d) Finally, there is concern regarding the potential for long-term toxicity, including carcinogenic, neurotoxic, immunotoxic, genotoxic, endocrine-disrupting and allergenic effects of many chemicals. We are particularly concerned about the effects of … persistent organic pollutants (POPs), (and) heavy metals … that contaminate the environment and to which men and women of reproductive age as well as children may be exposed.”
“Regional Priority Goal IV. We commit ourselves to reducing the risk of disease and disability arising from exposure to hazardous chemicals (such as heavy metals), (...) and biological agents ... during pregnancy, childhood and adolescence.”

Ministers and the European Union adopted the Children Environment and Health Action Plan which stipulates in its regional priority goal 4 countries commit ourselves to reducing the risk of disease and disability arising from exposure to hazardous chemicals (such as heavy metals), (...) and biological agents ... during pregnancy, childhood and adolescence.”
The work on children, environment and health aims to address challenges related to the presently incomplete knowledge of environmental health impacts in the early stages of development, and on the health impacts of multiple stressors, and to use this new knowledge as a basis for actions aimed at protection the future generations.
It is important that such new knowledge is gained taking into account the variations in development that characterise our region. It is a common misconception to think that in Europe all problems are solved because we are all industrialised and rich countries. The map shows the countries of the WHO European region by HDI quintile. The region is very far from homogenous, and ample room exists for cooperative study across human development levels.
The results of appropriate research studies can be used to implement prevention/remediation strategies and put in place evidence-based public health policies at the country level. These collaborative activities also result in technology transfer and capacity building, and in the build up of a network of trained scientific collaborators throughout the developing world. However, several steps need to be done to develop long-term children health survey
Precautionary principle

- Determine whether an uncertain risks merits a more thorough review
- Define problems to capture root causes of risks
- Consider all relevant evidence (interdisciplinary)
- Examine gaps in information and identify research and other ways to reduce uncertainty
- Identify options to reduce risks
- Determine action based on evidence and public review
- Determine follow-up

As stated earlier, precaution will need to be used in developing guidance for the protection of children from an ever-more complex chemical environment. The steps in applying precaution to the health of children includes:

- Determining whether an uncertain risk/problem merits a more thorough review – whether there is sufficient evidence to indicate a potential problem, or whether the cost of review is disproportionate to the cost of considered actions, including inaction.
- Broadly defining problems to capture root sources of risks, where appropriate
- Considering and examining all relevant evidence on exposure, hazard and risk in an interdisciplinary manner and taking account of variability as well as relevant direct, indirect, cumulative and interactive effects; this can include conducting routine health and environmental monitoring to provide a baseline understanding of health and ecological impacts, as well as health trends
- Considering the application of simplifying rules of thumb, safety factors, default values, or proxy indicators of exposure and effects when information is lacking.
- Comprehensively examining uncertainty and gaps in information, performing sensitivity analysis and identifying research and other ways to reduce uncertainties and gaps in knowledge where appropriate.
- Examining a wide range of options to reduce risks, as well as their trade-offs, advantages and disadvantages.
- Determining an appropriate course of action based on scientific evidence, the examination of alternatives, and public input. A wide variety of policy tools to implement preventive or protective actions should be considered, along with their economic, technical and political feasibility.
- Instituting post-implementation follow-up procedures to ensure continuous risk reduction and understand the positive and negative aspects of interventions
CONCLUSIONS

Scientific research needed to:

- Manage under conditions of uncertainty
- Identify priority xenobiotics by impact on human health esp. children and environmental effects
- Sources, upstream management, fluxes
- Risk management methods: assess current and optimize
- Supporting issues (methodology)
In this presentation, we opened by highlighting the similarities between the work done by WHO in the context of the Protocol on Water and Health, and the COST approach enabling cooperation between nationally-funded research programmes. The rest of the presentation brought elements of common concern, particularly related to children’s health in an ever more complex chemical environment. I trust that this presentation will have made a first contribution towards exploring possibilities for a mutually beneficial cooperation.