INTARESE Technical brief

Integrated Assessment of Health Risks of Environmental Stressors in Europe

Introduction

Most of us take it for granted that we can turn on a tap in our home or office and have safe drinking water. Yet even in Europe there are over 120 million people who don't have access to clean drinking water.

The hazards of untreated, unsafe drinking water are well-known and researched. Microbial contamination in untreated water can lead to many kinds of disease and may contribute significantly to mortality.

Treatment of sources such as ground and surface water is vital to produce safe drinking water. The treatments used to remove microbial contamination, such as chlorine disinfection, may themselves produce disinfection by-products (DBP) such as trihalomethanes (THMs) in the water. European regulations dictate the levels of DBPs that are considered safe for consumption.

The members of the water assessment work package saw a clear need for an integrated assessment of drinking water contaminants using the INTARESE approach. Currently, the research carried out for setting regulatory limits for disinfectant by-products in drinking water is based on toxicological (animal) evidence. The uncertainty factors incorporated into this type of evidence may make it an unreliable basis for estimating health impacts related to exposure to these chemicals.

An assessment based on epidemiological research was considered to provide a more realistic indication of the risks involved and so the water team began their first case study.

Our water resources are affected by many types of policies

The first phase case studies are trial runs of the INTARESE methodology applied to different policy areas. "The field of water policy is broad and our water resources can be affected by many different measures, not necessarily directly related to water" explains James Grellier, deputy work package leader and researcher at Imperial College London.

James Grellier

It's not just the health risks from current levels of contaminants in drinking water that need to be assessed. Our water sources are affected by so many different policies, many of which are not directly aimed at improving health.

The effect of climate change on water supplies, for example, may be considerable. As the climate changes and water resources dwindle, particularly in the Mediterranean, alternatives are being sought. These are climate-driven policies that are likely to have unintended impacts on health. Spain in particular is a good example of how climate change is driving water policy. Recent severe water shortages are leading politicians to consider alternatives, moving away from ground water to surface water sources.

Using surface water complicates the treatment process, as it contains much more organic matter and pollutants than ground water. In turn, the enhanced treatment

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process may mean more health risks for the people drinking the treated water.

It's not just climate change that impacts water-related policies – urbanisation, increased domestic use and marketing of bottled water are among many other factors.

The first step in the INTARESE methodology is scoping, deciding the particular areas to look at. With such a wide range of areas to assess and problems to look at in the arena of water policy, this step was absolutely crucial in defining a case study that would produce relevant, timely and informative results.

Problem framing

In order to define the area to study, the involvement of stakeholders is vital. One of the key outputs of INTARESE is to produce something that's useful to other people and there's no way to do that without knowing who the other people are or what they want.

"The original uncertainty in the definition of the problem is the most important." explains James "There's no way of quantifying it later on in the process, so you need people involved from the very beginning. Are we looking at the issues in the right way? Not all stakeholders want to look at the same things."

The water case study team invited everyone with an interest in water-related policies to be involved in deciding what areas to research.

Over five European countries were involved, with water companies and environmental agencies from each being asked to join in. At the European level the World Health Organisation and European Union were also involved.

With input from the stakeholders, the first phase water case study decided to use the INTARESE method to look at the health risks of chemically treated water through epidemiological data. This could then be used as a baseline study, building up a better database for future users of the INTARESE toolbox, and providing a comparison study for alternative policy scenarios in future assessments.

The main contaminants in drinking water were found to be from four main sources:

- Agriculture – nitrates, pesticides, pathogens, ethylene dichloride
- Water treatment and distribution – disinfectant by-products, lead, pathogens, ethylene dichloride, polycyclic aromatic hydrocarbons
- Industry – carcinogens, endocrine disrupting chemicals
- Geology – arsenic, uranium

"You need to involve the people affected from the very beginning. Not all stakeholders want to look at the same things"

Representative examples were selected from these to reduce the uncertainties involved. This first case study focused on the health impacts of exposure through drinking water to arsenic, disinfectant by-products and nitrates.

In addition to the contaminants being identified, the health effects of interest needed to be selected. The health effects most often associated with contaminants in treated drinking water, and those looked at here, are bladder cancer, methaemoglobinaemia ("blue baby syndrome") and small for gestational age babies.

Building up the assessment toolkit

The first phase case studies are being used not only to test the INTARESE methodology, but also to build up the data and resources that will be needed when the toolkit is being used by people to assess the impact of various policies.

The current EU regulatory limits are largely based on the results of toxicological studies. Basing this case study on epidemiological research was important for reducing the uncertainties associated with toxicological studies.

"Toxicological exposure-response functions (ERFs) have arbitrary protective uncertainty factors added, such as a multiplier of 10 to account for the difference between health effects on animals and humans. Epidemiology based studies are more reliable when estimating the magnitude of impacts, although exposure can be hard to estimate accurately" says James.

The accuracy of a health assessment is entirely dependent on the availability and accuracy of the data it's based on.

While ERFs linking concentrations of contaminants in drinking water to health risks were available for some of the substances investigated, there was no consensus in the epidemiological literature on disinfection by-products and adverse birth outcomes relating to fetal weight and growth. The team carried out a meta-analysis of the existing evidence and obtained exposure-response information for "small for gestational age", the outcome of interest.

The ERFs for the relevant contaminants and health effects derived by INTARESE will provide a basis for future integrated assessments. In the course of their work, the group also investigated the uncertainties associated with using such ERFs, and reported on the limits to using such exposure-response data in health impact assessment.

"The literature we used to derive an ERF for the effect on small for gestational ages is limited in quantity and quality. The results we've produced are novel," expands James. "Now that we have the ERFs, we can use them in future integrated assessments."

Once the ERFs had been calculated from the literature analysis, the actual health assessment could begin. Computational simulations were used to calculate the number of cases above what would normally be expected for each health effect and contaminant. Monte Carlo techniques were used in the Analytica software to build probabilistic causal models.

Key to the reliability of the results were the importance analyses, carried out to quantitatively analyse the uncertainties throughout the model. The uncertainties in all the assessments were found to be considerable. Using the Monte-Carlo techniques provided useful information on the uncertainties that could be quantified, enabling the team to show how uncertainties at different points along the chain contributed to a large but quantifiable uncertainty in the results.

Other uncertainties that were not immediately quantifiable were investigated qualitatively, looking at the uncertainties that may have arisen from structural issues such as the definition of the problem, from the application to actual European populations of the ERFs generated through meta-analysis, or the reliability of the data regarding exposure to drinking water.

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Looking to the next stage

The INTARESE water team are looking at how the second phase case study will build on the first phase and their connections with other European research projects.

Antonio Gasparrini

The first phase water case study has provided a reliable base for the next stage of the INTARESE project as well as a link between water policy and disability adjusted life-years.

"This case study has produced a flexible risk assessment model that we can improve upon in the second phase." explains Antonio Gasparrini from the London School of Hygiene and Tropical Medicine.

The second phase case study will build on recommendations from this one, including extending the assessment to other countries, assessing alternative policy scenarios and including private supplies in the assessment.

With so many large policy areas to look at, INTARESE understands the importance of working with other projects in order to get the data needed to base reliable assessments on. The HIWATE project is another European project, looking at the relationships between exposure to treated water and health effects. Its focus means that INTARESE can benefit from the ERFs it develops and it can benefit from the models developed by INTARESE.

Another European project, HEIMTSA, will use the second phase assessment as part of a larger integrated policy assessment across Europe.

With the results from the first phase assessment and collaborations with other European projects leading to the development of integrated assessment tools, INTARESE is paving the way for future integrated assessments and a clearer view of the health implications of policies.

Subscriptions to the INTARESE TECHNICAL BRIEF can be requested at http://www.intarese.org/

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