



## Integrated Assessment of Health Risks of Environmental Stressors in Europe

### Introduction

The end goal of the INTARESE project is a toolbox that people can use to assess the environmental and health risks and consequences of different policies. Such a tool will be invaluable to those people who'll be using it to make policy-based decisions, potentially affecting the health of entire communities.

But whilst hiding all the background information of data, models and calculations under a layer of abstraction means a better user experience, how can they

be certain that the information they are basing their decisions on is relevant and takes into account any uncertainties in the assessment?

Two work packages are helping to address the issue to ensure the toolbox user has confidence in their assessment. The integrated monitoring team are looking at the data currently available, identifying any gaps and working with other teams to make sure it's as comprehensive as possible. The uncertainty assessment

team are making sure that all uncertainties in an assessment are considered. Uncertainties that aren't easily quantified, such as the quality and relevance of the data available, are often overlooked in favour of quantifiable uncertainties such as sampling error.

With their results, users of the INTARESE toolbox will be secure in the knowledge that the data they are basing their decisions on is the best available and any shortcomings are acknowledged.

### A unique approach to a global problem

**There are many projects across Europe dedicated to monitoring the effects policy has on health and the environment. But INTARESE is the first of its kind to look at monitoring across more than one policy area and the whole of Europe, as researchers from Work Package 2.4 explain.**



Dr. Alena Bartonova

Monitoring is defined in the Oxford dictionary as 'watching a situation carefully for a period of time to discover something about it.' It's been used in the environmental area for many years, with diverse types of data, from river water quality to air pollution, being recorded and studied over periods of time.

Different types of monitoring focus on different areas, and integrated monitoring is a natural combination of established practices such as environmental and bio monitoring. Whilst bio-monitoring looks at the concentrations of toxic compounds in biological substances, and environmental monitoring looks at the quality of the environment, integrated monitoring has a wider focus and aims to incorporate all areas

of monitoring.

Hai-Ying Liu, of the Norwegian Institute for Air Research (NILU), explains: "When INTARESE started, we looked at what other projects and countries were doing in the area of integrated monitoring. We realised that our approach is quite unique and we needed to define exactly what integrated monitoring is."

Many other countries already have existing monitoring programmes, but they generally all focus on one aspect of the problem – monitoring the environment, ecosystem, or human health, but seldom integrating all. INTARESE aims to be one of the first projects to assess existing monitoring programs in all the areas relevant to an environmental

health risk assessment on the European scale.



Dr. Hai-Ying Liu

Available data, such as the concentration of a chemical in the environment, on its own doesn't provide enough information for us to assess risk. It needs to be related to the health impacts to provide any meaning to an assessment. Integrated monitoring is a way of ensuring the data is combined to provide relevant and comprehensive assessments linking the environment and health.

The first task for the team was to define what integrated monitoring is in terms of the INTARESE project. "There was no definition of integrated monitoring when we began," explained Alena Bartonova, from the NILU and leader of WP 2.4. "so we had to look at what we wanted to achieve. Realistically, it can't be everything – we had to keep it goal oriented and relevant to the policy nature of INTARESE."



Dr. Maria Dusinska

The definition the team settled on was an 'ongoing and systematic process to determine, analyze and interpret environmental quality and environment-related health status'. "We need to understand the mechanisms by which different environmental stressors contribute to environmental diseases and human welfare on population and individual levels." Says Dr Maria Dusinska, also at the NILU.

This means that the INTARESE integrated monitoring team is developing the novel concept of monitoring entire systems rather than their individual components. It will also address the spatial and time dimensions and monitoring processes, all the while keeping the end goal of assisting decision making in mind.

### Linking it all together

Ensuring the quality of the data available means finding gaps in the current knowledge. An integrated environmental health assessment relies on linking the environmental data to the expected health

impacts, but this information is often lacking. The team have been studying the methods used to link data to find out what needs to be improved.

The three areas of data linking each have many methods, and the team need to look at them all. Physiologically or biologically based pharmacokinetic (PBPK or BBPK) models are used to link internal exposure and dose data, whilst multiple tools are used to link dose and health effect data, including spatial statistics and dose-response assessments. The third group, linking hazards, exposure and health effects uses methods such as Bayesian belief networks and geographical information systems.

"Once we find the gaps, we can start to develop a model to extrapolate the information ourselves with consultation from other researchers," says Alena. "Knowledge of the gaps becomes particularly important when assessing the uncertainty of the data."

### Monitoring the monitored

A truly integrated assessment needs to combine data from the many already existing monitoring programmes. Combining this data poses many challenges to researchers, from the quality of the data to actually obtaining it. With many agencies and countries involved in monitoring programmes, getting data from them is difficult – costly, time-consuming and sometimes legally restricted. Different computer systems and formats for data storage are also a major challenge to data compatibility. Once the data has been obtained, the quality and accuracy of the data from other programmes cannot always be guaranteed and data sets may also be fragmented.

"We need to overcome these challenges," says Alena. "to be able to link together existing monitoring data from different sources for an integrated environmental health impact assessment. There's no single solution to this problem."

## Defining the undefinable

**Whilst integrated monitoring ensures that all relevant data necessary for an integrated assessment is obtained, determining the quality of the assessment based on that data is crucial to providing a solid foundation upon which to develop policy scenarios.**



Dr. Martin Krayer von Krauss

Many data sets used in integrated environmental health risk assessments use underlying assumptions that are hard to quantify. It's vital to know the uncertainty of all assumptions used in the model in order to determine the quality of the results. This is even more important for an end-user product like the INTARESE toolbox –how can policy makers rely on the results of their assessment when they may not be experts in that field?

Researchers in work package 1.5 are looking into ways to assess the uncertainty of some of the information in the more unquantifiable areas. These areas stem from steps in the assessment including the definition of the problem and the assumptions used in the data and model. The novel methods must complement traditional ones used for quantitative uncertainties, such as the Monte Carlo and Bayesian methods.

“Once we have the framework in place and tested it on the INTARESE case studies, it can be used as guidance for the users of the INTARESE toolbox to determine the uncertainty of their own assessments.” explains Dr Martin Krayer von Krauss of the European Centre for Environment and Health at the World Health Organisation, and deputy leader of WP 1.5.

“We've looked at the key areas – what the knowledge is used for, the criteria the quality can be judged against, and who should do the judging. The uncertainty in each assessment will be dependent on the context and stakeholders.”

### Putting it into context

The quality of knowledge can only be judged when put into the context of its purpose. Because the INTARESE method is using integrated assessments to help develop policies, all knowledge for those assessments is used in a policy rather than research context. Research in a policy context has the added complication of potentially being subject to political whims and aims. Knowledge used must be policy relevant, technically credible and politically legitimate to avoid becoming the subject of debate itself.

The context the INTARESE knowledge will be used in only emphasises the need for an accurate assessment of its uncertainty. With the potential for the knowledge itself to be used as a tool in a political debate, transparency in the process is crucial.

Researchers within WP 1.5 have responded to this need by devising a set of criteria to measure the quality of knowledge, that will be used by all parties involved to ensure the knowledge is the best possible for the situation.

Scientists traditionally focus on the quantitative uncertainties in their data, arising from problems such as sampling or measurement error. Integrated assessments also have to consider the often-ignored qualitative uncertainties, from areas such as the assumptions used in the models and poorly-defined problems, which can fundamentally alter the meaning and validity of any assessment.

## What to assess

INTARESE has defined nine criteria that knowledge must be assessed by. Criteria can score from one to four, with higher scores representing lower uncertainty.

- **Method** – the more rigorous the method used to produce, check and revise the data for the values of a model variable, the higher the score.
- **Empirical basis** – knowledge is scored higher for larger sample sizes, the degree to which it's based on measurement and observations, and whether it was collected under controlled circumstances.
- **Degree of validation** – data that's been independently reproduced and validated will score higher.
- **Level of uncertainty** – the extent to which we know the range of values for the model variable.
- **Applicability and relevance** – if the information available is actually the information needed, it will score higher. If it doesn't correlate well or needs much extrapolation, the score will be lower.
- **Importance of variable** – the bigger the effect on the outcome from a minor change to the model variable, the higher the score.
- **Source of information** – how reliable is the information source – did it come from peer-reviewed journals or a publication from an interest group?
- **Colleague consensus** – disagreement between researchers in the same field will increase the uncertainty of the data.
- **Stakeholder acceptance** – do the other (non-expert) stakeholders accept the data?

With a strong criteria list in place, the project members can get on with actually assessing the uncertainty in their data and preparing examples based on the INTARESE case studies.

## We'll be the judge of that

Perhaps the most difficult area is deciding who should judge the quality of the knowledge as many of the criteria are subjective.

"Different people will have different views on the relevance and reliability of the knowledge, depending on their background," says Martin. "It's good to have differing opinions, but it does pose more of a challenge presenting the results of the uncertainty assessment because a single conclusion just isn't possible. But when you're talking about policy decisions that affect everyone, you have to communicate the disagreements in the assessment too."

So the work package has embraced this by involving all the INTARESE stakeholders in the judging process. From policy makers to scientific experts, every stakeholder in the project will be represented. Such a diverse group of people with different backgrounds and experience will result in a wide range of scores, from which trends will be identified and the quality of the knowledge determined.

The members of WP 1.5 are aware there's a lot at stake here.

"Traditionally there's tension in the research community between the two approaches to uncertainty – quantitative and qualitative," explains Martin. "Scientists are more comfortable with qualitative techniques like Monte Carlo simulations. Our approach to unquantifiable uncertainties is messier – it involves talking to people and doesn't result in a final number."

As Martin puts it: "The risk of only looking at the numbers is that you create an impression of certainty when it's anything but."