SIM-E&H – IT TOOL FOR THE ENVIRONMENTAL HEALTH RISK ASSESSMENT

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The system SIM-E&H presented in this paper promote an integrated approach of the causal connection between environment and health based on knowledge management principles, and two categories of practical results: a modern information system based on Web server technology, and a set of direct effect tools used to prevent or reduce environmental risk.

The aim of SIM-E&H is to improve knowledge of the links between environmental exposures and four priority diseases, to exchange ideas about best practice and to help identify emerging issues on environment and health, to facilitate the transfer of scientific knowledge to policy development, and to strengthen the integration of the research results into relevant policy measures.

Keywords: environment, health, risk assessment, IT tool.

1. Introduction

It is remarkable the high quantity of information and knowledge patterns implicit in large databases coming from the monitoring of any system or dynamical environmental process. In this context is imperious necessary to design and develop a tool for environment and health data analysis and implicit knowledge management of databases with special focus on relations between the human health and the environmental factors [5].

The SIM-E&H system presented in this paper is a comprehensive system of collection, processing and evaluation of information on environmental contaminants and their effects on population health, based on knowledge management principles. SIM-E&H may provide high quality background data for decision-making by the national and local authorities in the field of health care policy, health risk management and control, and environmental protection [8].

The system SIM-E&H promote an integrated approach of the causal connection between environment and health, and two categories of practical results: a modern information system based on Web Server technology, and a set

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of direct effect tools used to prevent or reduce environmental risk (personal kits for UV and radioprotection).

While it has been possible to establish links between the health effects and some individual environmental factors, no clear overall picture of health impacts resulting from complex, real life exposure is available. SIM-E&H aims to achieve a better understanding of the environmental threats to human health to identify the disease burden caused by environmental factors in Romania, and to plan policy responses to the challenges that emerge. In line with the European Environment and Health Strategy, SIM-E&H focuses particularly on the links between environmental factors and four priority diseases: respiratory diseases, neuro-developmental disorders, cancer and disruption of the endocrine system.

2. IT techniques used by SIM-E&H

Reliable information of the environment, population health and their linkages is essential to optimally prioritize, develop and evaluate policies and actions in order to reduce hazardous environmental exposures and their health effects. The SIM-E&H objective is to establish a comprehensive information and knowledge system that generate and analyze environmental health information to support specific activities.

In minimizing the risks for human health from environmental factors it is important to gather more and better information on a coherent basis, and to communicate available information in a usable way to all citizens. It is important to better understand what drives public perception of risk so that we can properly manage risk communication and thus ensure that the hazards present in the environment are understood by those who need to be aware of them.

Almost all actors involved in environmental and health knowledge management are operating or implementing computerized systems for environmental and health information processing. The proper and efficient operation of the SIM-E&H system according to the European and other international rules needs to develop a global IT system and specific purpose equipments for all the involved partners. The open architecture of the system, the structure of the databases and corresponding computer programs enable the collection of results from the research network involved in this activity.

The information system is employed for the input, storage, structuring, integration, retrieval, and the presentation of various kinds and forms of environmental and health information such as raw measurement data, description of environmental and health issues as well as documents such as environmental regulations or literature references. The fundamental elements of the SIM-E&H information system include databases, data retrieval and data entry modules, a website for the visualization of the information, and results and reporting tools.

The website displays information about environmental-health themes together with texts, graphs, maps, fact-sheets and methodology sheets (fig.1).
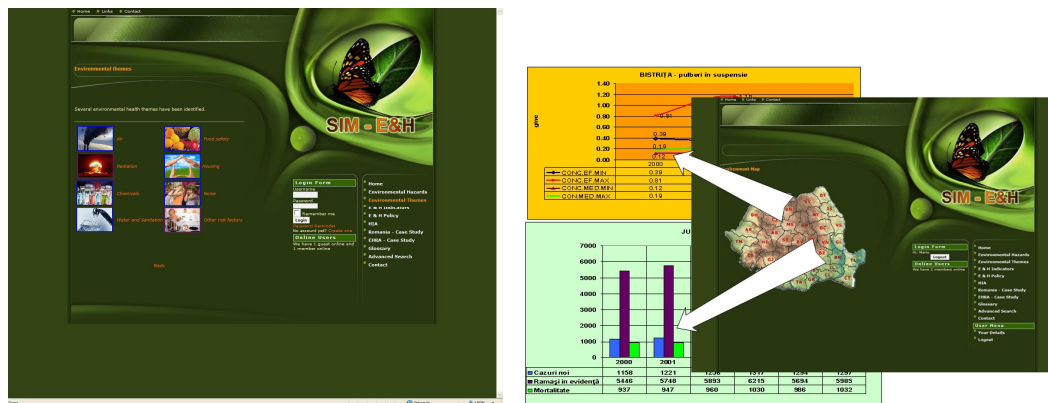

Fig. 1. Environmental-health themes presented by the SIM-E&H system

SIM-E&H uses a Geographical Information System (GIS) to give a new dimension to the representation of its data to perform analyses. GIS can determine geographical distribution and variation of diseases and of the environmental factors, and their prevalence and incidence [4].

The system itself represents, as a Web server, an effective tool for disseminating the environmental and health information. SIM-E&H provides citizens and professionals with access to information, and also exchanging information, data and knowledge as well as good practice examples benefiting public health and the environment.

3. SIM-E&H and the environmental health risk assessment

Environmental health risk assessment may be defined as "assessments that provide complete environmental health information to risk managers, policymakers and regulators, from which they can make the best possible decisions about policy and safety" [2]. Environmental health risk assessment provides a tool for appraising health risks in the broader process of Health Impact Assessment (HIA).

Environmental health information is needed by decision-makers and the public to identify and quantify existing and potential environmental health impacts, set priorities and develop and evaluate policies to prevent or diminish these problems [3]. Environmental health assessment efforts therefore need information not only for the diseases that are environmentally related, but also for potential environmental hazards and exposures that pose a risk to human health.

The way people perceive risks is often subjective and intuitive and they frequently view risks in a way that differs from scientific assessments. Therefore, the quality of information is greatly influenced by the attitude and perception by an individual and even by the society in general. At the level of the individual, perceptions would determine whether or not appropriate actions will be taken, while at the societal level, these would drive the agenda of regulatory agencies and may lead to policies that affect the safety, cost and even the existence of many products and technologies.

The estimate of risk is usually referred to as a "risk assessment." The term "risk assessment" refers to both the entire process of estimating risk-problem identification, exposure assessment, toxicity assessment, and risk characterization - and to the estimate itself. Assessments of environmental human health risks combine information on the amount of a substance humans are exposed to and the toxicity of that substance in order to state what is likely to happen.

Risk assessment is a scientific process of evaluating the adverse effects caused by a substance, activity, lifestyle, or natural phenomenon. Ideally, risk assessments are science-based estimates of the human health risk faced by a population exposed to a particular substance, and the risk should be stated as a range of probabilities. There are various models available for the environmental health risk assessment. The US National Academy of Sciences (1983) model is used in the development of risk assessment processes and considered influential as a template.

The risk analysis process has two major aspects: risk characterization and risk management. The **risk characterization** process involves integrating hazard identification, hazard characterization and exposure assessment outcomes. The process of interpreting and integrating the information on hazard and exposure to provide a practical estimation of risk is a complex activity and needs to establish an acceptable risk and how this risk should be managed. The **risk management** involves risk evaluation, which addresses the fundamental socio-economic problem of determining the optimal level of risk in society based on a trade off between risk, cost and benefit. Risk management also involves monitoring, evaluating and reviewing the implemented strategies.

Risk assessment is an iterative process that will be reviewed as the risk assessment progresses. After risk assessment is completed there may be a need to review the situation from time-to-time as new information becomes available or circumstances change to ensure that the risk assessment is still relevant and protective.

Risk assessment is characterized by uncertainty. Although scientists have learned much about environmental contaminants, limited data and knowledge still require researchers to make assumptions throughout the risk assessment process.

The results of a risk assessment should report what assumptions were made as well as the type of harm and its magnitude.

While clearly there has been very long interest in comparing risks posed by different threats to health, formal frameworks have been developed. Risk assessment has its roots in the environmental sector, where it was developed as a systematic way of comparing environmental problems that pose different types and degrees of health risk. Environmental risk assessment exercises generally comprise four elements:

1. **Hazard identification -** identifies the types of health effect that can be caused, based on toxicological data from laboratory or epidemiological studies.
2. **Exposure assessment -** combines data on the distribution and concentrations of pollution in the environment with information on behavior and physiology to estimate the amount of pollutant to which humans are exposed.
3. **Dose-response assessment -** relates the probability of a health effect to the dose of pollutant or amount of exposure.
4. **Risk characterization** is the result of all work done during the previous phases. During risk characterization, the assessor uses the results of analysis to estimate the risk posed to ecological entities and human health.

From public health point of view, in case of many environmental hazards, total elimination of health risk is not possible. In practice, the priority target should be efficient health protection of populations particularly sensible to specific environmental hazards: children, pregnant women, and elderly people.

In this context the SIM-E&H system represents an effective tool for the environmental health risk assessment and results dissemination. SIM-E&H provides citizens and professionals with access to information, and also exchanging information, data and knowledge as well as good practice examples benefiting public health and the environment.

4. SIM-E&H and the risk assessment for toxic air pollutants

The SIM-E&H system provides a range of health-related information on outdoor, indoor and personal exposure to air pollution. The aim of this information is a practical understanding of how the people can be exposed to different types of air pollution, what air pollutants they are exposed to, and the possible health effects from exposure and what the people can do to minimize or avoid exposure to air pollution.

The human health effects of poor air quality principally affect the body's respiratory system and the cardiovascular system. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, the individual's health status and genetics. The health effects caused by air pollutants may range from subtle biochemical and physiological changes to

difficulty breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and even premature death.

Air pollution can affect our health in many ways with both short-term and long-term effects. Different groups of individuals are affected by air pollution in different ways. Young children and elderly people or people with health problems such as asthma, heart and lung disease are much more sensitive to pollutants than are others. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging pollutants, i.e. the duration of exposure and the concentration of the pollutants must be taken into account [7].
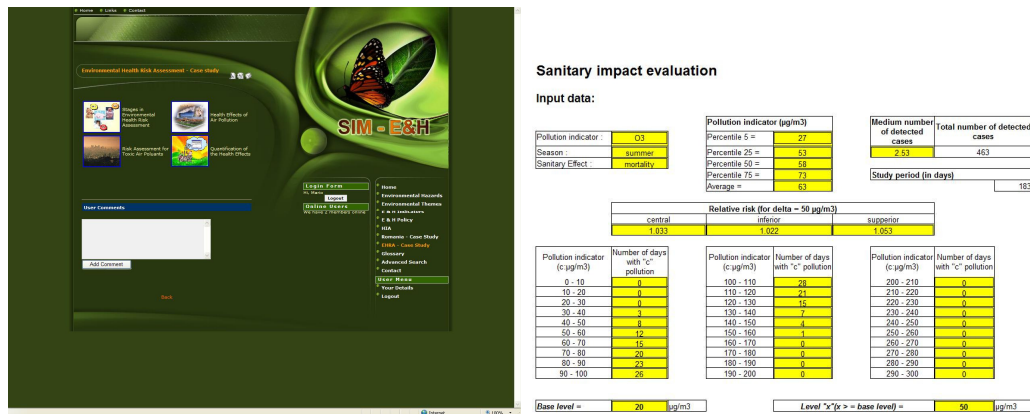
Fig. 2. The Environmental-Health Risk Assessment – Case study

A risk assessment for a toxic air pollutant combines results of studies on the health effects of various animal and human exposures to the pollutant with results of studies that estimate the level of people's exposures at different distances from the source of the pollutant. The estimates provided by these risk assessments are far from perfect, but they do help scientists evaluate the risks associated with emissions of toxic air pollutants.

Scientists and decision-makers use a **four-step risk assessment process** to estimate people's increased risk of health problems as a result of exposure to a toxic air pollutant [7]:

1. **Hazard identification** - evaluates all available information about the effects of a toxic air pollutant to estimate the likelihood that a chemical will cause a certain effect in humans.
2. **Exposure assessment** - is used to determine how much of the pollutant people are exposed to and/or how many people are exposed.

3. **Dose-response assessment** - estimates the dose-response relationship, which mathematically shows the change in the likelihood of health effects with changes in the levels of exposure to a toxic air pollutant.

4. **Risk characterization** - risk information is presented in different ways to illustrate how individuals or populations may be affected.

Uncertainty can be introduced into a health risk assessment at every step of the process. Uncertainty occurs because risk assessment is a complex process, and by their nature, risk estimates cannot be completely accurate. The main problem is that scientists don't have enough information on actual exposure and on how toxic air pollutants harm human cells.

As evidence of health effects of air pollution has accumulated, it is necessary to quantify the health effects of the air pollution. European governments, the World Health Organization (WHO), and other groups have begun to use data from these studies to inform environmental policies through, for example, quantitative estimates of impact of air pollution on public health.

Health impact assessment involves extrapolation of exposure-health associations measured in epidemiological studies to a target population characterized by a certain observed or predicted exposure pattern. The analysis must address important methodological issues relevant to both its design and conduct [10].

Since 1997, the Air and Health Surveillance Program (PSAS-9) has implemented an epidemiological surveillance system estimating short-term exposure-risk relationships between urban air pollution indicators and health indicators in France. Support by the National Institute for Public Health Surveillance (Institut de Veille Sanitaire - INVS), this program aims to provide health professionals with risk estimates and calculation tools for local urban health impact assessment. PSAS-9 is also part of European program such as APHEIS [1].

In this context, the SIM-E&H system uses the concepts underlying the health impacts assessment of air pollution, and the methodological guidelines recommended by the French air pollution and health surveillance program restricted to the health impacts assessment of outdoor urban air pollution. The method allows the quantification of the air pollution health effects as a number of attributable cases in the general population (fig.2). The methodological guidelines and the Excel spreadsheet developed by the INVS are in accordance with the World Health Organization orientations. The EIS-PA software allows the generation of a standardized HIA, for several air pollution and health indicators, and related to several scenarios.

The users can be able to calculate a type of risk and an expected number of cases, and to apply the risk assessment method in the air pollution context and to know its relevance and limits [1].

5. Conclusions

The SIM-E&H system presented in this paper try to assure the improvement of the information chain, to strengthen research on environment and health, to identify emerging issues for filling the knowledge gap on the link between environment and health, and to quantify the response by raising awareness, risk communication and education.

SIM-E&H bring together scientists and experts from a wide area and improve communication between all levels involved in the problem of environmental monitoring and public health. SIM E&H will serve as an information tool in the field of health and environment for different user groups, including policy makers, interested citizens and environmental health professionals.

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