Radiation in perspective: Improving comprehension of risks

Report of an international conference that explored why radiation risks are so commonly misunderstood

by
Franz-Nikolaus Flakus

Over the past century, few nuclear issues have commanded as much public and scientific attention as those related to radiation. Based on the scientific record and public debate, one clear message has emerged: radiation's real and perceived risks are commonly misunderstood. There are significant gaps between what scientists have documented about radiation effects and what the public generally believes to be true. Communication of the facts has proved difficult at best.

At local and national levels, efforts to bridge communication gaps have been central ingredients of nuclear information programmes for many years. At the global level, the problems now are being more directly addressed. In late 1994, the IAEA co-sponsored the first major international meeting principally devoted to the comprehension of radiation risks.* More than 400 health and regulatory authorities, social scientists, radiation experts, journalists, and nuclear communicators from 50 countries and nine international organizations attended the week-long conference. Held at the Carrousel du Louvre in Paris, it was organized at the invitation of France and hosted by the Institut de Protection et de Sûreté Nucléaire (IPSN). *(See box, next page.)*

This article highlights selected issues discussed at the conference, and offers some insights into the challenge of improving the communication about, and the comprehension of, radiation and its associated risks.

The scientific record and public perception

The conference featured technical sessions devoted to topics and case studies that have been particularly sensitive to misinterpretation in the past. Selected topics are briefly reviewed here.

Assessment of radiation health effects. According to our current knowledge, two main types of health effects induced by exposure to ionizing radiation are distinguished: effects mainly linked to cell killing (e.g. skin burns) called *deterministic effects*, and effects linked to cell modification (e.g. cancers or genetic disorders) called *stochastic* effects. Deterministic effects develop above a threshold and the severity of the effect increases with dose. For stochastic effects, the *probability* of occurrence increases with dose. Carcinogenesis involves a multistep process. A relatively long latency period is needed before clinical diagnosis can be made.

Stochastic effects of radiation are today not distinguishable from similar effects of other causative agents (e.g. tobacco, chemicals). Consequently, their occurrence can only be established in epidemiological studies comparing exposed and unexposed population groups. Effects of low radiation doses can be estimated only if a large number of persons is included in such studies. The most important epidemiological study in this context has been the one done over the past 40 years of the survivors of Hiroshima and Nagasaki. *(See box, page 10.)* Estimates of cancer risk from this survivors' study have been confirmed by other studies, including one on a large number of nuclear workers from Canada, the United States, and the United Kingdom.

Information on genetic disorders is based only on animal experiments and epidemiology could not demonstrate these effects. For the assessment of the risk represented by the carcinogenic effect of radiation, several assumptions have to be made and models have to be used. For

Mr. Flakus, who served as Scientific Secretary of the Paris Conference, is a senior staff member in the IAEA Department of Nuclear Safety.

*International Conference on Radiation and Society: Comprehending Radiation Risk, 24-28 October 1994, Paris, France. Proceedings are being published by the IAEA in three volumes, the first of which has been issued. See the *Keep Abreast* section in the *IAEA Bulletin* for ordering information.

most cancer localizations, the excess risk linked to radiation is proportional to the spontaneous cancer rate in the human population.

What late effects have been found on populations living in high altitude areas or where there are increased radiation levels, for example on monazite sands or in houses having high levels of radon? The findings of some studies reported at the conference indicate little risk of cancer induction in such groups.

Our scientific knowledge of radiation effects promises to expand in years ahead. Advances in modern molecular biology, for instance, might make it eventually possible to determine the sensitivity to ionizing radiation of an individual person and also to determine if a cancer or genetic disorder is caused by radiation or not.

Impact of radiation on the environment. A central part of this conference session concerned the protection of plants and animals. The protection of people from radiation may not always provide adequate protection to plant or animal life. This can be the case when plants and animals live near potentially harmful sources of

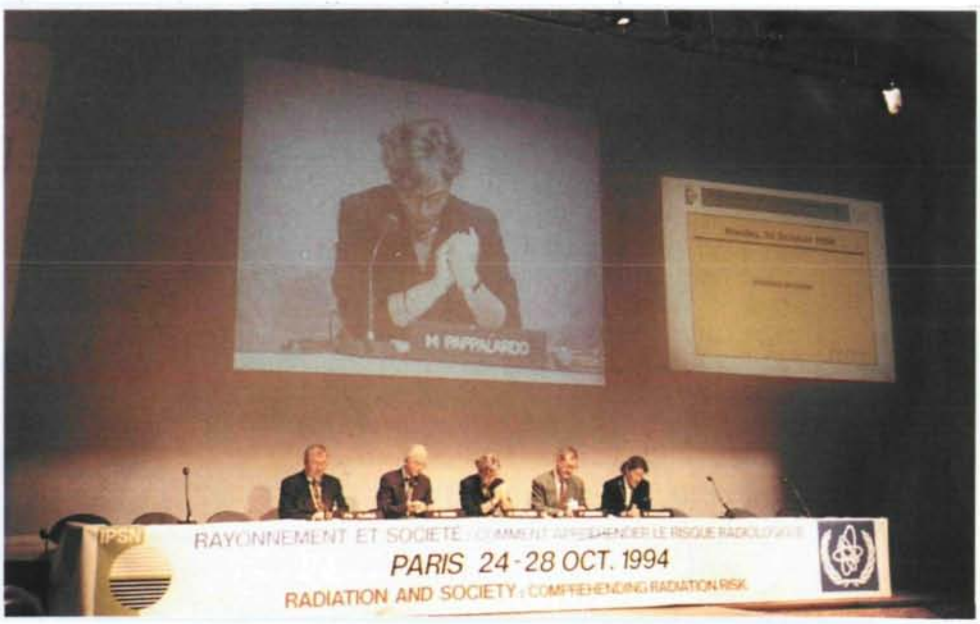
About the International Conference on Radiation and Society

The first of its kind at the global level, the International Conference on Radiation and Society in October 1994 attracted high governmental and media interest, and its format allowed for a free flow of discussion and viewpoints. Designed as a "discussion conference", the programme featured three distinct elements:

- **three "technical days", during which discussions focused on various topical issues grouped under five technical areas and five case study sessions;**
- **a "media day", which addressed topics related to the technical and case study sessions; radiation health effects in the context of environmental pollutants; communication of radiation risk; media analyses concerning controversial radiation case studies; and the media's influence on policy making,**
- **a "decision makers day", which served to explore economic, social, and political aspects in decisions involving radiation risk.**

In parallel to the plenary sessions, more than 80 scientific posters were exhibited. Prior to the conference, a set of 12 background papers was prepared to serve as a basis for the discussions. Riskkollegiet, the Swedish Risk Academy, had prepared 10 papers on comprehending radiation risks, the concept of probability, risk perception, interpreting epidemiological results, problems in radiation risk assessment, cause structure of global mortality, radiation levels, problems in risk comparisons, risk communication, and risk and ethics. Two additional background papers addressing the impact of radiation on the environment and the management of radiation risks had been prepared by France's Institut de Protection et de Sûreté Nucléaire (IPSN).

Among the conference's distinguished speakers were Madame Michele Papalardo, Director of the French Cabinet of the Ministry of Environment; P. Vesseron, Director of IPSN ; Hans Blix, IAEA Director General; and Morris Rosen, the IAEA's Assistant Director General for Nuclear Safety. Shown below, from left to right, are F.N. Flakus, the IAEA's Scientific Secretary of the Conference; Mr. Rosen; Madame Papalardo; Mr. Vesseron; and Ms. N. Parmentier, Chairperson of the Conference Steering Committee.



exposure that do not affect people living farther away. Experts at the conference pointed out that this situation is exceptional. For more common cases -- namely those where humans, plants, and animals live in the same location — measures to protect humans from potentially harmful radiation exposure will also ensure protection of other species.

Harm to the environment caused by radiation is almost entirely associated with accident conditions or the use of nuclear weapons. There is no evidence that the routine operation of nuclear facilities has caused environmental harm. In fact, participants urged that greater emphasis should be placed on the positive effects of nuclear power, including the role it is playing to reduce levels of emissions linked to environmental pollution and climate threatening processes.

In some countries proposals are being made for establishing environmental protection criteria for radiation. Conference participants noted that this could be seen as giving a misleading signal to non-radiation scientists and the public. While there may be ethical and other reasons for wishing to establish such criteria, the rules should be developed universally for all pollutants in the environment rather than for a single one.

Perception of radiation risk. The perception of risk depends on many factors, including the context in which the hazard occurs, the type of hazard, and the type of person who makes the judgments.

People are normally not especially concerned about circumstances which they believe they can control. Social debates and public outrage are easily triggered by scenarios of events that could have severe consequences but that are unlikely to occur — so-called high consequence/low probability events. There also seems to be a general tendency of people to respond more strongly to future threats than to future opportunities or benefits.

Some individuals reject nuclear activities because they do not accept additional risk in a society where there are already too many risks, while others are more favourable to nuclear development. Among most people, however, the most common attitude towards nuclear installations — or other types of major industrial projects — is "not in my backyard". Their emphasis is on the actual or perceived negative impacts that very often overshadow the positive sides of the industrial project or technology.

The reaction often reflects cultural, political, and ideological influences, as well as issues of credibility. Often, the main consequence of a large accident is the loss of people's confidence in the ability of authorities to manage the complex social and technological system. Confidence may return if authorities follow a policy of openness, take public demands into account, and become proficient in communicating both the risks and benefits.

Overall, perceptions of radiation risk can be more confounding than one might think. In the case of perceptions of health risks from exposure to radon in homes and buildings, the public generally believes the risks are *lower* than scientific estimates would substantiate. Several factors appear to contribute to this attitude: the voluntary nature of the risk, its connection with the home, the fact that there is no person or industry imposing this risk, and that it is not possible to say with certainty that a particular cancer victim has died from radon exposure.

Cancer and leukaemia clusters. The conference featured discussion of various studies on what are commonly called "cancer clusters". Discussions pointed out that it is almost impossible to distinguish a *post-hoc* cluster, which has arisen by chance, from one which is due to a locally caused excess risk. The correct scientific method is the *a priori* investigation of putative sources of risk. Such studies of childhood leukaemia around nuclear installations, for example, have been carried out. They reveal little, if any, evidence for an increased risk of childhood leukaemia.

Also discussed was the problem of media coverage and communication with the public. It was suggested that, when informing the public on these issues, scientists should not only point out that "the risk is low". They should try to look at the issue from the public's point of view, and take into consideration factors that may be influencing the perceptions of risk.

Radioactive waste disposal and the environment. Technical and philosophical aspects of high-level waste disposal — including the capa-

Effects in perspective

About one-half of the global burden of diseases is caused by all types of substances or organisms that occur in excess amounts in our environment. Simple measures can alleviate these effects and it is possible to provide significant improvements in health at low cost. The effects of ionizing radiation represent around 1% of the global burden of disease. This small contribution is dominated by natural radiation, medical care of patients, and fallout from nuclear weapons tests. Industrial radiation sources contribute less than one-hundredth of 1%.

The nuclear weapons legacy

The nuclear weapons legacy comprises essentially two components — their actual use, twice 50 years ago in August 1945 at Hiroshima and Nagasaki; and their potential use, in the form of nuclear weapons testing and environmental releases of radioactive materials from the nuclear weapons fuel cycle.

Among about 600,000 people living in Hiroshima and Nagasaki at the time of the bombings, approximately 180,000 immediate deaths were directly caused by the bombs, largely from blast and heat compounded by radiation. About 100,000 survivors in both cities, who experienced an average dose of 0.2 Gy, have been followed medically for more than 40 years. Through 1994, less than 50% of these survivors are deceased, including about 8000 deaths from cancer. About 5% of these cancer deaths have been attributed to radiation from the atomic bombs. In terms of loss of life expectancy, the average individual loss among the study group of survivors is less than one year. However, it is about 12 years on average for persons who died from radiation-induced solid cancer and 26 years for those who died of leukemia.

Studies of genetic effects are in progress on the offspring of the survivors. Since no demonstrable genetic effect has been found in the first generation, very little effect may be expected, if any, in later generations.

Risk data based on studies of A-bomb survivors have been used to establish radiation protection standards. Much effort has been made to publish and disseminate scientific data to the general public. However, the terminology used in this context is difficult to understand for lay people and more effort is needed to prepare and disseminate reports comprehensible to the general public.

One question raised at the conference was why the nuclear energy option seems to be better accepted in Japan than in other countries. Several reasons were offered. They included Japan's strict adherence, rooted in the law, to only peaceful uses of nuclear energy; the clear distinction between nuclear energy and nuclear bombs; strict regulation of nuclear safety; the involvement of local communities, including financial compensation schemes; and the political commitment to gaining a better understanding and acceptance of nuclear energy.

Nuclear weapons testing. During the period 1945-80, a total of 520 nuclear weapons tests were conducted in the atmosphere, principally by the former Soviet Union and the United States but also by the United Kingdom, France, and China. The total energy released was equivalent to 545 Mt of TNT explosives. These tests were accompanied by substantial emissions of radionuclides into the atmosphere, resulting in worldwide environmental contamination. The highest radiation doses were received by populations living in the vicinity of nuclear weapons test sites.

In addition to atmospheric tests, more than 1000 tests have been conducted underground, resulting occasionally in small releases of radioactive materials to the atmosphere.

Several accidents have occurred at nuclear weapons facilities, the most serious being those in 1957 at Windscale in the United Kingdom and at Kyshtym in Russia. The radiation doses and health effects resulting from environmental releases in the early years of nuclear weapons production in the 1940s and 1950s are being investigated in the Russian Federation as well as in the United States.

bility for making safety predictions far into the future for radioactive waste repositories — were central features of discussion on this topic. Scientists acknowledged the inevitable uncertainties involved in making predictions over such extended time periods. At the same time, they emphasized that several different ways exist for providing assurance of safety. Confidence in long-term assessments is enhanced by comparisons with natural analogues in the environment.

Concerning waste transport between countries, discussions pointed to the importance of rules and practices that prevent movement of waste materials to countries without the resources and technology to handle them. A currently accepted position — determined more on political than on safety or economic grounds — is that each country should solve its own radioactive waste problems. A potentially beneficial approach, considering the number of small countries which have to deal with radioactive waste problems, would be regional repositories serving their needs.

The media, scientists, and decision-makers

In three media fora, scientists, journalists, policy-makers, and other conference participants explored factors relating to perception and communication of radiation risk, and the influence of media and the public on policy making.

The scientific facts about radiation risk and media approaches to communicating risk need to be distinguished. Messages of scientists are necessarily based on statistics. The public essentially wants to know whether there is a risk or not. However, most people find the quantification of probability difficult to understand, and find it hard to accept that probabilities can never be zero. While the public generally regards the risk from natural radiation as inevitable, people do not want more risks and uncertainties added to their lives.

For scientists, the fora made some important points about effective communications. An important role of the scientist is to supply reliable information, without speculation, to build trust. Since openness is a prerequisite for credibility, scientists should provide simple information and make more detailed backup material available for further reference.

Communication should also be immediate. What comes out first strikes the public. Later messages seem to come from a defensive stance and are basically weak ones. In debate, scientists should be willing to discuss both bad and good news to gain credibility and build trust. Trust among scientists and journalists further could be strengthened through topical seminars and workshops.

The conference session on decision-making was directed at senior policy officials. Ministerial-level officials were invited to talk about the rationale and strategy for decision-making involving radiation issues. A number of points were addressed, including the question of how public perceptions, expert opinions, and persuasive types of communication influence the decision-making process.

The session emphasized that decision-makers should take into account some basic elements when dealing with radiation issues: they should acknowledgte the risk to be dealt with, state their commitment to protection, and then act upon that commitment. Overall, the aim must be to create a climate in which the public is convinced that all aspects, including bad news, are fully explored, and where varying views receive a complete and proper hearing. Toward that end, political structures and processes, as well as media channels, can be positively used. Additionally, the importance of having legislation in place that is clearly communicated to the public was stressed, so that the laws and principles upon which risks are controlled can be understood.

A step forward

As a global pioneer in its field, the Paris conference marked a significant step forward in a process that undoubtedly will require far more time, attention, and resources. Better communication, and greater comprehension, of radiation risks will require a concerted effort among scientists, journalists, decision-makers, and the public.

One clear message of the conference is that difficulties in communication of radiation safety differ from country to country. Moreover, actions to ameliorate the situation need to be tailored to prevailing issues of national debate — for example, radon issues in the United States, or Chernobyl health effects in Ukraine and Belarus.

The conference also underlined the difficulty of expressing scientific facts of radiation effects in a form useful to non-specialists, and it helped illuminate the roadblocks to better comprehension. A clear message was that greater efforts are needed to place radiation issues in perspective, by improving communication of comparative studies about radiation risks and other hazards.

There seem to be no magic recipes for bringing about quick changes to the complex problem of comprehending radiation risks. Yet the Paris conference represented an important step forward by bringing together people closely involved in framing and communicating solutions. ❐

The Chernobyl accident: Communicating the consequences

Although its size and consequences were apparent early, the Chernobyl accident in 1986 was characterized by communication gaps between the population, political decision makers, journalists, and experts.

The resultant confusion caused people to lose confidence in messages they received. Immediately after the accident, a report by the World Health Organization (WHO) gave reasonable conclusions and recommendations, especially pointing out differences in response measures that were taken by countries. Rather than trying to reconcile these differences, too many scientists indulged in speculation as to Chernobyl's potential effects. Consequently, the public was left with predictions ranging from 10,000 to 500,000 fatal cancers, numbers which the media in some cases wrongly reported as acute deaths.

Years after the accident, some articles in the media included descriptions of malformed plants and animals. A number of cows, other animals, and sensitive plants such as pine trees did die from exposure to high radiation doses. However, no evidence of fatal damage or malformations on a wide scale have been confirmed. The effects were seen mostly within the 10 kilometer exclusion zone that was set up around the Chernobyl site.

International Chernobyl Project. In 1991, the IAEA's International Chernobyl Project examined the radiological consequences of the accident, with the exception of certain aspects such as the health of the "liquidators", namely those who fought to get the accident under control. The general conclusions were that in 1990 there were no health consequences directly linked to radiation exposure but that some thyroid cancers in children should be expected. Post-accident traumatic stress disorders were seen whether people had actually been irradiated or not. Numerous people, however, rejected the conclusions, including politicians and some experts.

Now some new signs are starting to emerge, primarily an excess of thyroid cancer among children in the Russian Federation, Belarus, and Ukraine. These were at first met with skepticism in the scientific community because of the short latency period and comparisons with other studies. In several recent reports on this subject, the increased incidence of thyroid cancer in a number of specific regions and in particular age groups of children is confirmed. These cancers generally seem to be occurring among groups of children who were estimated to have received doses to the thyroid of 1 to 2 Gy.

Other emerging effects. Some data were also presented at the conference on diseases emerging among the Chernobyl liquidators that are not normally attributable to radiation exposure. They include illnesses of the nervous system, blood and circulatory systems, and psychic diseases. A number of experts at the conference felt that this phenomenon seems to be restricted to the region, with the common factor being some exposure to the Chernobyl accident. It was suggested that other populations previously exposed to high levels of radiation, such as survivors of the Hiroshima and Nagasaki bombings and the inhabitants near nuclear test sites on the Marshall Islands, should be examined for the same type of effects.