High levels of natural radiation: Report of an international conference in Ramsar

Researchers are studying areas where high radiation levels are naturally part of the environment

by J.U. Ahmed

Public awareness about exposure to natural sources of radiation has been growing in recent years at a rather accelerated pace. Exposure to high levels of radon indoors, for example, has drawn considerable attention, and a number of countries have already adopted regulatory measures to mitigate exposure to radon in existing houses and to establish radon limits for new buildings. Another area of interest has been the presence of radium and radon in natural springs that are considered health resorts. And, in some areas of the world, the fact that external radiation levels are naturally much higher than normal has drawn the attention of many national and international bodies.

This growing awareness has prompted more widespread scientific investigations, mainly at national levels. Such investigations have comprised large-scale surveys, radiochemical studies of natural environmental radionuclides, transport and transfer of radionuclides from the environment to man, and epidemiological studies to investigate health risks from high levels of natural radiation.

In view of these developments, an international conference on the subject was held in November 1990 to review the latest information and to examine potential health impacts. The meeting was organized by the Islamic Republic of Iran's Atomic Energy Commission and held in Ramsar, a city located in an area having quite high levels of natural radiation, at the foot of the Elburz mountains on the southern coast of the Caspian Sea. Organized in co-operation with the IAEA, World Health Organization (WHO), United Nations Environment Programme (UNEP), and International Nuclear Track Society (INTS), the conference attracted nearly 200 specialists from Iran and 30 other countries. They built upon the work of previous international conferences on this subject in Pocos de Caldas, Brazil in 1975 and in Bombay, India in 1981.

This article presents the technical highlights of the Ramsar conference, including its principal recommendations.

Mr Ahmed is a staff member in the IAEA's Radiological Safety Section, Division of Nuclear Safety.

Technical highlights

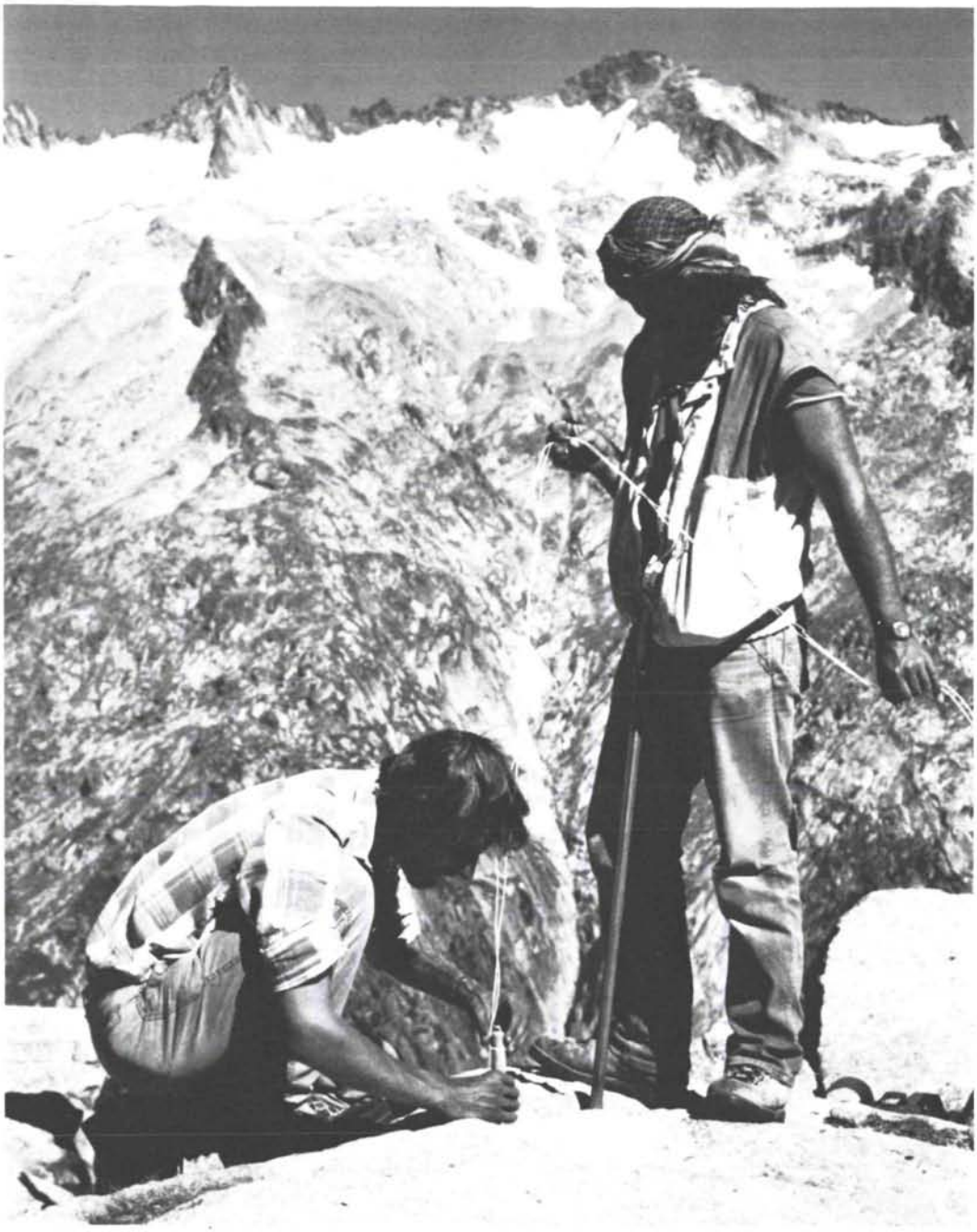
Exposure levels. The current average radiation dose to the world's population from natural sources of radiation is 2.4 millisievert per year (mSv/y), as reported by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). These sources include cosmic rays and terrestrial radionuclides such as potassium-40, uranium-238, thorium-232, and associated decay products.

Wide variations in exposure to these natural sources of radiation occur. Extreme values have been estimated to range up to 100 times the average values. Exposures to cosmic radiation range from 0.26 mSv at sea level to 20 times that level at an altitude of 6000 metres.

At the Ramsar conference, some papers presented results of national surveys on external radiation levels in areas of high natural radiation. A survey in Poland, for example, showed that outdoor radiation dose rates vary greatly from place to place — from between 20 and 190 nanogray per hour (nGy/h). Highest values were found in red-brick buildings.

In the city of Ramsar, a survey of outdoor radiation doses showed potential gamma exposures from 0.05 to 9 millirem per hour. Indoors, the potential gamma doses in houses range from 0.6 to 360 mGy per year.

In India, a comprehensive review of dosimetric and biological studies of high radiation areas of the southwest coast have been done over the past 35 years covering a population of 70 000. It showed an average exposure of 10 mGy per year, with the highest personal



Exposure to cosmic radiation at high altitudes can be 20 times more than at sea level. (Credit: Nagra informiert)

exposure of 32.6 mGy per year in a residential house that registered an external radiation dose level of 38.4 mGy per year.

Radon indoors. Also presented were results of a number of national surveys on radon. The levels of radon indoors show a wide range, depending on the place, type of house, and ventilation conditions. The radon levels in the Ramsar area showed concentrations of up to 37 kilo-becquerel (kBq) per cubic metre, leading to a potential effective dose equivalent for residents of up to 98.5 mSv per year.

In Czechoslovakia, radon levels in houses (located in areas crossed by radon ingress from tectonic disturbances in a granite massif) were as high as 10 kBq per cubic metre. In Joachimstal, a survey revealed that houses built with plaster and mortar contain extremely high concentrations of radium, as high as 80 kBq per kilogram.

"Technologically enhanced" radiation. Natural sources of radiation can be modified in industrial operations or other human activities. Such "technologically enhanced" radiation seems to be the largest contributor to the general public's radiation exposure, based on presentations at the conference. The world's current production of phosphate fertilizer, for

example, will result in the collective effective dose equivalent commitment of 300 000 man-Sv per year. For comparison, the 1986 Chernobyl accident's radiological impact in the Northern Hemisphere was estimated to be 600 000 man-Sv, or an amount equivalent to 2 years of worldwide production of phosphate fertilizer.

Biological effects. One conference session was devoted to biological effects, particularly cytogenic studies in high natural radiation areas. Two papers from the Netherlands presented a novel method of biological dosimetry based on premature chromosome condensation and studies on the origin of chromosome alterations induced by X-rays.

Chromosome aberration studies carried out on the inhabitants in the areas of high natural radiation around Ramsar indicated pronounced differences among them when compared to a control group. However, a study of one Ramsar family tree showed that the grandfather, uncle, mother, father, and aunt have lived for 70, 110, 76, 63, and 70 years, respectively. As a whole, the family has not shown any evidence of any special disease.

Epidemiological studies. Epidemiological studies carried out in areas of high natural radiation in Japan, China, and India have not shown any significant health effects which could be attributed to exposures to natural sources of radiation. No significant differences in health have been determined between people living in areas of high natural radiation and those living elsewhere.

The Japanese study was done on three population groups of 2.2 million, 2.9 million, and 2.8 million people from areas that included 28 cities and 11 towns. Exposures ranged from 7.6 mGy/h to above 10.5 mGy/h. The study showed that geological differences in natural radiation levels did not cause any detectable increase in cancer mortality.

In Yangjiang, China, an extensive epidemiological study was carried out for nearly 20 years in an area of high natural radiation characterized by homogeneous distribution of environmental gamma exposure and a large and stable population. The study compared this population with a nearby control population of the same size. Altogether, the study investigated about one million cumulative person-years for cancer mortality. The results showed no increase in cancer mortality in the area of high natural radiation compared to the control area. Rather, the study noted a trend that cancer mortality was lower in the area of high natural radiation. However, the statistical confidence interval in the analysis was large, and it needs to be narrowed before more confidence can be placed in the results. The incidence of hereditary diseases and congenital defects were similar in both groups. A cytogenic study showed that the frequency of chromosomal aberrations in circulating lymphocytes was higher in the area of high natural radiation than in the control area.

Of particular interest in the Indian study was a statistical analysis of data required for a response curve at low radiation doses. From the analysis, it was concluded that the minimum size of a population group at one level of statistical significance requires 100 000 person-years. As a result, epidemiological surveys in monazite areas of populous countries, such as China and India, appear to offer the best opportunity to study what effects low levels of radiation have on cancer risks.

Conference recommendations

Among the recommendations adopted at the conference were the following:

- It was recognized and recommended that efforts should be further focused on epidemiological studies in populous areas of high levels of natural radiation. Biological research should also receive increased emphasis in order to develop more knowledge on the biological effects of low levels of exposure from natural sources of radiation, specifically about dose-effect relationships. The health of the population in areas of high natural radiation should be carefully studied, including observations of any mental retardation among young children during the gestation period from 8–15 weeks. The intelligence quotient of children should also be tested carefully.
- International efforts should continue to establish criteria for characterizing areas of high levels of natural radiation. They should be characterized with respect to geological parameters and the types of chemicals that may be carried by water to the population areas.
- Research and development studies should receive increased consideration for remedial actions to alleviate the radiation exposure situation in affected areas. In specific cases where surveys strongly justify remedial measures, such steps should be undertaken even in the absence of established regulatory policies. However, in taking such remedial actions, governmental approval should be obtained and agreement of the populations concerned should be secured.
- Radionuclides which are significant from the viewpoint of health hazards should be identified in high-radiation areas and be studied in detail, both with respect to their measurement and the extent of human exposure to them.