

Chernobyl: The true scale of the accident

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20 years later a UN report provides definitive answers and ways to repair lives

A total of up to four thousand people could eventually die of radiation exposure from the Chernobyl nuclear power plant (NPP) accident nearly 20 years ago, an international team of more than 100 scientists has concluded.

As of mid-2005, however, fewer than 50 deaths had been directly attributed to radiation from the disaster, almost all being highly exposed rescue workers, many who died within months of the accident but others who died as late as 2004.

The new numbers are presented in a landmark digest report, "Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts," just released by the Chernobyl Forum. The digest, based on a three-volume, 600-page report and incorporating the work of hundreds of scientists, economists and health experts, assesses the 20-year impact of the largest nuclear accident in history.

The Forum is made up of 8 UN specialized agencies, including the International Atomic Energy Agency (IAEA), World Health Organization (WHO), United Nations Development Programme (UNDP), Food and Agriculture Organization (FAO), United Nations Environment Programme (UNEP), United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and the World Bank, as well as the governments of Belarus, Russia and

Ukraine.

"This compilation of the latest research can help to settle the outstanding questions about how much death, disease and economic fallout really resulted from the Chernobyl accident," explains Dr. Burton Bennett, chairman of the Chernobyl Forum and an authority on radiation effects. "The governments of the three most-affected countries have realized that they need to find a clear way forward, and that progress must be based on a sound consensus about environmental, health and economic consequences and some good advice and support from the international community."

Bennett continued: "This was a very serious accident with major health consequences, especially for thousands of workers exposed in the early days who received very high radiation doses, and for the thousands more stricken with thyroid cancer. By and large, however, we have not found profound negative health impacts to the rest of the population in surrounding areas, nor have we found widespread contamination that would continue to pose a substantial threat to human health, with a few exceptional, restricted areas."

The Forum's report aims to help the affected countries understand the true scale of the accident consequences and also suggest ways the governments of Belarus, Ukraine and Russia might address major economic and social problems stemming from the accident. Members of the Forum, including representatives of the three governments, will meet September 6 and 7 in Vienna at an unprecedented gathering of the world's experts on Chernobyl, radiation effects and protection, to consider these findings and recommendations.

Major Study Findings

Dozens of important findings are included in the massive report:

- Approximately 1,000 on-site reactor staff and emergency workers were heavily exposed to high-level radiation on the first day of the accident; among the more than 200,000 emergency and recovery operation workers exposed during the period from 1986-1987, an estimated 2,200 radiation-caused deaths can be expected during their lifetime.
- An estimated five million people currently live in areas of Belarus, Russia and Ukraine that are contaminated with radionuclides due to the accident; about 100,000 of them live in areas classified in the past by government authorities as areas of "strict control". The existing "zoning" definitions need to be revisited and relaxed in light of the new findings.
- About 4,000 cases of thyroid cancer, mainly in children and adolescents at the time of the accident, have resulted from the accident's contamination and at least nine children died of thyroid cancer; however the survival rate among such cancer victims, judging from experience in Belarus, has been almost 99%.
- Most emergency workers and people living in contaminated areas received relatively low whole body radiation doses, comparable to natural background levels. As a consequence, no evidence or likelihood of decreased fertility among the affected population has been found, nor has there been any evidence of increases in congenital malformations that can be attributed to radiation exposure.
- Poverty, "lifestyle" diseases now rampant in the former Soviet Union and mental health problems pose a far greater threat to local communities than does radiation exposure.
- Relocation proved a "deeply traumatic experience" for some 350,000 people moved out of the affected areas. Although 116,000 were moved from the most heavily impacted area immediately after the accident,

later relocations did little to reduce radiation exposure.

- Persistent myths and misperceptions about the threat of radiation have resulted in "paralyzing fatalism" among residents of affected areas.
- Ambitious rehabilitation and social benefit programs started by the former Soviet Union, and continued by Belarus, Russia and Ukraine, need reformulation due to changes in radiation conditions, poor targeting and funding shortages.
- Structural elements of the sarcophagus built to contain the damaged reactor have degraded, posing a risk of collapse and the release of radioactive dust;
- A comprehensive plan to dispose of tons of high-level radioactive waste at and around the Chernobyl NPP site, in accordance with current safety standards, has yet to be defined.

Alongside radiation-induced deaths and diseases, the report labels the mental health impact of Chernobyl as "the largest public health problem created by the accident" and partially attributes this damaging psychological impact to a lack of accurate information. These problems manifest as negative self-assessments of health, belief in a shortened life expectancy, lack of initiative, and dependency on assistance from the state.

"Two decades after the Chernobyl accident, residents in the affected areas still lack the information they need to lead the healthy and productive lives that are possible," explains Louisa Vinton, Chernobyl focal point at the UNDP. "We are advising our partner governments that they must reach people with accurate information, not only about how to live safely in regions of low-level contamination, but also about leading healthy lifestyles and creating new livelihoods." But, says Dr Michael

Repacholi, Manager of WHO's Radiation Program, "the sum total of the Chernobyl Forum is a reassuring message."

He explains that there have been 4,000 cases of thyroid cancer, mainly in children, but that except for nine deaths, all of them have recovered. "Otherwise, the team of international experts found no evidence for any increases in the incidence of leukemia and cancer among affected residents."

The international experts have estimated that radiation could cause up to about 4,000 eventual deaths among the higher-exposed Chernobyl populations, i.e., emergency workers from 1986-1987, evacuees and residents of the most contaminated areas. This number contains both the known radiation-induced cancer and leukaemia deaths and a statistical prediction, based on estimates of the radiation doses received by these populations. As about quarter of people die from spontaneous cancer not caused by Chernobyl radiation, the radiation-induced increase of only about 3% will be difficult to observe. However, in the most exposed cohorts of emergency and recovery operation workers some increase of particular cancer forms (e.g., leukemia) in particular time periods has already been observed. The predictions use six decades of scientific experience with the effects of such doses, explained Repacholi.

Repacholi concludes that "the health effects of the accident were potentially horrific, but when you add them up using validated conclusions from good science, the public health effects were not nearly as substantial as had at first been feared."

The report's estimate for the eventual number of deaths is far lower than earlier, well-publicized speculations that radiation exposure would claim tens of thousands of lives. But the 4,000 figure is not far different from estimates made in 1986 by Soviet scientists, according to Dr Mikhail Balonov, a radiation expert with the International Atomic Energy

Agency in Vienna, who was a scientist in the former Soviet Union at the time of the accident.

As for environmental impact, the reports are also reassuring, for the scientific assessments show that, except for the still closed, highly contaminated 30 kilometer area surrounding the reactor, and some closed lakes and restricted forests, radiation levels have mostly returned to acceptable levels. "In most areas the problems are economic and psychological, not health or environmental," reports Balonov, the scientific secretary of the Chernobyl Forum effort who has been involved with Chernobyl recovery since the disaster occurred.

Recommendations

Recommendations call for focusing assistance efforts on highly contaminated areas and redesigning government programs to help those genuinely in need. Suggested changes would shift programs away from those that foster "dependency" and a "victim" mentality, and replacing them with initiatives that encourage opportunity, support local development, and give people confidence in their futures.

In the health area, the Forum report calls for continued close monitoring of workers who recovered from Acute Radiation Syndrome (ARS) and other highly exposed emergency personnel. The Report also calls for focused screening of children exposed to radioiodine for thyroid cancer and highly exposed clean-up workers for non-thyroid cancers. However, existing screening programs should be evaluated for cost-effectiveness, since the incidence of spontaneous thyroid cancers is increasing significantly as the target population ages. Moreover, high quality cancer registries need continuing government support.

In the environmental realm, the Report calls for long term monitoring of caesium and strontium radionuclides to assess human exposure and food

contamination and to analyse the impacts of remedial actions and radiation-reduction countermeasures. Better information needs to be provided to the public about the persistence of radioactive contamination in certain food products and about food preparation methods that reduce radionuclide intake. Restrictions on harvesting of some wild food products are still needed in some areas.

Also in the realm of protecting the environment, the Report calls for an "integrated waste management program for the Shelter, the Chernobyl NPP site and the Exclusion Zone" to ensure application of consistent management and capacity for all types of radioactive waste. Waste storage and disposal must be dealt with in a comprehensive manner across the entire Exclusion Zone, according to the Report.

In areas where human exposure is not high, no remediation needs to be done, points out Balonov. "If we do not expect health or environmental effects, we should not waste resources and effort on low priority, low contamination areas," he explains. "We need to focus our efforts and resources on real problems."

One key recommendation addresses the fact that large parts of the population, especially in rural areas, still lack accurate information and emphasizes the need to find better ways both to inform the public and to overcome the lack of credibility that hampered previous efforts. Even though accurate information has been available for years, either it has not reached those who need it or people do not trust and accept the information and do not act upon it, according to the Report.

This recommendation calls for targeting information to specific audiences, including community leaders and health care workers, along with a broader strategy that promotes healthy lifestyles as well as information about how to reduce internal and external radiation exposures and address the main causes of disease and mortality.

In the socioeconomic sphere, the Report recommends a new development approach that helps individuals to "take control of their own lives and communities to take control of their own futures." The Governments, the Report states, must streamline and refocus Chernobyl programs through more targeted benefits, elimination of unnecessary benefits to people in less contaminated areas, improving primary health care, support for safe food production techniques, and encouragement for investment and private sector development, including small and medium-size enterprises.

Notes Vinton, "The most important need is for accurate information on healthy lifestyles, together with better regulations to promote small, rural businesses. Poverty is the real danger. We need to take steps to empower people."

Answers to Longstanding Questions How much radiation were people exposed to as a result of the accident?

With the exception of on-site reactor staff and emergency workers exposed on April 26, most recovery operation workers and those living in contaminated territories received relatively low whole body radiation doses, comparable to background radiation levels and lower than the average doses received by residents in some parts of the world having high natural background radiation levels.

For the majority of the five million people living in the contaminated areas, exposures are within the recommended dose limit for the general public, though about 100,000 residents still receive more. Remediation of those areas and application of some agricultural countermeasures continues. Further reduction of exposure levels will be slow, but most exposure from the accident has already occurred.

How many people died and how many more are likely to die in the future?

The total number of deaths already attributable to Chernobyl or expected in the future over the lifetime of emergency workers and local residents in the most contaminated areas is estimated to be about 4,000. This includes some 50 emergency workers who died of acute radiation syndrome and nine children who died of thyroid cancer, and an estimated total of 3,940 deaths from radiation-induced cancer and leukemia among the 200,000 emergency workers from 1986-1987, 116,000 evacuees and 270,000 residents of the most contaminated areas (total about 600,000). These three major cohorts were subjected to higher doses of radiation amongst all the people exposed to Chernobyl radiation.

The estimated 4000 casualties may occur during the lifetime of about 600,000 people under consideration. As about quarter of them will eventually die from spontaneous cancer not caused by Chernobyl radiation, the radiation-induced increase of about 3% will be difficult to observe. However, in the most highly exposed cohorts of emergency and recovery operation workers, some increase in particular cancers (e.g., leukemia) has already been observed.

Confusion about the impact has arisen owing to the fact that thousands of people in the affected areas have died of natural causes. Also, widespread expectations of ill health and a tendency to attribute all health problems to radiation exposure have led local residents to assume that Chernobyl related fatalities were much higher than they actually were.

What diseases have already occurred or might occur in the future?

Residents who ate food contaminated with radioactive iodine in the days immediately after the accident received relatively high doses to the thyroid gland. This was especially true of children who drank milk from cows who had eaten contaminated grass. Since iodine concentrates in the thyroid gland, this was a major cause of the high incidence of thyroid cancer in children.

Several recent studies suggest a slight increase in the incidence of leukemia among emergency workers, but not in children or adult residents of contaminated areas. A slight increase in solid cancers and possibly circulatory system diseases was noted, but needs to be evaluated further because of the possible indirect influence of such factors as smoking, alcohol, stress and unhealthy lifestyle.

Have there been or will there be any inherited or reproductive effects?

Because of the relatively low doses to residents of contaminated territories, no evidence or likelihood of decreased fertility has been seen among males or females. Also, because the doses were so low, there was no evidence of any effect on the number of stillbirths, adverse pregnancy outcomes, delivery complications or overall health of children. A modest but steady increase in reported congenital malformations in both contaminated and uncontaminated areas of Belarus appears related to better reporting, not radiation.

Did the trauma of rapid relocation cause persistent psychological or mental health problems?

Stress symptoms, depression, anxiety and medically unexplained physical symptoms have been reported, including self-perceived poor health. The designation of the affected population as "victims" rather

than "survivors" has led them to perceive themselves as helpless, weak and lacking control over their future. This, in turn, has led either to over cautious behavior and exaggerated health concerns, or to reckless conduct, such as consumption of mushrooms, berries and game from areas still designated as highly contaminated, overuse of alcohol and tobacco, and unprotected promiscuous sexual activity.

What was the environmental impact?

Ecosystems affected by Chernobyl have been studied and monitored extensively for the past two decades. Major releases of radionuclides continued for ten days and contaminated more than 200,000 square kilometers of Europe. The extent of deposition varied depending on whether it was raining when contaminated air masses passed.

Most of the strontium and plutonium isotopes were deposited within 100 kilometers of the damaged reactor. Radioactive iodine, of great concern after the accident, has a short half-life, and has now decayed away. Strontium and caesium, with a longer half life of 30 years, persist and will remain a concern for decades to come. Although plutonium isotopes and americium 241 will persist perhaps for thousands of years, their contribution to human exposure is low.

What is the scope of urban contamination?

Open surfaces, such as roads, lawns and roofs, were most heavily contaminated. Residents of Pripjat, the city nearest to Chernobyl, were quickly evacuated, reducing their potential exposure to radioactive materials. Wind, rain and human activity has reduced surface contamination, but led to secondary contamination of sewage and sludge systems. Radiation in air above settled areas returned to background levels, though levels remain higher where soils have remained

undisturbed.

How contaminated are agricultural areas?

Weathering, physical decay, migration of radionuclides down the soil and reductions in bioavailability have led to a significant reduction in the transfer of radionuclides to plants and animals. Radioactive iodine, rapidly absorbed from grasses and animal feed into milk, was an early concern and elevated levels were seen in some parts of the former Soviet Union and Southern Europe, but, given the nuclide's short half life, this concern abated quickly. Currently and for the long term, radiocaesium, present in milk, meat and some plant foods, remains the most significant concern for internal human exposure, but, with the exception of a few areas, concentrations fall within safe levels.

What is the extent of forest contamination?

Following the accident, animals and vegetation in forest and mountain areas had high absorption of radiocaesium, with persistent high levels in mushrooms, berries and game. Because exposure from agricultural products has declined, the relative importance of exposure from forest products has increased and will only decline as radioactive materials migrate downward into the soil and slowly decay. The high transfer of radiocaesium from lichen to reindeer meat to humans was seen in the Arctic and sub-Arctic areas, with high contamination of reindeer meat in Finland, Norway, Russia, and Sweden. The concerned governments imposed some restrictions on hunting, including scheduling hunting season when animals have lower meat contamination.

How contaminated are the aquatic systems?

Contamination of surface waters throughout much of Europe declined

quickly through dilution, physical decay, and absorption of radionuclides in bed sediments and catchment soils. Because of bioaccumulation in the aquatic food chain, though, elevated concentrations of radiocaesium were found in fish from lakes as far away as Germany and Scandinavia. Comparable levels of radiostrontium, which concentrates in fish bone, not in muscle, were not significant for humans. Levels in fish and waters are currently low, except in areas with "closed" lakes with no outflowing streams. In those lakes, levels of radiocaesium in fish will remain high for decades and, therefore, restrictions on fishing there should be maintained.

What environmental countermeasures and remediation have been taken?

The most effective early agricultural countermeasure was removing contaminated pasture grasses from animal diets and monitoring milk for radiation levels. Treatment of land for fodder crops, clean feeding and use of Cs-binders (that prevented the transfer of radiocaesium from fodder to milk) led to large reductions in contamination and permitted agriculture to continue, though some increase in radionuclide content of plant and animal products has been measured since the mid-1990s when economic problems forced a cutback in treatments. Some agricultural lands in the three countries have been taken out of use until remediation is undertaken.

A number of measures applied to forests in affected countries and in Scandinavia have reduced human exposure, including restrictions on access to forest areas, on harvesting of food products such as game, berries and mushrooms, and on the public collection of firewood, along with changes in hunting to avoid consumption of game meat where seasonal levels of radiocaesium may be high. Low income levels in some areas cause local residents to disregard these rules.

What were radiation-induced effects on plants and animals?

Increased mortality of coniferous plants, soil invertebrates and mammals and reproductive losses in plants and animals were seen in high exposure areas up to a distance of 20-30 kilometers. Outside that zone, no acute radiation-induced effects have been reported. With reductions of exposure levels, biological populations have been recovering, though the genetic effects of radiation were seen in both somatic and germ cells of plants and animals. Prohibiting agricultural and industrial activities in the exclusion zone permitted many plant and animal populations to expand and created, paradoxically, "a unique sanctuary for biodiversity."

Does dismantlement of the Shelter and management of radioactive waste pose further environmental problems?

The protective shelter was erected quickly, which led to some imperfections in the shelter itself and did not permit gathering complete data on the stability of the damaged unit. Also, some structural parts of the shelter have corroded in the past two decades. The main potential hazard posed by the shelter is the possible collapse of its top structures and the release of radioactive dust.

Strengthening those unstable structures has been performed recently, and construction of a New Safe Confinement covering the existing shelter that should serve for more than 100 years, starts in near future. The new cover will allow dismantlement of the current shelter, removal of the radioactive fuel mass from the damaged unit and, eventually, decommissioning of the damaged reactor.

A comprehensive strategy still has to be developed for dealing with the

high level and long-lived radioactive waste from past remediation activities. Much of this waste was placed in temporary storage in trenches and landfills that do not meet current waste safety requirements.

What was the economic cost?

Because of policies in place at the time of the explosion and the inflation and economic disruptions that followed the break-up of the Soviet Union, precise costs have been impossible to calculate. A variety of estimates from the 1990s placed the costs over two decades at hundreds of billions of dollars. These costs included direct damage, expenditures related to recovery and mitigation, resettlement of people, social protection and health care for the affected population, research on environment, health and the production of clean food, radiation monitoring, as well as indirect losses due to removing agricultural lands and forests from use and the closing of agriculture and industrial facilities, and such additional costs as cancellation of the nuclear power program in Belarus and the additional costs of energy from the loss of power from Chernobyl. The costs have created a huge drain on the budgets of the three countries involved.

What were the main consequences for the local economy?

Agriculture was hardest hit, with 784,320 hectares taken from production. Timber production was halted in 694,200 hectares of forest. Remediation made "clean food" production possible in many areas but led to higher costs in the form of fertilizers, additives and special cultivation processes. Even where farming is safe, the stigma associated with Chernobyl caused marketing problems and led to falling revenues, declining production and the closure of some facilities. Combined with disruptions due to the collapse of the Soviet Union, recession, and new

market mechanisms, the region's economy suffered, resulting in lower living standards, unemployment and increased poverty. All agricultural areas, whether affected by radiation or not, proved vulnerable.

Poverty is especially acute in affected areas. Wages for agricultural workers tend to be low and employment outside of agriculture is limited. Many skilled and educated workers, especially younger workers, left the region. Also, the business environment discourages entrepreneurial ventures and private investment is low.

What impact did Chernobyl and the aftermath have on local communities?

More than 350,000 people have been relocated away from the most severely contaminated areas, 116,000 of them immediately after the accident. Even when people were compensated for losses, given free houses and a choice of resettlement location, the experience was traumatic and left many with no employment and a belief that they have no place in society. Surveys show that those who remained or returned to their homes coped better with the aftermath than those who were resettled. Tensions between new and old residents of resettlement villages also contributed to the ostracism felt by the newcomers. The demographic structure of the affected areas became skewed since many skilled, educated and entrepreneurial workers, often younger, left the areas leaving behind an older population with few of the skills needed for economic recovery.

The older population has meant that deaths exceed births, which reinforces the perception that these areas are dangerous places to live. Even when pay is high, schools, hospitals and other essential public services are short of qualified specialists.

What has been the impact on individuals?

According to the Forum's report on health, "the mental health impact of Chernobyl is the largest public health problem unleashed by the accident to date." People in the affected areas report negative assessments of their health and well-being, coupled with an exaggerated sense of the danger to their health from radiation exposure and a belief in a shorter life expectancy. Anxiety over the health effects of radiation shows no signs of diminishing and may even be spreading. Life expectancy has been declining across the former Soviet Union, due to cardiovascular disease, injuries and poisoning, and not radiation-related illness.

How have governments responded?

The resettlement and rehabilitation programs launched in Soviet conditions proved unsustainable after 1991 and funding for projects declined, leaving many projects unfinished and abandoned and many of the promised benefits under funded. Also, benefits were offered to broad categories of "Chernobyl victims" that expanded to seven million now receiving or eligible for pensions, special allowances and health benefits, including free holidays and guaranteed allowances. Chernobyl benefits deprive other areas of public spending of resources, but scaling down benefits or targeting only high-risk groups is unpopular and presents political problems.

Given significant reduction of radiation levels during past twenty years, governments need to revisit the classification of contaminated zones. Many areas previously considered to be at risk are in fact safe for habitation and cultivation. Current delineations are far more restrictive than demonstrated radiation levels can justify.

The report identifies the need to sharpen priorities and streamline the

programs to target the most needy, noting that reallocating resources is likely to face "strong resistance from vested interests". One suggestion calls for a "buy out" of the entitlement to benefits in return for lump sum start-up financing for small businesses.

Source: International Atomic Energy Agency

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