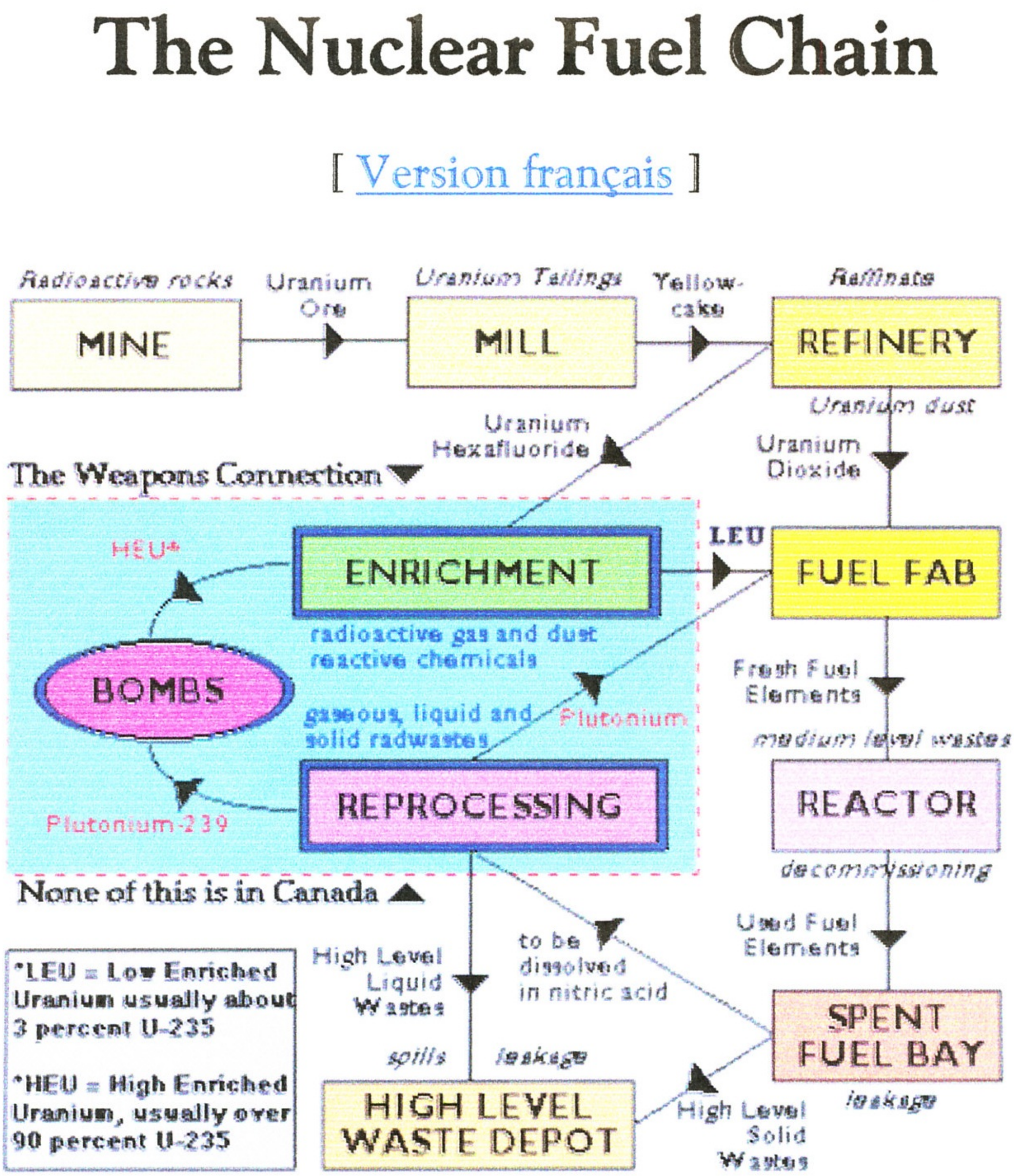
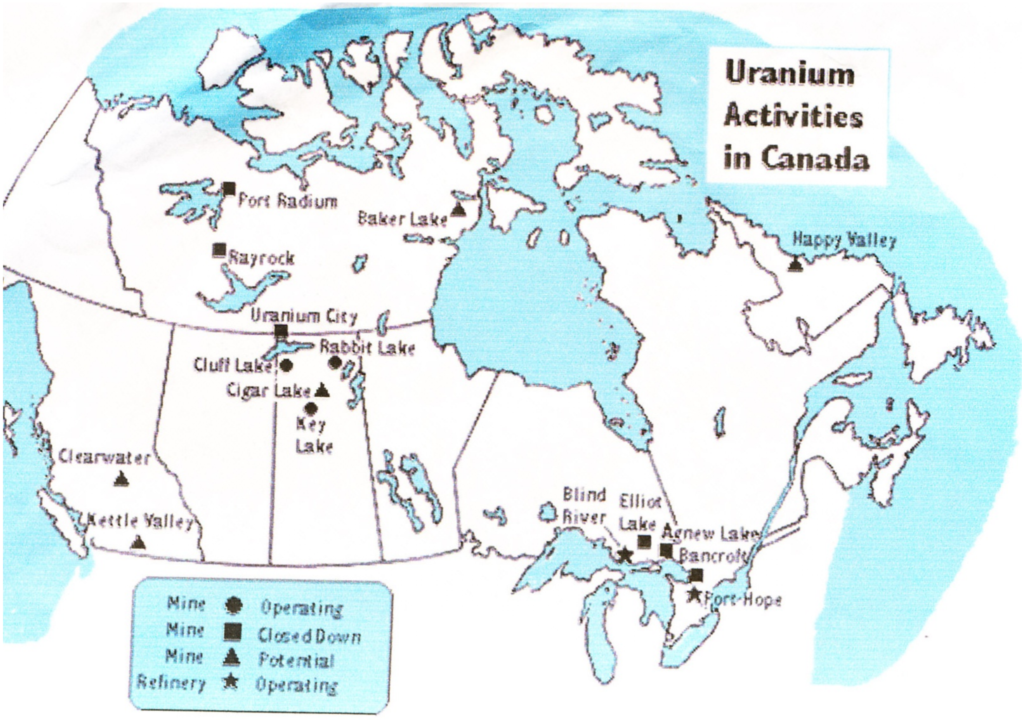
Radiation is given off from many sources from its mining, transportation, refining, enriching, nuclear power generation, waste storage, use of depleted uranium (DU) for armaments, to the manufacture of nuclear weapons, their testing and their use. When looking at risk, one needs to know the frequency and also the severity if things go wrong. So that while nuclear power plant disasters are only about every ten to twenty years, when things go wrong, they are catastrophic. Accidents, miscalculations, terrorists (getting hold of a nuclear weapon or making one, making a dirty bomb contaminated with radioactive material or cyber terrorism controlling a nuclear weapon) and the risk of actual war remain.





Map of Uranium Mining Activities in Canada

MINING

Uranium is highly toxic to kidneys as a heavy metal and radioactive, both itself and its decay elements, or daughters, such as radon gas that is the number two cause of lung cancer in Canada. Uranium 238 has a half-life of 4.47 billion years and makes up 99.3% of natural uranium. Uranium 235 has a half-life of 704 million years and accounts for 0.7% of natural uranium and is the key ingredient for enriched uranium for nuclear power (3-5%) (CANDU Canadian reactors don't require enriched uranium) and nuclear weapons (about 20% to 90%). U235 is concentrated through centrifuging and is the same process for peaceful nuclear power use or military use and is just dependent on time of the centrifuging.

Kazakhstan is the largest producer of uranium at 27% with Canada number two at 20% but has the highest concentration of uranium at 15-20%. Australia is the third largest producer at 15%. Mining often occurs on Indigenous land and employees Indigenous labours who are often not aware of the hazards of radiation. Radiation contaminates the tailings. Sometimes there are accidents such as at Rabbit Lake, Saskatchewan where there was a large release of radioactive water – two million Litres of arsenic and radium contaminated water. Here is a list of accidents involving Cameco: (https://d3n8a8pro7vhmx.cloudfront.net/ccwa/pages/201/attachments/original/1470361486/Cameco_Incidents_VERSION_SUBMITTED_WITH_ERMP_PLUS_UPDATES_2016.pdf) We are also aware of the tailing pond releases at Mount Polley in British Columbia and the recent one in Brazil. Radon gas often escapes from these tailing areas. Many defunct mining companies go bankrupt and don't properly clean up their mining sites leading the taxpayer to pick up the bill.

Elliot Lake, Canada

Uranium mining site http://www.nuclear-risks.org/en/hibakusha-worldwide/elliot-lake.html

As a lasting legacy of the "golden age" of uranium mining, the radioactive tailings of Elliot Lake pose a threat to the environment of the Great Lakes region and the health of its inhabitants. Many hundreds of miners have already succumbed to the long-term effects of radiation exposure and tens of thousands more deaths are expected as a result of radioactive pollution in the coming decades.

History

In 1954, uranium was discovered near Elliot Lake in the Canadian province of Ontario. With the U.S. nuclear weapons program in dire need of fissile material, it was the time of the great "uranium rush." A few years later, two companies, Denison Mines and Rio Algom, began to operate 12 mines and processing mills in the region. Elliot Lake quickly became "the uranium capital of the world." In the 1970s, uranium miners in Elliot Lake became alarmed at the high incidence of lung cancer and silicosis and went on strike. The Ontario government appointed a commission to investigate the health effects of radiation on uranium miners in Elliot Lake. German and Czechoslovakian studies had established a connection between radon gas inhalation and lung cancer in uranium miners decades ago (see the corresponding posters in this exhibition). Similar studies by the the Canadian commission found that the Elliot Lake miners cohort had twice as many cases of lung cancer as the control group (81 observed lung cancer deaths versus 45 expected). The commission made several recommendations regarding safety standards and concluded that "from the occupational health point of view, it is certain that exposure to radon daughters leads to an increased risk of lung cancer for the working force as a whole." As a result of this evidence, the Steel Workers Union of America warned miners against working in Elliot Lake's mines. The union's environmental representative, Paul Falkowski stated in 1976: "If anybody does not like to go to the hospital with lung cancer, he should have a very close look at the Elliot Lake situation before he signs on."

Health and environmental effects

Eventually, even the British Columbia Medical Association (BCMA) began to warn of a "gradually flowering crop of radiation-induced cancers" among uranium miners. Their studies found that by 1984, a total of 274 uranium miners had already died of lung cancer. A British study found a threefold increase in the risk of cancer among uranium miners.

Soon it became clear that the region's entire population – not only miners – had been exposed to increased levels of radiation. Large quantities of radioactive waste rock and tailings remained from the milling process. This refuse still contains 85 % of the original radioactivity in the form of uranium progeny such as thorium-230 or radium-226 and gives off at least 10,000 times as much radon gas as the undisturbed ore.

A company specialized in radioactive waste management calculated in 1992 that the radon gas released through uranium mining in Elliot Lake would cause an effective collective dose of 10 million Person-Sievert. Over the course of a thousand years, the radon gas alone would therefore be responsible for 2,300 to 26,000 deadly cases of cancer, although this number could well increase by a factor of 1,000 through erosion and other environmental influences. Aquatic and airborne releases from the uranium tailings are expected to cause an additional 1,600 to 24,400 cancer deaths over a 1,000-year period in the region. Not accounted for in these calculations are accidental spills, such as the two million liters of tailings from the Stanleigh uranium mine that polluted Elliot lake in August 1993. Regardless of how many cancers are eventually caused by radioactive pollution from

uranium mining, every single case constitutes a calamity for the affected person and his or her family. Every case of cancer that is caused by the nuclear industry is one too many.
Adding to this already worrying development, radioactive waste rock was used in the construction of homes in Elliot Lake well into the 1970s. Acceptable levels of radon contamination were exceeded about 20 times. Studies by the Elliot Lake Environmental Assessment Board demonstrated that indoor radon levels would result in a 30 % rise in the incidence of lung cancer. As a result, the city had to react and began installing fans under floorboards in order to blow radon gas out of the houses.
The BCMA condemned the negligence in the construction of houses from radioactive waste as "tantamount to allowing an industrially induced epidemic of cancer." A 1982 report published by the Canadian Atomic Energy Control Board estimated a 40 % increase in lung cancer for inhabitants of contaminated houses.

Outlook

In the early 1990s, the Ontario uranium mines were decommissioned due to economic pressure from the Saskatchewan mines and the decision of the U.S. Atomic Energy Commission to purchase uranium for its nuclear programs from U.S. sources only. The town of Elliot Lake fell into decay and many moved away. Those who stayed continue to suffer from decades of occupational radiation exposure, contamination of soil, water and air through mine waste and uranium tailings, and high concentrations of residential radon. Meaningful epidemiological research has not been done to this day. The people of Elliot Lake have become Hibakusha, developing cancer and other radiation-induced diseases because their health was considered less important than cheap uranium for nuclear weapons and power plants.

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Saskatchewan, Canada http://www.nuclear-risks.org/en/hibakusha-worldwide/saskatchewan.html

Uranium mining site

Saskatchewan mines roughly 25 % of the world's uranium. The radioactive tailings produced by the mining process contaminate native land, pose a health threat to the local population and remain a dangerous legacy for future generations. The miners themselves are most acutely affected by radiation-induced diseases.

History

The Athabasca Basin in Northern Saskatchewan has some of the world's most extensive and most highly concentrated uranium deposits. With the commissioning of the Beaverlodge Mine in 1953, the region experienced a veritable "uranium rush."

Uranium City sprang up overnight and mines were opened at Rabbit Lake, Cigar Lake and Cluff Lake. Recently, high-grade uranium ore deposits were discovered at McArthur River. Currently, most of the uranium in Saskatchewan is mined by two uranium giants: the Canadian Mining and Energy Corporation (CAMECO), and the French nuclear company Areva.

In the 1950s, practically all of the uranium mined in Saskatchewan was used for the production of U.S. nuclear weapons. It is safe to say that during these years, when the U.S. was testing nuclear weapons above ground in the Pacific and in Nevada, the radioactive material spread over those areas came from Saskatchewan. From the 1960s onward, a larger proportion of Saskatchewan's uranium was mined for use in nuclear power plants. After almost half a century of mining, Saskatchewan uranium is used in almost every nuclear power reactor in Canada, the U.S., Japan, South Korea and Western Europe.

Health and environmental effects

Radiation effects are greatest among the uranium miners themselves. The Saskatchewan Uranium Miners Cohort Study showed that while the miners generally tended to show better health parameters than the average population ("healthy worker effect"), their rate of lung cancer was significantly increased by up to 30 %. Of the 16,770 miners in the cohort, 2,210 (23 %) were diagnosed with cancer between 1969 and 1999. Further studies were not undertaken, based on the claim that mining safety standards had been improved and that no effects were likely to be seen in statistical analysis.

Along with the miners, the local population was also affected by radioactive contamination from uranium mining. Uranium ore is usually crushed and processed in a mill to extract a small quantity of enriched "yellowcake." The remaining wastes are either dumped on large tailings heaps or in tailings ponds. For every ton of "yellowcake," up to 1,000 tons of radioactive tailings are produced. Because these tailings contain substances such as radon, radium, polonium and thorium, they retain about 85 % of the ore's original radioactivity. Uranium tailings must be secured for thousands of years in order to prevent these substances from entering the biosphere. Radon gas, however, identified by the WHO as the second leading cause of lung cancer after smoking, is continuously emitted during mining, milling and from the tailings. The native Cree and Dene people rely on fish and caribou for their survival. Both are greatly affected by uranium mining contamination.

Outlook

For people affected by radiation exposure, there is no light at the end of the tunnel. Saskatchewan Premier Allan Blakeney said in 1970s that "on the issue of radioactive waste disposal we have had to make a leap of faith and assume that a satisfactory means of disposal will shortly be found." Several decades later, there is no satisfactory solution – only a longer list of failed attempts. The first phase of the clean-up of Saskatchewan's abandoned uranium mine sites was only announced in 2007 and is estimated to cost $24.6 million. The growing volume of nuclear waste poses a safety and health risk for generations to come. As a result, the native people of the Dene, Metis, Cree and Settlers have begun to organize themselves in organizations like the "Keepers of the Athabasca" or the "7000 Generations," protesting against the harmful environmental effects of uranium mining and calling for more responsibility by the nuclear industry. They too, are Hibakusha; they too are affected by nuclear weapons and the industry behind them – an industry that accepts the radioactive contamination of an entire region in order to keep uranium prices low. A peaceful, healthy and sustainable future for Saskatchewan requires an end to uranium mining, independent scientific research on its environmental and medical effects, compensation for those affected and a stringent decontamination of the region.

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http://www.nuclear-risks.org/en/hibakusha-worldwide/arlit-akokan.html

Niger, a country with one of the world’s lowest ranks on the Human Development Index, is also the world’s third largest producer of uranium. Uranium is the raw material needed for nuclear fuel, as well as nuclear warheads. The downside of this lucrative business: In mining cities like Arlit and Akokan, independent researchers have found increased cancer rates as a result of radioactive tailings and dust from uranium mining.

http://www.nuclear-risks.org/en/hibakusha-worldwide/black-hillspaha-sapa.html

Black Hills/Paha Sapa, USA

Uranium mining site

The Black Hills are considered a sacred place by the Lakota people and are representative of the entire four-state region of South Dakota, Wyoming, Montana and North Dakota, where thousands of uranium mines or exploration wells are located. For more than 40 years, the local population has been exposed to the radioactive legacy of the former uranium rush.

History

Because of their enormous amount of natural resources, the Black Hills have been extensively mined for centuries. The Native American Lakota nation shares a long history with the mountains, which they consider a sacred spiritual site and call “Paha Sapa.” In 1868, the U.S. government signed the Fort Laramie Treaty with the Great Sioux Nation, which guaranteed the Lakota that no white settlement would take place in the Black Hills. Only a few years later, however, gold was discovered in the area and, with the ensuing gold rush, the treaty was no longer honored.

Apart from gold mining, which still plays an important role in the region today, the discovery of uranium in the 1950s has had an immense impact on the life of the Lakota. Uranium ore was initially mined in the southwestern Black Hills near the city of Edgemont, but very soon more mines opened all over the Black Hills and the nearby Cave Hills. Between 1951 and 1964, the yield of the mines in the region exceeded 680,000 kg of yellowcake, the refined uranium dust needed for nuclear warheads and reactors. In the 1980s, environmentalist groups managed to stop uranium mining in the area. Because of regulations and limited efforts to rehabilitate the region, however, the abandoned mines were never properly sealed or protected from leaks and spills.

Health and environmental effects

The old mine shafts, which were not adequately sealed, are a major concern of the people living in the region. According to the environmentalist organization “Defenders of the Black Hills,” there are hundreds of these unsealed mines, as well as thousands of exploration wells and drill holes, some more than 200 m deep, scattered all across the four-state area. Many are filled with water and there is the constant danger of leaks and spills into the surrounding creeks that can potentially contaminate underground aquifers or the larger Cheyenne and Missouri rivers. Field studies in the years 1999–2000 found radiation doses of 40 mSv/h, or about 200–400 times natural background radiation.

After the U.S. Geological Survey found elevated concentrations of dissolved uranium in the Arikaree aquifer below the Lakota reservation of Pine Ridge, the local council asked the Agency for Toxic Substances and Disease Registry (ATSDR) to investigate water and air samples. They found increased concentrations of alpha emitters in drinking water supplies as well as unhealthy levels of radon gas in private residences at Pine Ridge. The "Defenders of the Black Hills" also conducted their own investigations in cooperation with Energy Laboratories and detected alpha emitters exceeding recommended dose levels. Drinking this water and ingesting the radioactive particles can cause cancer and other diseases.

Within the reservation, an extremely high number of people suffer from cancer, diabetes and kidney failure. High incidences of stillbirths, miscarriages and deformities are also reported among the population of the Black Hills. Beyond the small preliminary air- and water-studies however, no investigations of the evident health problems of Pine Ridge residents have been undertaken so far.

Outlook

Although uranium mining was stopped in the 1980s, new mines were commissioned in the 1990s. In 2011, the Canadian company Powertech announced plans to restart uranium mining in the Black Hills near Edgemont. Environmentalists are concerned about further contamination of the underground aquifers of the Black Hills region, four of which would be affected by the planned mine. In addition to the social and economic problems of reservation life, the Lakota suffer from the legacy of four decades of uranium mining. To this day, there has not been an adequate scientific workup of the Lakota's health problems. Therefore, the effects of further radioactive contamination of the region through continued uranium mining cannot even be predicted. What can be said with certainty, however, is that the health of the local population has been sacrificed for the profits of the nuclear industry. Like so many people around the world, who are suffering from the industry's endless appetite for cheap uranium for its warheads and power plants, the Lakota, too, can rightly be called Hibakusha.

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http://www.nuclear-risks.org/en/hibakusha-worldwide/church-rockkinlitsosinil.html

Church Rock/Kinłitsosinil, USA

Uranium mining site

In July 1979, a dam breach at the United Nuclear Corporation's uranium mill in Church Rock, New Mexico released massive amounts of radioactive waste water into the Puerco

River. The Church Rock radiation spill was larger in magnitude than the nuclear reactor meltdown at Three Mile Island earlier that year, and is considered the largest release of radioactivity in the history of the U.S. civil nuclear program. The indigenous Navajo people have been exposed to increased levels of radiation for decades.

History

The small town of Church Rock, New Mexico is part of the semi-autonomous Navajo Nation. After uranium was discovered here in the early 1950s, the town became the hub of the uranium mining industry in the region. Today, there are 20 abandoned uranium mines and mills in the Church Rock area, most of which produced uranium ore for the expanding U.S. nuclear weapons program. In 1968, the United Nuclear Corporation (UNC) opened the largest underground uranium mine in the United States in Church Rock. UNC's Church Rock Mill, which employed about 200 Navajo workers and produced more than 1,000 tons of uranium oxide (U3O8) per year. For every ton of this concentrated uranium, several thousand tons of radioactive tailings were dumped in the surrounding countryside, which was largely used for livestock grazing and recreation, or in large tailings ponds, to protect them from winds.

After numerous smaller leaks had already occurred in the past, a major breach of a tailings dam on July 16, 1979 released more than 1,000 tons of radioactive waste and 360 million liters of contaminated effluent into the nearby Puerco River. The Church Rock uranium mill spill would gain dubious fame as the largest release of radioactive contaminants in U.S. history, even surpassing the nuclear meltdown at Three Mile Island several months earlier.

Despite dramatic spikes of radioactivity readings in water, air and soil samples, requests by the Navajo Tribal Council to have the site declared a disaster area were denied. The mill was closed in 1982 and was placed on the U.S. Environmental Protection Agency's (EPA) national priorities list.

Health and environmental effects

Tailings from Church Rock contained radium, thorium and other uranium decay products capable of causing cancer after ingestion or inhalation. The rural, low-income Native American population living in the region have been chronically exposed to these radioactive isotopes for more than three decades.

Contamination of water supplies and soil, as well as farm animals and vegetable crops, exposed the local population to doses of excess radiation and while there was no evidence of acute harm to the 1,700 individuals most affected by the spill, public health experts have expressed concerns regarding the long term health effects of chronic radiation exposure. The EPA detected widespread radium contamination in 14 areas around Church Rock and has acknowledged an elevated health risk from radium-contaminated dust particles, radon gas, polluted rainwater, radioactive runoff and contaminated livestock. Diseases associated with exposure to these radioactive substances include bone marrow depression, cataracts, kidney disease, malformations and cancer. Children and people with genetic predispositions or immunodeficiency have a higher risk, as their bodies are more vulnerable than average to ionizing radiation.

In 1990, the Radiation Exposure Compensation Act (RECA) mandated "compassion payments" of $100,000 to uranium miners diagnosed with cancer or respiratory ailments. Receiving this compensation was made difficult, however, by a certification process that presented barriers to Navajo claimants. In 2003, the Navajo Nation founded the Church Rock Uranium Monitoring Project (CRUMP) in order to assess environmental and health impacts of abandoned uranium mines on the local population.

Outlook

Between 2003 and 2007, the Church Rock Uranium Monitoring Project found increased uranium concentrations and levels of gamma-radiation in soil samples near residential areas. Water from the

Puerco River, which was used for watering and livestock, was also found to be contaminated. The long-term effects of this radioactive exposure have not been studied. In 2012, plans were announced to conduct an epidemiological study on pregnant Navajo women to assess health effects of uranium exposition on them and their children. The Navajo Nation has repeatedly called for a federally funded clean-up of abandoned mines that produced uranium for U.S. nuclear weapons and has also voted to ban the resumption of uranium mining. The Navajo of Church Rock are also Hibakusha. Their health was compromised for cheap nuclear fuel and fissile material for nuclear warheads.

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Jáchymov, Czech Republic http://www.nuclear-risks.org/en/hibakusha-worldwide/jachymov.html

Uranium mining site

Having grown rich by the discovery of uranium in its mines, the town of Joachimsthal/Jáchymov soon became one of the Soviet Union's suppliers of fissile material for its nuclear weapons program. A large number of miners, many of whom were forced laborers, soon developed lung cancer due to exposure to radioactivity.

http://www.nuclear-risks.org/en/hibakusha-worldwide/jadugoda.html

Jadugoda, India

Uranium mining site

Uranium mining in the region around Jadugoda has not only contributed to India's nuclear weapons program, but has caused grave environmental damage as well. Also, the indigenous Adivasi people are experiencing serious health problems due to continued exposure to radioactivity from working in the mines and living near the irradiated tailings.

History

When India began searching for fissile material to fuel its young nuclear industry in the early 1950s, it found uranium ore deposits near the sleepy village of Jadugoda (also spelled Jadugora) in the state of Jharkhand. About 35,000 people belonging to the indigenous Adivasi tribes live within a 5-kilometer radius of the mines. These communities had to give up their fields and rice paddies to make room for the mining industry. In 1967, India's state owned uranium corporation, UCIL, began mining uranium near Jadugoda and, later, near the surrounding villages of Bhatin, Narwapahar and Turamdih, employing 5,000–7,000 people in the mines. A uranium processing plant was also set up, manufacturing "yellowcake," which is used to provide energy for nuclear power plants and to deliver the fissile material for India's nuclear weapons program.
As a result of low uranium content of 0.06 %, the Jadugoda mines generate large quantities of radioactive waste, so called tailings, which are transported by pipelines to huge tailings ponds. Accidents and spills at these nuclear waste depositories are frequent, however, as safety precautions are minimal. On December 24, 2006 for example, a pipe carrying radioactive wastes from the mill to a tailings pond burst, discharging highly toxic wastes into the Subarnarekha river.

Health and environmental effects

The people of Jadugoda are exposed to radioactivity in several ways: mining and milling operations produce uranium dust and release radon gas, both of which are inhaled by miners and cause internal irradiation. Uranium ore is transported in uncovered trucks on bumpy roads, causing radioactive debris to fall off and land on the side of the road, where it can irradiate unwitting pedestrians for many years.
The mine tailings retain 75–80 % of the ore's original radiation and are dumped in unlined and uncovered ponds, which emit radon gas and gamma radiation. Villages such as Dumridih are located right next to these tailings ponds. During the dry season, dust from the tailings is blown through these villages; during the monsoon rains, radioactive waste spills into the surrounding creeks and rivers, causing further internal radiation as villagers use the contaminated water for washing and drinking. Radioactive waste rock was also used to construct roads and houses in the villages.
An independent study carried out by the Indian Doctors for Peace and Development (IDPD) in 2007 surveyed nearly 4,000 households in a large-scale case-controlled study. They found that babies born in the affected area had almost twice as many congenital deformities as babies born in non-contaminated control villages and that these led to death in 9 % of the cases – more than 5 times higher than the reference mortality rate. The study also showed a higher rate of infertility among couples in the affected area, a lower life expectancy and a higher mortality rate due to cancer. A study performed by the Kyoto University of Japan in 2004 found excess gamma radiation exceeding 1 mSv per year in the villages and reaching 10 mSv per year around the tailings ponds. As internal radiation probably contributes most to total doses however, the individual levels of exposure to

radioactivity are likely to be much higher than these estimates. It has been established that an additional exposure of 1 mSv per year leads to two additional cancer cases per 10,000 people per year, while an additional exposure of 10 mSv would lead to 20 additional cancer cases per 10,000 people per year.

Outlook

As several studies have shown significant health effects of uranium mining on the local population, comparable to those found in other uranium mining sites around the world, the Bihar Legislative Council called in 1998 for an evacuation of the villages at least 5 km away from the tailings ponds as well as more effective safety precautions. Their report was largely ignored and nothing has happened since. Instead, UCIL has financed and published studies that aim to demonstrate that no medical effects are to be expected in the local population. The tragedy in Jadugoda continues. In the process of helping the Indian government develop nuclear weapons, the Adivasi became Hibakusha.

Further information

On YouTube you can find two informative background movies on the subject of uranium mining in Jadugoda:
"Buddha weeps in Jadugoda" produced by the Bindrai Institute for Research Study & Action:
http://youtu.be/upzt4ESu908
"Jadugoda – The Black Magic," produced by IDPD:
http://youtu.be/eIOmavVcG3M

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Mailuu-Suu, Kyrgyzstan http://www.nuclear-risks.org/en/hibakusha-worldwide/mailuu-suu.html

Uranium mining site

The former uranium mining town of Mailuu-Suu is notorious for its insecure radioactive waste rock heaps and tailings dumps in tectonically unstable hillsides. Thousands of people have already been affected by radioactive contamination of the Mailuu-Suu river system and the region's high seismic activity continually threatens to wash more radioactive waste into the drinking water supply of the valley.

Mounana, Gabon http://www.nuclear-risks.org/en/hibakusha-worldwide/mounana.html

Uranium mining site

During decades of uranium mining in the jungle of Gabon, the French nuclear company COMUF neglected environmental safety standards, exposed mine workers to high doses of radiation and dumped thousands of tons of radioactive waste into the delicate ecosystem of the Mitembe River. This radioactive legacy continues to harm the environment of the region and the health of its inhabitants.

http://www.nuclear-risks.org/en/hibakusha-worldwide/olympic-dam.html

Olympic Dam, Australia

Uranium mining site

The uranium mine at Olympic Dam poses a threat to the ecosystem of the region and a health hazard to the workers and the surrounding populations. Uranium tailings, leaks and spills have caused severe radioactive contamination of the environment. With plans on the way to enlarge the mine in the coming years, comprehensive studies on health and ecological effects are urgently needed.

History

The Olympic Dam mine near the town of Roxby Downs in South Australia is not only the largest underground mine on the continent, but is also the site of the world's largest known uranium ore deposit. Western Mining Corporation began drilling at Roxby Downs in 1975, producing the first shipments of copper, gold, silver and uranium in 1988. In 2005, the mine was taken over by the global mining firm BHP Billiton. Olympic Dam yields about 4,500 tons of uranium oxide per year, producing about 10 million tons of radioactive tailings in the process – more than 2,000 tons for each ton of uranium oxide.

As uranium mining is heavily dependent on water for processing ore and suppressing radioactive dust, up to 15 million liters of fresh ground water are pumped from Australia's largest aquifer, the Great Artesian Basin, to the mine each day. BHP Billiton is currently planning to expand operations at Olympic Dam, turning it into one of the world's largest open pit mines. This would increase uranium production to about 8,000 tons a year, making Olympic Dam the biggest uranium mine in the world. Water use, however, would also more than double to 42 million liters daily, and the amount of new radioactive tailings would reach 68 million tons each year.

Health and environmental effects

The depletion of groundwater supplies in the Great Artesian Basin poses a severe environmental hazard to the delicate ecosystem of the Australian Outback, which depends on the mound springs, naturally rising up from the Great Artesian Basin. They provide sustenance not only for the local flora and fauna, but also for the Aboriginal communities like the Arabunna or the Kokatha, who have been living in this arid region for centuries. For the indigenous people of Australia, the mound springs hold great spiritual and cultural significance and the gradual disappearance of the sacred springs through receding levels of groundwater is seen as a tragedy of epic proportions. An additional cause of concern is the growing mounds of tailings, retaining about 80 % of the ore's original radioactivity. The International Atomic Energy Agency (IAEA) reported that tailings dam leaks have already led to the release of more than five million m^3 of radioactive waste into the environment. Many more leaks and spills may have gone unreported.

As part of its enlargement plans, BHP Billiton has announced that seepage of radioactive waste water would amount to eight million liters per day for ten years and would then decrease to an "operational steady state" of three million liters per day. In addition, the company identified several possible health hazards such as breaches of tailings dams, erosion of embankments, radioactive radon emissions from tailing dumps and the inhalation of radioactive dust. They also conceded the possibility of a contamination of soils, groundwater and the surrounding environment.

Outlook

While the South Australian parliament has already given the green light to expansion of the mine, Aboriginal groups, opposing further encroachment on their traditional lands, filed a lawsuit, trying to prevent what many in Australia view as an environmental disaster in the making. Medical experts, including Nobel Prize winner Prof. Peter Doherty, former Dean of Adelaide Medical School Prof. Bob Douglas, and Executive Dean of Health Sciences at Flinders University Prof. Michael Kidd, recommended freezing the project until health impacts could be studied. They demanded that BHP should put aside funds to pay for the health effects for centuries. To this day, no independent comprehensive health assessments of the local population or environmental studies of radioactive contamination have been published. The people in the region who are suffering from increased radiation levels are also Hibakusha – their health was negatively affected by the nuclear industry's insatiable appetite for cheap uranium.

Further information:

The intelligent documentary "Uranium – is it a country?" was shot at Olympic Dam in 2009: www.strahlendesklima.de/en/uranium

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http://www.nuclear-risks.org/en/hibakusha-worldwide/radium-hill.html

Radium Hill, Australia

Uranium mining site

Radium Hill, Australia's first uranium mine, was operational between 1906 and 1961. Due to their exposure to uranium dust and radon gas, many miners developed lung cancer. In addition, unsecured tailings dumps have caused severe radioactive contamination of the surrounding countryside.

History

After the inadvertent discovery of radium and uranium in the desert northeast of Adelaide, the first mines sprang up in 1906 and the area was named "Radium Hill." In 1911, a refinery began to produce radium compounds which were sold to international researchers, including Ernest Rutherford and Marie

Curie. In March 1952, the Australian government signed a contract with the UK-USA Combined Development Agency, guaranteeing uranium supply, and Radium Hill began to produce fissile material exclusively for the U.S. and UK nuclear weapons programs. The mine's output between 1954 and 1961 was almost 970,000 tons of ore, which was then processed to about 860 tons of fissile uranium oxide (U_3O_8) or "yellowcake." The radioactive leftovers of uranium mining, waste rock and tailings, however, were left at Radium Hill.
The mine was officially decommissioned in 1961. The three large tailings dumps, containing an estimated 225,000 tons of radioactive waste, were left uncovered so that winds swept away radioactive debris for almost 20 years, contaminating the surrounding countryside. In 1981, the tailings were finally covered with soil. Due to persistent erosion, however, radioactive waste continues to be discharged from the tailings dumps to this day. Until 1998, about 16 shipments of radioactive waste, including contaminated soil from the area around Adelaide, were deposited at the newly founded nuclear waste depository at Radium Hill.

Health and environmental effects

Since the 1980s, scientists from Adelaide University have been investigating the relationship between occupational exposure to radon progeny and rates of lung cancer in uranium mine workers. Incidences were calculated using death registers and by interviewing surviving miners. A total of 2,574 former mine workers with lung cancer were identified. Exposure was estimated from historical records of radon gas concentrations in the mine. Among the miners traced until the end of 1987, lung cancer mortality was significantly elevated, compared to the average population in Australia (standardized mortality ratio of 1.94). Compared to open-pit miners, lung cancer mortality was markedly increased among underground miners, particularly those with long-time exposure to radioactive substances. Miners with more than 40 year of occupational exposure showed a five-fold increase, while miners with 10–40 years of occupational exposure showed a two-fold increase in the risk for lung cancer, assuming an arbitrary average of 170 hours of radiation exposure per year – the so-called "working level month" or WLM.
Uranium mining presented a public health problem not only for the miners, but for the entire local population. Radioactive mine tailings contaminated large parts of the region, as they were not properly secured from wind or erosion. In 2006, radiation measurements near the tailings were still as high as 0.94 mSv/h – more than 3,000 times natural background radiation of 0.0003 mSv/h. Also, radioactive isotopes such as thorium, rubidium and uranium have been found in local soils, especially in the most affected regions towards the south, where the city of Adelaide is located, 460 km away.

Outlook

While uranium mining was halted at Radium Hill in 1961 and no more radioactive waste has been deposited there since 1998, the entire site remains a radioactive danger zone, with tailings and waste rock not properly secured from erosion and dispersion. To this day, no proper epidemiological studies have been undertaken to investigate the health effects of uranium mining and the radioactive contamination of the region. The people, whose health has been compromised for the production of nuclear weapons, they are also Hibakusha.

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http://www.nuclear-risks.org/en/hibakusha-worldwide/ranger.html

Ranger, Australia

Uranium mining site

Ranger is an open-pit uranium mine in the middle of the World Heritage Kakadu National Park. Numerous radioactive leaks and spills have contaminated the Kakadu wetlands, which are the home of the Mirarr Aboriginal people. Increased cancer rates have been found in the local population, but further studies have so far not been undertaken.

History

Energy Resources of Australia, Ltd (ERA), a subsidiary of the global company Rio Tinto, began mining uranium at Ranger in 1980. While the mine has an annual output of about 4,000 tons of uranium oxide, mine tailings and radioactive waste rock amount to 1.5 million tons per year. This nuclear waste is stored in so-called tailings ponds and still contains about 80 % of the ore's original radioactivity. In order to prevent the spread of radioactive dust or radon gas, the tailings are supposed to be covered by two meters of water, which cannot always be ensured during dry season, with the result that radioactive dust is blown into the National Park. During the wet season, the tailings dams often overflow, spilling radioactively contaminated refuse into the wetlands. Since 1981, there have been at least 120 such incidents. In 2004, the mine was temporarily shut down after it was discovered that workers drank water containing about 400 times the permissible level of uranium. In 2009, a breached dam released six million liters of radioactively contaminated water into Gulungul Creek in the National Park. In 2011, operations at Ranger were suspended for six months because a tailings dam came close to overflowing. Uranium is transported on trucks straight through the National Park, posing an additional hazard to the vulnerable ecosystem.

Health and environmental effects

There is great concern among environmentalists and the local Aboriginal population about radioactive contamination of Australia's most famous National Park. In 2009, Alan Hughes, the Commonwealth Supervising Scientist appointed to monitor the environmental impacts of the mine, made public that the mine's tailings dam was leaking 100,000 liters of waste water every day, polluting the park's groundwater with heavy metals, toxic chemicals, and radioactive substances such as radium and uranium. The contamination of the wetlands and the park's diverse wildlife is poisoning the Mirarr's sources of food and water.

Even small levels of radiation exposure are known to be an increased risk to human health. In 2005/2006, a study performed by the Federal government's leading indigenous research body found that cancer incidence among the Aboriginal population of Kakadu had increased 90 % more than would be expected. Radioactive contamination is the most likely explanation for this significant rise in cancer cases, but large-scale epidemiological and ecological studies are needed to further investigate these findings. The Gundjeihmi Aboriginal Corporation, which represents the Mirarr, has long been calling for proper health studies to assess rates of stillbirths, miscarriages, congenital malformations or cancer – symptoms which have been on the rise in the local population since the beginning of uranium mining.

Outlook

Although Ranger was slated to close in 2008, ERA announced it would extend the run-time of the mine until 2020, so it could extract an additional 11,000 tons of uranium from low-grade ore stockpiles using a dangerous technology known as Acid Heap Leaching. This proposal was abandoned in 2011, following strong opposition from environment, health and indigenous groups. The nearby Jabiluka site was also designated for uranium mining, but a huge domestic and international campaign led by the Mirarr was able to prevent this project. There are still no concrete plans for an effective monitoring of environmental or health effects. On December 7, 2013, about one million liters of radioactive refuse leaked into the National Park, prompting the temporary closure of Ranger Mine. The people of Kakadu continue to be Hibakusha – casualties of the nuclear industry and its endless appetite for cheap uranium.

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Rössing, Namibia http://www.nuclear-risks.org/en/hibakusha-worldwide/roessing.html

Uranium mining site

The Rössing uranium mine has been a cause for concern for more than 30 years. Unsafe and inhumane working conditions, occupational exposure to radioactivity and the contamination of the environment with uranium tailings and radioactive waste rock all pose serious public health problems.

http://www.nuclear-risks.org/en/hibakusha-worldwide/shiprocktse-bit-ai.htmlUranium mining site

Shiprock/Tsé Bit' A'í, USA

Uranium mining site

The uranium mine at Shiprock left a legacy of health and environmental damage that affects indigenous Navajo communities to this day. Moreover, pressure is mounting to reopen the mines in order to fuel new generations of nuclear warheads and power plants.

History

Named for a prominent rock formation, Shiprock is a town in northwest New Mexico and part of the Navajo Nation, the largest indigenous reservation in the United States. For almost three decades, uranium was mined here in order to produce fissile material for U.S. nuclear weapons and power plants. Mining around Shiprock began in the 1940s, and was especially active in the following two decades, when U.S. nuclear weapons production peaked. The Vanadium Corporation of America and Kerr-McGee were the principal mining companies. Few, if any, health and safety regulations existed to protect the poorly paid miners and mill workers, most of whom were recruited from local Navajo communities. While the connection between uranium mining and lung cancer had been established as early as the 1930s, and the dangers of radon gas, which permeates uranium mines, were well known, this information was withheld from the miners and their families. In fact, there is no word for "radiation" in the Navajo language. When mining operations ceased in the 1970s, more than 200 tunnel openings were left unsealed and enormous piles of radioactive waste rock and tailings were abandoned without adequate protective measures.

Health and environmental effects

During the 1960s, studies found dramatic spikes in lung cancer and other illnesses in the region. Of the 150 Navajo who worked at the uranium mines in Shiprock, 133 had died of lung cancer or various forms of fibrosis by 1980. Lung cancer risk in Navajo uranium miners is 20–30 times greater than for other Navajo men. Moreover, 67 % of lung cancer cases in Navajo men between 1969 and 1993 have been attributed solely to uranium mining, without any relevant confounding factors. A frequently cited article described a statistically significant association between uranium mining and congenital birth defects among Navajos born in Shiprock.

As a reaction to these worrying developments, the miners organized a union and formed the Uranium Radiation Victims Committee, which educated people about the hazards of uranium mining. The group sued the state and federal governments for compensation and sought stricter legislation to protect people and the environment from the effects of uranium mining. In 1990, the U.S. Congress passed the Radiation Exposure Compensation Act. That same year, the Navajo Tribal Council formed the Office of Navajo Uranium Workers to create a worker registry and provide medical care to those affected by radiation. In 2010, as part of a $270 million settlement with Kerr-McGee, the Environmental Protection Agency (EPA) and the Navajo nation received $14.5 million to address uranium contamination, including $1.2 million specifically for Shiprock. To this day, however, up to 9.5 million liters of contaminated water leaks into the San Juan River from Shiprock uranium mills every year. The EPA stated that "approximately 30 % of the Navajo population does not have access to a public drinking water system and may be using unregulated water sources with uranium contamination."

Outlook

Today, Shiprock is usually associated with the 400,000 m² nuclear waste dump, containing the waste rock and tailings from more than 22 uranium mines and mills. In the mid 2000s, studies showed that more than 1.8 million liters of groundwater were contaminated with uranium, selenium, radium, cadmium, sulfate and nitrate. Parts of the San Juan River showed uranium concentrations that were between 47 to 97 times above official safety levels. While tribal officials have noted progress on groundwater clean-up in Shiprock, they have criticized the ongoing failure of the U.S. government to assess the health impacts of decades of radioactive exposure of miners and local populations. In their search for cheap uranium for its civil and military nuclear programs, the U.S. government knowingly exposed the local population to radioactivity, turning the Navajo of Shiprock into Hibakusha.

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http://www.nuclear-risks.org/en/hibakusha-worldwide/spokane-reservation.html

Spokane Reservation, USA

Uranium mining site

Over several decades, the Spokane Reservation was contaminated by open-pit uranium mining and its inhabitants exposed to increased levels of radioactivity. As on other Native American lands, no proper studies were conducted to assess the health effects on the local population.

History

The Spokane Indian Reservation, about 640 km² in size, was created in 1881 for the local Native American population, who call themselves Spokane – the "Children of the Sun." In 1954, two locals discovered uranium on the reservation. It was the time of the great "uranium fever," and the U.S. Atomic Energy Commission was offering lucrative contracts in order to jump-start the uranium industry in the country. The U.S. nuclear weapons program was in desperate need of fissile material and people all over the country were looking for prospective uranium deposits. In 1955, the LeBret brothers opened the Midnite uranium mine with help from the Newmont Mining Corporation. The uranium business offered jobs and wealth, but brought with it a haunting legacy: after Midnite Mine was closed in 1981, 33 million tons of radioactive waste had accumulated in the reservation. In 1978, a second mine was opened in Spokane. Sherwood produced about 2.9 million tons of tailings and more than 267,000 m³ of radioactive waste until it was decommissioned in 1984.

Health and environmental effects

Like other uranium mining projects on Native American land in the U.S. and Canada, the open-pit mines in Spokane had enormous effects on the lives and health of local residents. According to the Native American Sovereignty, Health, Air, Water and Land Society (SHAWL), mine sludge was transported in uncovered trucks through the reservation on the way to the mill and frequent spills resulted in a total of 40 hot spots along the highway.

Contamination of groundwater and soil with radioactive isotopes such as radium-226, radon-222, lead-210 and uranium poses severe health threats to the Spokane people. Contaminated water continues to drain into Blue Creek and Spokane River and eventually feeds into Lake Roosevelt. Sediment, plant and water samples have all been shown to contain high levels of radioactivity. Like other indigenous populations, the Spokane people's subsistence lifestyle and their cultural practices, such as hunting, fishing, gathering roots and berries, logging and the use of medicinal plants, predispose them to an increased exposure to radioactivity.

Workers in the mine and mill handled uranium ore and yellowcake powder daily, mostly without proper protective gear. They brought home ore samples or dust on their clothing, so that their families also breathed in radioactive dust and were exposed through contaminated food and drink. Residents and mine workers complained about not being informed of the risks of radioactivity. According to SHAWL and local physicians, the rate of cancer, autoimmune diseases, renal failure and stillbirths in Spokane is higher than the national average. Despite all the evidence of exposure to radioactive and heavy metal toxins, no baseline health studies have ever been undertaken in Spokane and no dose estimates exist which could help in assessing health effects.

Outlook

A clean-up plan, estimated to cost 193 million USD, was finally agreed upon in 2011 – 30 years after the Midnite Mine was closed. In the meantime, the local population has been continually exposed to radioactivity and no proper epidemiological studies have been conducted. The full impact of uranium mining on the environment and public health may never be known. The people of Spokane are also Hibakusha, because their health was sacrificed for cheap uranium for power plants and nuclear warheads.

Further reading

An informative article called "Radioactivity on the Spokane Reservation" was published in the newspaper "The Spokeman" on June 5th, 2011: www.spokesman.com/picture-stories/radioactivity-spokane-reservation.

SHAWL's website (shawlsociety.blogspot.de) also offers a wide array of articles and background information about the situation in Spokane, such as the video "The Midnite Uranium Mine": www.youtube.com/watch?v=59TR_NXyZY0

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Têwo/Diébù, China http://www.nuclear-risks.org/en/hibakusha-worldwide/tewodiebu.html

Uranium mining site

"Uranium Mine 792" at Diébù has been producing uranium for the Chinese nuclear industry and nuclear weapons program since 1967. Reports about radioactive contamination and a lack of safety measures, endangering the health of miners and the inhabitants of the region, have been ignored and subdued by the authorities.

Wismut region, Germany http://www.nuclear-risks.org/en/hibakusha-worldwide/wismut-region.html

Uranium mining site

Between 1946 and 1990, the joint Soviet-East German stock company Wismut turned the Erzgebirge mountain range in Saxony and the adjacent Vogtland in Thuringia into one of the world's largest uranium mining regions and the most important supplier of uranium to the Soviet nuclear weapons program. As a lasting legacy, many thousands of workers and inhabitants of the region are still suffering from radiation induced diseases such as lung cancer

Witwatersrand, South Africa http://www.nuclear-risks.org/en/hibakusha-worldwide/witwatersrand.html

Uranium mining site

Inadequate controls and safety standards in the uranium mining industry in the Witwatersrand basin have resulted in an environmental catastrophe. Radioactive tailings and contaminated water are not just detrimental for the ecosystem in the region, but also represent a grave public health problem. At the same time, South Africa's nuclear industry is a good example of the intangible connection between civil and military nuclear programs and the inherent proliferation risk of nuclear energy.

Transportation.

Yellowcake is the processed uranium that is then transported, often by truck to a refining plant. In Canada, it goes from Northern Saskatchewan to Blind River and then to Port Hope, Ontario. Accidents do happen and there is the risk of radioactive contamination of the environment, particularly rivers and lakes that maybe used for drinking water.

Refining

Accidents do happen. Here is one at Blind River: 'Nuclear Awareness News', Canada, Spring 1990 WISE Nuclear Monitor #335 6/7/90 http://scott-ludlam.greensmps.org.au/let-thefacts-speak

The soil around Port Hope is particularly contaminated by radioactive waste. The government is spending large sums of money to remove the soil, that is on school grounds and all around the city. This radioactivity can cause miscarriages, mutagenic and teratogenic effects to foetuses, including down's syndrome. It can cause leukemias in children and cancers in women.
See; http://forum.stopthehogs.com/phpBB2/viewtopic. php?t=1254
CCNR submission on the proposed relicensing of Cameco's Port Hope Conversion Facility, 19 Dec 2011, www.ccnr.org/CCNR_Submission_2011.pdf

Nuclear Power Plants

There have been a few studies such as the KiKK study in Germany that found higher incidence of leukemias in children less than five years who had lived within five kilometres of a nuclear power plant. https://www.nirs.org/wp-content/uploads/radiation/radhealth/kikkcommentary0709ijoeh.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3844919/
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Studies in Canada have been poorly designed by covering too large an area for a limited duration with too small a sample size such that small differences aren't significant.
https://www.sciencedirect.com/science/article/pii/S2213538315300199
As mentioned, there have been major disasters of Chernobyl and Fukushima with the latter still releasing radiation into the environment. Large tracks of land are now uninhabitable and food sources are contaminated with radioactivity, including fish near Fukushima. Radioactivity is concentrated up the food chain and we are the top predator.

http://www.nuclear-risks.org/en/hibakusha-worldwide/chernobyl.html

Chernobyl, Ukraine

Nuclear power plant meltdown

The Chernobyl nuclear meltdown in April 1986 was the most devastating nuclear catastrophe in history. Huge stretches of land were radioactively contaminated and made uninhabitable for generations. Nuclear fallout led to tens of thousands cases of cancer, malformations, still-births and deaths – not just in the former Soviet Union, but around the world.

History

The first nuclear reactor unit in Chernobyl was built between 1971 and 1977. By 1983, the plant had been expanded to include four reactor units. The neighboring city of Pripyat was home to 18,000 inhabitants, most of whom were employed directly or indirectly by the plant. The disaster began during a systems test on Saturday, April 26 in 1986. An emergency shutdown was attempted after a sudden power surge and a super-critical mass was reached, leading to a nuclear chain reaction. The reactor roof, weighing 1,000 tons, was lifted up by a giant explosion and the graphite on the fuel rods caught fire. A plume of highly radioactive smoke drifted over large parts of Eastern- and Central Europe and covered whole regions with radioactive fallout. Belarus, north of Chernobyl, received an especially large amount of fallout. Scandinavian countries, Asia Minor, and parts of Central Europe such as Bavaria registered radioactive iodine-131 and cesium-137. The nuclear meltdown was kept secret from the population for days, critically delaying evacuation efforts and protective measures.

Health and environmental effects

The immediate victims of the Chernobyl disaster were the roughly 800,000 people, mostly young red army recruits from across the Soviet Union, who were called in to control the effects of the meltdown – the "liquidators." They had to carry radioactive debris across the accident site with their bare hands and construct a giant sarcophagus above the destroyed reactor. Approximately 15 % of them had already died by the year 2005, 19 years after the catastrophe; more than 90 % have developed diseases, many probably related to radiation exposure.

The explosions and fire spread radionuclides over large parts of Europe. Ingested or inhaled, these particles settle in living tissues, where they irradiate surrounding cells, causing cell damage, genetic mutations and, ultimately, cancer. Three radioisotopes are especially important. Iodine-131 is known to cause thyroid cancer, cesium-137 can cause solid tumors in basically all type of tissues and strontium-90 is a major cause of leukemia.[2] Chernobyl fallout affected not only the highly irradiated regions of the former USSR, but also parts of Northern, Central and Southeast Europe. As large-scale epidemiological research was never undertaken in the rest of Europe, one has to rely on calculations of morbidity and mortality based on collective dose estimations. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) estimated that the population of Europe was exposed to a collective effective dose of 400,000 Person-Sv and collective thyroid dose of 2,400,000 Person-Gy due to Chernobyl. Using internationally accepted risk factors, 21,000 people can be expected to develop thyroid cancer due to Chernobyl fallout and another 36,000 to 140,000 people would develop other types of cancer. A study published in the International Journal of Cancer also estimated 41,000 cases of cancer and more than 15,000 cancer deaths on account of Chernobyl.

While these numbers may seem small in comparison to the size of the affected population, it has to be recalled that each individual case represents a heavy burden not just to a single individual, but to a whole family. Also, these numbers most probably represent only a fraction of the true impact of the catastrophe, as the collective dose estimates and risk factors were subject to systemic underestimations. As with all man-made catastrophes, every single case is one too many. All over

Europe, Chernobyl fallout also led to a rise in stillbirths, malformations, genetic disorders such as Down syndrome, autoimmune diseases such as diabetes and cardiovascular diseases. The psychological, environmental, economic and social effects of the catastrophe must also not be forgotten.

Outlook

In 1986, the ruptured reactor was covered by a temporary sarcophagus. The Ukrainian government has now ordered a new sarcophagus to be built in order to contain the estimated 180 tons of nuclear waste still left inside the reactor. The costs of this new structure add up to 1.5 billion US-dollars.

Because of genomic instabilities and transgenerational effects caused by radiation, the full extent of the disaster on people's health may never be fully known. Chernobyl is more than just a singular event. It continues to kill – day by day, every year. The Soviet government, the nuclear industry and lobby groups such as the International Atomic Energy Agency (IAEA) have been able to obstruct critical publications in their attempt to close the file on Chernobyl. Cynically, they have declared the health problems of the liquidators were caused by stress and bad lifestyle. But the consequences of the Chernobyl catastrophe will continue to affect hundreds of thousands of families for many decades to come. They, too, are Hibakusha. The file on Chernobyl must not be closed.

Further reading

Read the thoroughly researched report "Health Effects of Chernobyl – 25 years after the reactor catastrophe" of the German IPPNW affiliate and the Society for Radiation Protection online at: www.chernobylcongress.org/fileadmin/user_upload/pdfs/chernob_report_2011_en_web.pdf

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http://www.nuclear-risks.org/en/hibakusha-worldwide/fukushima.html

Fukushima, Japan

Nuclear power plant meltdown

The three reactor meltdowns at the Fukushima Dai-ichi nuclear power plant in March 2011 caused the greatest radioactive contamination of the world's oceans ever recorded. In addition, it contaminated soil, air, food and drink and exposed the public to dangerous levels of radiation. It is still too early to predict the full extent of health effects of the disaster, but due to the high amount of radioactivity released, it must be assumed that several tens of thousands of excess cancer cases will occur in the coming decades. Every single case of cancer is one too many.

History

On March 11, 2011, a magnitude 9.0 earthquake hit Northeastern Japan, severely damaging the Fukushima Dai-ichi nuclear power plant. The tsunami that followed wreaked further havoc on the region and complicated the situation. With no electricity to power the cooling systems, water inside the reactors began to boil off, causing meltdowns of the fuel rods. According to TEPCO, all fuel rods in reactor 1 melted, as did 57 % of the fuel rods in reactor 2 and 63 % of those in reactor 3. The heat and pressure from the melting fuel rods caused multiple explosions and a fire in the spent fuel pond of reactor 4.

TEPCO, the company responsible for the plant, began to vent radioactive steam and pumped seawater into the reactors for cooling. These desperate measures were able to prevent larger explosions such as in Chernobyl, but at the same time led to a massive radioactive contamination of groundwater reservoirs and the ocean. Also, emissions from fires, explosions, evaporation and deliberate venting caused several radioactive clouds, which spread nuclear fallout in all directions. About 79 % of fallout occurred over the Pacific Ocean, the rest spread over mainland Japan, including metropolitan Tokyo. The most severe contamination occurred on March 15, when radioactive particles were blown northwest towards the villages of Iitate and Namie, which are among the most heavily contaminated municipalities today.

A total of 200,000 people were forced to leave their homes in a 20 km zone around the power plant. Highly contaminated places outside this zone, such as Iitate or Namie, were only evacuated weeks later and in the initial chaos some people were even sent to places of higher contamination. Despite better knowledge, the government failed to order the distribution of stable iodine to the general population – most likely to prevent mass panic. On April 12, the Fukushima nuclear meltdowns were categorized as a level 7 nuclear accident – the highest level on the International Nuclear Event Scale (INES), previously reached only by the Chernobyl disaster.

Health and environmental effects

Total atmospheric emission in the first four days of the Fukushima nuclear disaster most likely amounted to about 20 % of the total iodine-131 emissions and 40–60 % of the total cesium-137 emissions of the Chernobyl catastrophe. In addition, strontium-90, xenon-133, plutonium-239 and more than two dozen other radioactive substances were emitted. The contamination of the Pacific Ocean with more than 9 Peta-Becquerel of cesium-137 (1 PBq = 1 quadrillion Becquerel) and more than 68 PBq of iodine-131 constitutes the largest radioactive discharge into the world's oceans ever recorded.

Radioactive fallout also contaminated soil, vegetation and ground water reservoirs. In the long term, internal radiation from inhalation of radioactive dust or ingestion of contaminated food and drink represents the most relevant threat to public health. Increased radiation doses have been detected in all kinds of fruits and vegetables grown in the affected regions, as well as in meat, fish, sea-food, rice, milk, tea and tap water. From regions in Southern Germany that were affected by Chernobyl fallout, we know that even after 30 years, local produce can still be too highly irradiated to be safe for consumption. In many regions of northeastern Japan, agricultural production or fishing will not be possible for a long time.

Children are most severely affected by radioactivity, as their bodies have a higher sensibility to radiation and as their natural habits expose them to higher doses. Screenings found increased levels of radioactive cesium-137 and iodine-131 in children, while first clinical studies have already shown unexpectedly high numbers of pediatric thyroid cancers in the affected population.

We can reasonably assume that in years to come, hundreds of additional thyroid cancer cases will be diagnosed. As with lung cancer in smokers, it is not possible to prove that radioactive contamination causes an individual cancer, but with cancer cases showing significant deviation from normal incidence, causality becomes more and more probable. The next years will hopefully bring some clarity and help us make better predictions of long-term health effects.

Alternatively, it is possible to calculate the expected number of cancer cases based on the collective effective dose of the population. It is accepted that there is a linear correlation between radiation dose and cancer risk, meaning that there is no threshold underneath which radiation is safe. In a large enough population, even low doses can cause significant health effects. Based on the individual dose estimates published by the WHO, we can reasonably estimate that Fukushima fallout will lead to 20,000–66,000 additional cases of cancer in Japan in the coming decades. It is very likely, however, that the WHO dose calculations represent systematic underestimations, so that the number of expected cancer cases may in fact be even higher.

Outlook

The situation at the Fukushima Dai-ichi plant is still out of control. Even ten months after the earth-quake, daily radioactive emissions still amounted to 1,440 Mega-Becquerel (1 MBq = 1 million Becquerel) and in 2013, new radiation peaks were measured in ground- and seawater. At the same time, the amount of radioactively contaminated cooling water is increasing by 400,000 liters each day, much of which flows back into the ocean.

Bowing to pressure from scientists, doctors and parents, the Japanese government has decided to lower permissible levels of radioactivity in food. The scathing criticism of the Japanese parliament's Fukushima Nuclear Accident Independent Investigation Commission, which identified corruption and collusion of the nuclear village as one of the main causes of this "man-made disaster," eventually led to the shut-down of all of Japan's nuclear plants. But the future of nuclear energy in Japan is still undecided. The newly elected government has strong ties to the nuclear industry and has already called for restarting many of the plants.

In the meantime, children in Fukushima wear dosimeters and breathing masks outside, pass radioactive hot-spots on their way to school, are barred from contaminated play-grounds, sport fields and beaches and will be subject to medical tests for the rest of their lives. Already, the people affected by Fukushima fallout are called the "new Hibakusha" in Japan.

It is still too early to estimate the full extent of the consequences from nuclear catastrophe. Large-scale epidemiological studies are required, but it is important that research is performed by independent scientists not associated with the nuclear lobby. Claims by researchers affiliated with the nuclear industry that no health effects are to be expected are unscientific and cynical. The Hibakusha of Fukushima deserve to be told the truth.

Further reading:

Current information about the Fukushima nuclear disaster can be found on the IPPNW website www.fukushima-disaster.de

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http://www.nuclear-risks.org/en/hibakusha-worldwide/sequoyah-and-watts-bar.html

Sequoyah and Watts Bar, USA

Nuclear power plants

The twin nuclear power plants of Sequoyah and Watts Bar were included in this exhibition in order to represent nuclear reactors around the world, all of which pose a danger to public health and the environment even without any massive catastrophes – through chronic leakage, spills and malfunctions. In addition, Watts Bar produces tritium for the U.S. nuclear weapons program.

History

The Sequoyah and Watts Bar nuclear power plants, located in Eastern Tennessee between the cities of Chattanooga and Knoxville, are run by the Tennessee Valley Authority (TVA) and have been in operation since 1981 and 1996, respectively. Sequoyah has a bad track record for nuclear incidents: On January 19, 1981, a generator tube malfunctioned, forcing the TVA to shut down the entire plant. On February 11, an operator error triggered an emergency alert: as a result, more than 370,000 liters of radioactive water rained down on 14 workers during the plant shutdown because, in order to cut cost, management had decided to use radioactively contaminated water as emergency coolant rather than fresh, uncontaminated water. Steam leaks, tube malfunctions and overflowing drainage tanks were just some of the reported failures at the plant in the following years. Between 1985 and 1988, Sequoyah was forced to shut down again after an independent review concluded that the plant did not comply with current safety standards. Similar concerns forced another shutdown less than five years later. In 1999, the U.S. Department of Energy selected Watts Bar for the production of tritium, an important component of nuclear weapons. This is just one example of how civil nuclear facilities are used to supply military nuclear components.

According to the independent Union of Concerned Scientists, Sequoyah has a core damage frequency of 1 in 26,525 reactor years, while Watts Bar's risk of a nuclear meltdown is eight times higher – 1 in 3,030 reactor years – despite having been built 15 years later. The nuclear authorities only require a core damage frequency of less than 1 in 1,000, so that even Watts Bar meets these requirements. By comparison, the nuclear power plant at Three Mile Island experienced a meltdown one year after it was commissioned. The Chernobyl meltdown came three years, and Fukushima 40 years, after commissioning. All three plants were constructed with much longer service times in mind.

Health and environmental effects

Tritium, a radioactive isotope of hydrogen, has a half-life of twelve years and emits beta-radiation. It is considered dangerous to inhale or ingest tritium, because, once incorporated, it can damage DNA, causing mutations and cancer. In December 2011, TVA found elevated levels of up to 700 Becquerel per liter of radioactive tritium in groundwater samples taken only 23 meters from of Sequoyah's discharge canal into the Tennessee River. According to TVA, the contamination was most likely caused by a spill in the 1980s or an overflow of the canal in 2003. This raises many questions, such as how many leaks occurred in total, how many of these were actually reported and how high the concentration levels would have been at the time of the incidents. Normal tritium levels in inland waterways are usually well under 10 Bq/l, while rivers around power plants have been found to contain tritium with concentrations of up to 3,000 Bq/l in other Western countries. The effects of radiation exposure on workers and nearby residents around Sequoyah have not been studied so far. A German study, however, published in the "International Journal of Cancer" in 2008, found increased rates of childhood cancer in the vicinity of nuclear power plants. One possible explanation is the leak of radioactive isotopes, including tritium through system failures or the routine exchange of fuel rods, during which the reactor core is opened.

Outlook

After the Fukushima nuclear meltdowns, the U.S. Geological Survey found that the Sequoyah plant, positioned in a seismic zone, has the fourth-highest earthquake risk of all U.S. nuclear reactors. The chances of an earthquake causing a meltdown in one of Sequoyah's reactors was calculated to be 1 in 19,608 – 25 times more likely than being struck by lightning. At Watts Bar, the risk is slightly lower, at 1 in 27,778. In addition, the dams above the Sequoyah plant would not withstand a massive flood of the Tennessee river, putting the nuclear plant and its emergency generators at risk. The people in Tennessee do not want to become Hibakusha like the people in Fukushima.

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Three Mile Island, USA

Nuclear power plant meltdown

The most infamous nuclear reactor accident in U.S. history occurred at the Three Mile Island nuclear plant in March 1979. Equipment malfunction, design-related problems and human error led to a partial meltdown of the reactor core and the release of vast amounts of radioactive gas and liquid. To this day, effective lobbying and cover-up efforts by the nuclear industry have prevented a meaningful scientific analysis of the effects on health and the environment.

History

The Three Mile Island nuclear power plant is located roughly 16 km from Harrisburg, Pennsylvania and was commissioned in 1978. More than two million people lived within 80 km of the plant. On March 28, 1979, the failure of the plant's cooling system led to the worst nuclear catastrophe before Chernobyl. An emergency valve was opened to relieve pressure, accidentally releasing large quantities of coolant fluid. This resulted in a severe overheating of the reactor core and a meltdown of the radioactive fuel rods. The containment vessel held, but for several days, significant amounts of radioactivity were released into air, water and soil, mainly in the form of about 1.59 Peta-Becquerel (Peta = quadrillion) of krypton-85 gas with a half life 10 years, and 740 Giga-Becquerel (Giga = billion) of iodine-131. Engineers needed five days after the meltdown to identify the causes, regain control of the cooling systems, and reseal the reactor core. About 70 % of the reactor core had been damaged and 50 % of the fuel rods had melted down. To get rid of the 150,000 liters of radioactive water, which had been contaminated in the course of cooling efforts, the Nuclear Regulatory Commission (NRC) took the controversial decision to dump it directly into the Susquehanna River.

Health and environmental effects

The news of the meltdown was initially downplayed, but within days elevated radiation levels were registered in four adjacent counties. Authorities claimed that external exposure to radioactivity was relatively low, but did not take into consideration the cumulative effects of low-level radiation through ingestion of radioactive particles and never measured actual exposure in the field. Instead, the public was informed that the levels of radioactivity released were too low to cause any harmful effects. Nevertheless, Pennsylvania Governor Thornburgh ordered the evacuation of more than 140,000 pregnant women and small children from the area.

In Dauphin and Lebanon, the two counties immediately adjacent to the site, studies found significantly elevated cancer and death rates in children, adolescents and young adults. From 1979 to 2001, 120 residents of these counties had died of cancer by age 19, a rate 46 % above the state average.

Immediately after the meltdown, a large scale cover-up began. Pennsylvania Health Commissioner MacLeod, who warned publicly of a significant rise in hypothyroidism and infant deaths after the disaster, was fired immediately. Nuclear specialist Steven Wing of the University of North Carolina, Chapel Hill alleged that “a manipulation of research” had taken place: A court order prohibited upper limit or worst case estimates of releases of radioactivity or population doses if these had the potential to harm the interests of the nuclear industry.

Outlook

Cleanup and decontamination efforts took around 14 years and cost American taxpayers about $1 billion. Thorough research on the health effects of the radioactivity released during the five days of the meltdown remains limited to this day. The nuclear industry’s lobbying worked well, with several industry-sponsored studies showing few or no effects of the disaster on population health. Many scientists, however, such as Joseph Mangano of the Bulletin of Atomic Scientists, criticized that no detailed studies were ever conducted on residents who lived outside of the 16 km-zone, on infant death rates or on the impact of radioactive noble gas.
Independent investigations of the nuclear meltdown in Chernobyl have provided evidence, however, that radioactivity released by civil nuclear disasters causes significant harm to people’s health. The people affected by fallout from Three Mile Island are also Hibakusha – casualties of an irresponsible nuclear industry.

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There is also a risk of aging nuclear power plants having an accident. Pickering plant in Ontario with six old reactors, A was built in 1971 and station B built in 1983, the 4th oldest in North America and the 7th oldest in the world is an accident waiting to happen. It is also large, providing 15% of Ontario’s electricity and is in close proximity to a large number of people; Toronto. There have been many accidents and miscalculations in the past. There have been problems with some employees taking drugs. Being an old plant, there are design flaws with having just a single vacuum system for the six operating reactors as opposed for one each. Pickering also lacks two completely separate shutdown systems. The concrete is crumbling. There are also risks from the climate; tornadoes, or the water intakes being blocked. There is the risk of terrorists.

OTHER NUCLEAR FACILITIES

There are also other types of nuclear facilities doing research, making diagnostic imaging material, research for the military, etc.

Ezeiza, Argentina
http://www.nuclear-risks.org/en/hibakusha-worldwide/ezeiza.html

Nuclear facility

The Ezeiza Atomic Center is located in a suburb of Argentina’s capital city Buenos Aires. In recent years, it has been the cause of much concern, as radioactive waste has contaminated the groundwater of adjacent neighborhoods, affecting up to 1.6 million people. Epidemiological studies have not been undertaken; the government and the country’s nuclear commission have denied any responsibility.

Hanford, USA

http://www.nuclear-risks.org/en/hibakusha-worldwide/hanford.html

Hanford, USA

Nuclear facility

At the Hanford Site, the U.S. produced most of its weapons-grade plutonium during the Cold War. Although the compound was decommissioned in 1988, it remains the most radioactively contaminated site in the Western Hemisphere.

History

The Hanford Site was built in the 1940s to produce plutonium for the U.S. nuclear weapons program. Located near the city of Richland in Washington State, the compound stretches over an area of more than 150,000 hectares and consists of more than 500 buildings, including nine nuclear reactors. Hanford supplied the material for the Trinity Test, the world's first nuclear detonation, in July of 1945. It also provided the plutonium for "Fat Man," the bomb which destroyed Nagasaki one month later. In the following four decades, the Hanford Nuclear Site produced more than 67 metric tons of plutonium for the U.S. nuclear arsenal.

In 1986, the U.S. Department of Energy, in response to public pressure and a request under the Freedom of Information Act, released 19,000 pages of previously classified documents that revealed, among other things, that radioactive releases from Hanford had contaminated air, groundwater, soil and the Columbia River. Fallout had spread more than 200 radioactive isotopes over Oregon, Idaho, California, Montana and Canada. In December 1949, Hanford scientists had deliberately released between 259 and 444 Tera-Becquerel (1 TBq = 1 trillion Becquerel) of radioactive iodine-131 in order to test monitoring equipment for radiation doses. The amount of iodine-131 released in these "experiments" was 350 to 600 times more than the total amount released during the Three Mile Island nuclear meltdown (0.74 TBq).

Health and environmental effects

Workers at Hanford were exposed to more than 200 radioactive isotopes including 0.07 TBq plutonium-239, 1.55 TBq cesium-137 and 28.3 TBq radioactive strontium. Plutonium, ruthenium and other radionuclides were detected as far away as Spokane and Mount Rainier. The main danger to the general public, however, came from more than 40 TBq of iodine-131 released between 1944 and 1972, which contaminated air, soil and foodstuff.

According to the Hanford Environmental Dose Reconstruction Project, run in cooperation with the U.S. Centers for Disease Control, the thyroid of a child living close to Hanford could have received a cumulative dose of 2,350 mSv (confidentiality interval 540–8,700 mSv), equivalent to about 670 chest-CT examinations (average thyroid dose 3.5 mSv). A significant number of children may have developed thyroid cancer due to Hanford nuclear fallout, but no epidemiological studies were ever performed on the affected population.

Especially affected by radioactive contamination were native peoples living downwind or downriver from Hanford: the Colville, Coeur d'Alene, Kalispel, Kooten-ai, Nez Perce, Spokane, Umatilla, Warm Springs and Yakama. The 7,400,000 TBq of highly radioactive waste stored in Hanford amount to about 60 % of the total U.S. nuclear waste. According to the U.S. Department of Energy, more than 200 million liters of radioactive and chemical waste are stored in leaking underground tanks on the Hanford Nuclear Site. Due to leaks and improper disposal, an estimated 3.5 million liters of radioactive effluent have already contaminated the groundwater over an area of more than 123,000 acres. It is unclear, whether this contaminated water has already reached the Columbia River. As radioactively contaminated water was deliberately pumped into the river until 1971, high levels of zinc-65, arsenic-76, phosphorus-32, sodium-24 and neptunium-239 have been found downstream from Hanford.

Outlook

Ever since plutonium production in Hanford ended in 1988, the "largest civil works project in the history of mankind" is costing tax-payers more than $2 billion per year and is slated to continue until 2052. An additional safety threat is posed by the aging nuclear power plant at Hanford.

Surprisingly little epidemiological research has been done on the population affected by radioactive contamination and the full extent on public health may never be known. The people living around Hanford, especially the socially marginalized natives, are all Hibakusha, as their health has been compromised by the fanatical longing for ever larger and more destructive nuclear arsenals.

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La Hague, France
http://www.nuclear-risks.org/en/hibakusha-worldwide/la-hague.html

Nuclear facility

The reprocessing facility La Hague produces plutonium and uranium from spent nuclear fuel. Large amounts of plutonium and nuclear waste are stockpiled, creating a dangerous proliferation risk. Also, radioactive discharge from the plant pollutes the sea and the atmosphere. Several studies have already shown increased rates of childhood leukemia around La Hague.

Mayak, Russia

Nuclear facility

Through a series of accidents and spills, the Russian nuclear facility at Mayak contaminated more than 15,000 km² with highly radioactive waste. In 1957, the so-called Kyshtym accident alone made large parts of the Eastern Urals uninhabitable. Thousands of people had to be relocated and, to this day, the region affected by nuclear fallout is considered one of the most contaminated places on earth.

Tomsk-7/Seversk, Russia

www.nuclear-risks.org/en/hibakusha-worldwide/tomsk-7seversk.html

Nuclear facility

The explosion of a nuclear reprocessing facility in Tomsk-7 dispersed large amounts of radioactivity over an area of 120 km², exposing tens of thousands of people to increased levels of radiation and contaminating air, water and soils for many generations to come. It is considered the most serious Russian nuclear accident after Chernobyl and the Kyshtym accident at Mayak.

Windscale/Sellafield, UK

http://www.nuclear-risks.org/en/hibakusha-worldwide/windscalesellafield.html

Nuclear facility

Europe's largest civil and military nuclear complex is located in Sellafield. It used to produce plutonium for the British nuclear weapons program and now serves as a reprocessing site for nuclear waste. A fire in 1957, as well as numerous accidents and radioactive leaks, have polluted the environment and exposed the population to increased levels of radiation.

History

In 1946, the British government commissioned the "Windscale" nuclear facility near the town of Sellafield in Northern England. The first nuclear reactors were built to produce weapons-grade plutonium and the first British nuclear bombs were produced in 1952. Four years later, the world's first commercial nuclear power plant began producing electricity. Due to its design, however, the reactor's graphite blocks stored too much energy, which needed to be released at regular intervals. During one such release on October 7, 1957, faulty temperature gauges and gross misjudgment by the staff caused an overheating of the core. As a result, nearly 10 tons of radioactive fuel inside the reactor caught fire and burned uncontrollably for two days, polluting the atmosphere with radionuclides such as plutonium, cesium, strontium and iodine. The water that was used to extinguish the fire evaporated, adding to the radioactive emissions. Luckily, prevailing wind patterns blew most of the radioactive plume out to sea. The population was only informed about these events on October 11 and was not evacuated, despite the danger of nuclear fallout. Milk that had been radioactively contaminated with iodine-131 was banned in the region for several weeks and two million liters were dumped into the Irish sea.

By the beginning of the 1980s, the name "Windscale" had become tarnished by countless incidents, spills and irresponsible handling of radioactive contaminants. In order to gain a fresh start in light of public scrutiny, the name of the nuclear complex was changed in 1981 to "Sellafield." Over time, the function of the complex changed to the reprocessing of used fuel rods and the production of mixed oxide (MOX) fuel, a mixture of uranium und plutonium. MOX-fuel production is being criticized by many countries, as the increased availability of plutonium also increases the danger of nuclear weapons' proliferation.

Health and environmental effects

The Windscale fire and the ensuing fallout, are estimated to have caused at least 190 cases of cancer, more than half of which were fatal. The marine environment of the Irish Sea also suffered from the disaster, as well as from countless other spills, leaks, incidents and the deliberate or accidental discharge of radioactive effluent. In 2004 and 2005, 83,000 liters of radioactive acid leaked into the North Sea, containing carcinogens such as strontium-90 and cesium-137. Through bioaccumulation in the marine food chain, these substances pose a grave threat to the fishing regions around Great Britain, Norway and Ireland. Even the pro-nuclear International Atomic Energy Agency (IAEA) has had to admit that Windscale was a major contributor to radioactive pollution of the Atlantic Ocean. Increased levels of radionuclides, such as cesium-137, cobalt-60 and americium-241 were also found in soil samples around the complex, suggesting radioactive contamination of agricultural products for human consumption. In 2002, a British study found that children of Sellafield workers have a nearly doubled risk of developing leukemia or lymphoma.

Outlook

The U.S. Institute for Resource and Security Studies has called Sellafield "one of the world's most dangerous concentrations of long-lived radioactive materials." Sellafield is vulnerable to a variety of risks: natural catastrophes could compromise the cooling systems, human error and negligence could cause fires, explosions or other types of accidents. The compound could be a target of a terrorist or a hacker attack, and even a computer virus could potentially trigger a catastrophe. Following the Fukushima nuclear meltdowns in 2011, the British government decided to at least cease producing MOX at Sellafield, but with no way of disposing of the spent fuel, Sellafield is more and more turning into a radioactive waste dump. The health concerns of the local population, exposed for decades to high levels of ionizing radiation, are continually being ignored by the government; meaningful scientific research is not being undertaken. The people of Sellafield are also casualties of the nuclear industry – their health has been compromised in order to produce nuclear weapons and fuel for nuclear reactors. They are also Hibakusha.

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NUCLEAR WASTE

Currently, radioactive waste is stored in water baths on site at nuclear power plants. This could be a target for terrorists and would release tremendous amounts of radioactivity. These and nuclear power plants would also be prime targets in a war.

See www.cnl.ca/en/home/environmental-stewardship/whiteshell/default.aspx

Questions regarding radioactive waste in Manitoba

In particular, the questions you have sent me seem to be focussed on industry plans for the "in-situ decommissioning" of an old shut-down nuclear research reactor (called the WR-1 reactor) located at that federally-owned site, near the edge of Whiteshell Provincial Park.

By the "Atomic Energy Board" I presume the questioner is referring to the Canadian Nuclear Safety Commission (CNSC), which is Canada's current nuclear regulatory agency. (The predecessor of the CNSC was called the Atomic Energy Control Board, or AECB.)

See www.nuclearsafety.gc.ca/eng/resources/environmental-assessments/ongoing/manitoba/decommissioning-whiteshell-reactor-1.cfm

I have written two submissions for the Canadian Coalition for Nuclear Responsibility (CCNR) that were submitted to the CNSC in 2017 and 2018. These submissions are highly critical of current industry plans to "entomb" the reactor entrails in concrete and leave that concrete radioactive mausoleum near the shore of the Winnipeg River as a permanent radioactive waste dump — despite the fact that this site was never chosen to serve such a purpose, and despite the long-held view that radioactive waste should never be left (abandoned) near circulating water.

See www.ccnr.org/CCNR_WR1_2017.pdf and. www.ccnr.org/CCNR_WR1_Supp_2018.pdf .

The proponent of the concrete entombment of the Whiteshell reactor is Canadian Nuclear Laboratories (CNL), owned and run by a private consortium of multinational for-profit corporations. In their licence application to the CNSC they say that the concrete will safely contain the radioactivity for 300 years, despite the fact that most concrete structures have an expected lifetime of 50 years or less. In its own report, CNL gives a partial list (Table 7.2.1-1) of some of the many human-made radioactive materials that are in question. They do not mention the half-lives of these materials. The half-life of a radioactive substance is the time it takes for half of the material to disintegrate.

Of the 22 radionuclides indicated in Table 7.2.1-1, eleven of them have half-lives of over 100 years, nine of them have half-lives over 1,500 years, seven of them half half-lives over 15,000 years, four of them half half-lives over 100,000 years, and one of them has a half-life over 15 million years. In my own report for CCNS, I separated the half-lives into two columns — less than 100 years, and more than 100 years.

Anishinabek Nation and Iroquois Caucus Radioactive Waste Working Group

In Ontario, the heartland of Canada's nuclear industry, the Anishinabek Nations' Union of Ontario Indians (comprising 40 First Nations located throughout Ontario) joined forces in 2017 with the Iroquois Caucus to form a Radioactive Waste Working Group, which meets from time to time to assess radioactive waste matters in the province and to coordinate activities. They issued a Joint Declaration on the transport and abandonment of radioactive wastes that encompasses five important principles for the responsible long-term management of radioactive waste of all kinds. The Assembly of First Nations passed a resolution along the same lines later that same year in Winnipeg.

See www.ccnr.org/Joint_Declaration_2017.pdf and www.ccnr.org/AFN_Resolution_2017.pdf

Last year, a delegation of five chiefs from the affected First Nations in Ontario, accompanied by three others, came to the United Nations in New York City to communicate their positions on the subject of radioactive wastes. A video of this event, held on the occasion of the 17th Session of the UN Permanent Forum on indigenous issues, is posted on the web site of the United Nations and will be there for at least 3 years.

See http://webtv.un.org/watch/radioactive-waste-and-canadas-first-nations-unpfii-side-event/5775372426001/

The nature of the radioactive waste problem and alternative approaches

Ever since the dawn of the nuclear age in Canada, the federal government and the Canadian nuclear industry have promised that all dangerous radioactive byproducts created by the industry would be safely stored and kept out of the environment for countless thousands of years – a period of time that dwarfs the span of recorded human history.

Many people, scientists and non-scientists alike, regard the long term management of radioactive waste as one of the major unsolved problems of the human race. Many ideas have been proposed, but all have proven to have serious pitfalls or drawbacks. Dumping in the oceans, now forbidden by international law. Burial in the antarctic ice fields, likewise forbidden.

Shooting it into outer space, regarded as far too dangerous due to rocket failures and explosions.

LONG TERM MANAGEMENT METHODS RECEIVING INTERNATIONAL ATTENTION (noted by NWMO)
www.ccnr.org/GE_NWMO_ITK_Questions.pdf

High-Level Radioactive Waste – Geological Disposal

For example, the long-term management of irradiated nuclear fuel, called “high-level nuclear waste”, is still an open question as there is as yet no licensed and operating repository to store such waste anywhere in the world. The nuclear industry has long advocated burying this waste is a “deep geological repository”, and eventually abandoning it there But there have been eight attempt in the USA to situate such a repository, and all eight attempts have failed.

In 1978, the Ontario Royal Commission on Electric Power Planning published a report (A Race Against Time) that recommended a ban on new nuclear reactors unless such a high-level waste repository solution is found by 1985. That same year, Quebec banned any new reactors in the province. At the same time, the governments of Canada and Ontario launched a $700 million research project that lasted 15 years to demonstrate the concept of deep geological disposal of high-level waste. The Underground Research Laboratory was built near Lac du Bonnet in Manitoba (not far from Pinawa) to “validate” the concept of geological disposal, but no radioactive materials were allowed to be emplaced in that experimental repository, and Manitoba subsequently passed a law forbidding the import of high-level radioactive wastes into the province for the purpose of permanent disposal.

See https://web2.gov.mb.ca/laws/statutes/ccsm/r010e.php

Following a ten-year environmental assessment process with public hearings in five provinces conducted by an independent panel, the government of Canada told the waste-producing utilities in Ontario, Quebec and New Brunswick, to establish an industry-owned agency, the Nuclear Waste Management Agency (NWMO), to find a “willing host community” somewhere in Canada that would be prepared to accept all of Canada’s high-level nuclear waste for eventual deep geological disposal.

That search is still ongoing, with only five out of the eleven original candidate communities still in the running. Each of the remaining five communities, all in Ontario, typically with a population less than 1000, receive $300,000 per year just for participating. The estimated cost of the ultimate disposal of irradiated nuclear fuel underground in Canada is estimated to be about $26 billion dollars. Many believe the true cost is likely to be double or triple that amount, and some (including myself) are skeptical that the plan will succeed, given the failures that have already occurred elsewhere.

Low-Level and Intermediate-Level Radioactive Wastes

Even after the intensely radioactive high-level waste (the irradiated nuclear fuel) has been removed from the reactor, the entire core area of the facility (where the fuel was housed) and the primary cooling system (the pipes, pumps, condensers, and other equipment used to circulate the coolant through the core to prevent the fuel from overheating and "melting down" at a very high temperature) has also become radioactive waste.

Moreover there are gloves, mops, filters, fuelling machines, cranes and other materials which have become so radioactively contaminated that they too must be stored as radioactive waste and must not be recycled for commercial use for fear of introducing radioactive wastes into the marketplace. All such wastes are called "low-level and intermediate-level wastes" in order to distinguish them from the much more intensely radioactive irradiated fuel.

In Ontario there are 22 electricity-producing nuclear reactors (18 of which are still operating). Ontario Power Generation is hoping to get approval from the government of Canada to put all of the low-level and intermediate-level radioactive waste from all of its 22 reactors into a deep underground storage facility less than a mile from Lake Huron. Inspired by the idea of a geologic repository for high-level waste, this underground repository (700 metres deep) is intended to host a bewildering variety of radioactive wastes in many different kinds of physical and chemical forms. When filled the repository would be sealed and abandoned, following a lengthy period of consolidation and monitoring.

This proposal has elicited a storm of protest and the final decision has been delayed for years. Over 100 Great Lakes Mayors and top elected officials have joined forces in calling on the Canadian government to reject OPG's proposed nuclear waste repository. The Saugeen Ojibway First Nation has not yet given its approval and OPG has promised that it will not proceed against the wishes of that First Nation. Environment Minister Catherine McKenna has withheld any federal government decision, pro or con, for the OPG project, until the Saugeen FN declares itself on this matter,

See http://stopthegreatlakesnucleardump.com

Much of the motivation for such protests has to do with dramatic failures of underground repositories for low-level and intermediate-level wastes in the USA and Germany that have occurred in recent years. The German government has formally admitted that the emplacement of similar radioactive wastes in the deep underground Asse-2 facility, an abandoned salt mine, has been an unmitigated disaster. They have now ordered the radioactive waste to be removed from the facility and brought back to the surface, an onerous task that is expected to take at least 30 years and cost at least two billion dollars. It has emerged that radioactive materials were leaking from the Asse-2 facility for over ten years before the industry alerted officials to the problem, presumably because to admit the waste was leaking would be bad public relations and would constitute a major embarrassment to Germany's nuclear industry.

Another deep underground repository for low- and intermediate-level wastes at Morsleben, in Germany, also appears to be failing, as the entire repository seems to be sagging and collapsing. So far the government has not decided what to do in the case of Morsleben, but Germany admits it seems to be another case of very questionable practices when it comes to the long-term confinement of radioactive waste.

The only deep geological repository for radioactive wastes in North America is located near Carlsbad New Mexico. It is called the Waste Isolation Pilot Project (WIPP). Scientists and engineers from OPG, NWMO, and CNSC, all praised the WIPP facility in sworn testimony as an example of state-of-the-art safe storage of low and intermediate level radioactive waste in a deep underground repository. Then, in February 2014, one sealed drum of radioactive waste stored in a deep underground chamber exploded and turned into a flame-thrower, spreading plutonium-bearing radioactive dust throughout the underground shafts and chambers. The highly dangerous radioactive dust rose 700 metres vertically upwards to the surface where it contaminated 22 workers, then drifted downwind to lightly contaminate the town of Carlsbad. The WIPP facility had to be closed for over two years and required over a billion dollars of decontamination work before it could be "opened for business" again.

Decommissioning of Nuclear Reactors

There is at present no Canadian government policy on the final decommissioning of defunct nuclear reactors, nor is there any proposed repository or other facility in Canada to receive the large volumes of radioactive rubble from such decommissioning activities. The proposed deep geological repository for high-level radioactive wastes planned for by the NWMO specifically excludes decommissioning wastes, as well as all other low and intermediate level wastes. Similarly, the planned OPG deep underground facility for low and intermediate level wastes at Kincardine, on the shore of Lake Huron, also excludes decommissioning wastes.

So what is one to do with the decommissioning wastes?

When it comes to the long-term management of radioactive structural materials and radioactively contaminated equipment left over from old, shut-down nuclear reactors, Atomic Energy of Canada Limited (AECL) has always in the past advocated the dismantling of such facilities, with all radioactive materials carefully packaged and labelled and shipped off-site to be eventually placed in some specially designed radioactive waste storage facility. The reactor site itself would be completely decontaminated and returned to “green field” status, meaning that it would be able to be safely and freely used for any other purpose whatsoever. Conceptually, the site would be returned to pristine condition, as if the nuclear reactor had never been there.

See for example AECL-6332, “Decommissioning of CANDU Nuclear Power Stations”, by G. N. Unsworth, https://www.ipen.br/biblioteca/rel/R42114.pdf

The Age of Nuclear Power may be fading, but the Age of Nuclear Waste is just beginning

But things have changed. Because of dwindling prospects for sales of new nuclear power reactors, the Stephen Harper government sold the CANDU nuclear reactor division of AECL to the highly controversial and scandal-ridden company SNC-Lavalin in 2011 for a mere $15 million. SNC has subsequently been awarded billions of dollars in contracts to refurbish old CANDU reactors in Ontario and overseas, without having been saddled with any of the radioactive waste liabilities that remain the property and the sole responsibility of AECL and the Canadian taxpayer. The Auditor General of Canada has estimated the federal government's radioactive waste and decommissioning liabilities at $7.9 billion.

The Harper government subsequently — in 2015, just prior to the election of Justin Trudeau's government -- put SNC-Lavalin and four other profit-oriented multinational corporations from the USA and the UK in charge of all federally-owned radioactive waste, nuclear reactors, and nuclear research facilities, with a mandate to "reduce" the radioactive waste liabilities as quickly and cheaply as possible. That consortium of multinationals, operating under the name "Canadian Nuclear Laboratories (CNL), has been receiving close to a billion dollars a year from federal taxpayer, all of it funnelled through the coffers of the crown corporation AECL, whose staff has been slashed from about 3600 to only 40 individuals. The original consortium members were SNC-Lavalin, CH2M, Fluor, W.S. Atkins, and Rolls-Royce.

See cnea.co/members.html

Two years earlier, in 2013, SNC had been barred for 10 years from bidding on any projects financed by the World Bank because of well-documented fraudulent and unethical conduct overseas. This criminal behaviour by SNC-Lavalin was known to the government at the time. Recently, the Honourable Jody Wilson-Raybould, Canada's first indigenous person to be appointed as Canada's Attorney General, and the first woman to hold that post, resigned from cabinet in a swirl of controversy surrounding criminal charges that have been laid against SNC-Lavalin for alleged corrupt activities in Libya. Criminal charges are also pending for SNC-Lavalin, involving tens of millions of dollars in bribes related to the building of the McGill Superhospital in Montreal.

The consortium that owns and operates CNL is now made up of four multinationals, as SNC-Lavalin in 2017 acquired (purchased) one of the other players – W.S. Atkins based in the UK. It turns out that SNC-Lavalin is not the only scandal-ridden company involved in the consortium. In fact, all four consortium partners have been found guilty of unethical and/or criminal activities in the field of radioactive waste management in other countries.

The current "quick and dirty" plan by the consortium to "entomb" the Whiteshell reactor in concrete and abandon the radioactive remains beside the Winnipeg River is completely at odds with all previous promises from AECL. A letter signed by several retired AECL scientists and engineers from the Whiteshell Nuclear Research Establishment expressed great concern over this in-situ abandonment scheme as upsetting and scientifically unjustified.

See www.ccnr.org/Letter_Retired_Engineers_&_Scientists_2017.pdf

It is also worth noting that the International Atomic Energy Agency (IAEA), with headquarters in Vienna, has clearly declared that the entombment of a defunct reactor is NOT an acceptable strategy except in extreme circumstances. The following paragraph is copied from the IAEA in-line glossary of nuclear industry terms:

*"**Entombment**. The encasing of part or all of a facility in a structure of long lived material for the purposes of decommissioning. i Entombment is not considered an acceptable strategy for decommissioning a facility following planned permanent shutdown. Entombment may be considered acceptable only under exceptional circumstances (e.g. following a severe accident). In this case, the entombment structure is maintained and surveillance is continued until the radioactive inventory decays to a level permitting termination of the licence and unrestricted release of the structure."*

The IAEA position stated above is completely in accord with all previous Canadian thinking on decommissioning of nuclear reactors. For example, on page 4 of a glossy 7-page OPG insert that was published in the National Post, under a banner headline entitled "Decommissioning in Canada's Near Future", we read:

"entombment is only used under exceptional circumstances, usually when there has been a severe accident. It involves building a concrete structure to encase the plant, preventing the possibility of any radioactive leaks. The Entombment strategy removes the need of ever having to transport the radioactive materials away from the plant, but the site can never be regenerated."

See www.opg.com/generating-power/nuclear/nuclear-waste-management/documents/Nuclear_Renaissance_brochure.pdf

Health Dangers of Radioactivity

Radioactive materials are made of unstable atoms. These unstable atoms continually disintegrate, or explode, giving off dangerous subatomic projectiles in the form of "atomic radiation". Such invisible emissions are totally undetectable by our five senses, and they are harmful to living things. Since radioactivity cannot be shut off, these waste materials must be kept out of the environment of living things for as long as they pose a hazard. As it turns out, that corresponds to many thousands of years.

Cancer, leukaemia, and damage to reproductive cells (eggs and sperm) are among the harmful biological effects that may be caused by chronic exposure to radioactive materials, whether externally (from contaminated soil or buildings) or internally (by eating contaminated food, drinking contaminated water, or breathing contaminated air).

Chronic exposure to atomic radiation will also compromise the immune system by adversely affecting the most radio-sensitive blood cells, thereby making the individual more vulnerable to infectious diseases of all kinds. In addition there is evidence of increased cardiovascular disease (heart attacks and strokes) associated with chronic exposure to radioactivity.

Here is a link to a background document on the subject of health effects caused by radioactive exposure that I wrote for the Algonquin First Nation of Pikwakanagan whose traditional unceded territory includes the AECL/CNL Chalk River Laboratories site on the Ottawa River in Ontario, just about 250 km upstream from the nation's capital.

See http://ccnr.org/Pikwakanagan_3.pdf

Rolling Stewardship

At present, there is no solution to the problem of sequestering long-lived radioactive waste in a permanently satisfactory way — one that would allow for the safe walk-away abandonment of the dangerous material. Such is the case for all long-lived human-made radioactive waste, whether it is high-level waste (irradiated nuclear fuel), low-level and intermediate-level waste (from nuclear reactor operations), or decommissioning waste (from defunct nuclear reactors).

Therefore, placing such wastes beyond human control will leave future generations powerless to deal with the consequences of eventual leakage and radioactive contamination of food, water, soil and air. While nuclear proponents want to limit their own financial liability by claiming that the problem has been addressed once and for all, the long-term protection of the health and safety of people and the environment is a never-ending concern and must take priority.

Accordingly, the Canadian Coalition for Nuclear Responsibility (CCNR) advocates an entirely different approach called Rolling Stewardship — an intergenerational waste management concept whereby each successive generation passes on the relevant knowledge and provides the necessary tools and resources to the next generation, so that these human-made radioactive wastes are never placed beyond human control and are never left completely unattended.

See www.ccnr.org/Rolling_Stewardship.pdf and www.ccnr.org/CCNR_Undertaking_final.pdf

We have no way to eliminate radioactive waste materials altogether, or to render them harmless, but we do know how to package them in leak-proof containers that will prevent them from getting out into the environment of living things for decades, perhaps even for centuries. But not forever.

Therefore ongoing routine monitoring is needed, to alert society to any failures of containment. For this reason, our descendants need to be fully informed about the nature of the radioactive waste and empowered to improve upon our own clumsy attempts to deal it. They need to be able to monitor the waste and retrieve it when necessary. If leakage occurs, they need to be able to detect the problem and take corrective action in a timely manner – perhaps by repairing the original containers or by repackaging the waste in new, greatly improved containers. For this to be a possibility, the waste must be segregated into categories, carefully documented, and stored neatly in a recoverable form.

Rolling Stewardship is not intended as a mere caretaker operation, but as an active, fully involved societal effort to continually improve security by retrieving, re-characterizing and re-packaging the waste in ever more protective ways, until such time as a genuine solution to the radioactive waste dilemma is found – perhaps in the guise of a new hitherto non-existent technology that can destroy the waste, or render it harmless, or remove it permanently from the Earth.

The Official Plan for WR-1 – An Alternative to Entombment

Entombment is a radical departure from past practice. The consortium seeks permission to dump the radioactive components of WR-1 into the sub-basement, then flood the subterranean workings with a liquid mixture of sand and cement, ultimately abandoning the congealed mass as a permanent radioactive waste dump right beside the Winnipeg River.
CCNR believes that incorporating the radioactive remains of the WR-1 reactor in an enormous subterranean concrete blob that will eventually crumble and allow migration of radionuclides into the groundwater and the Winnipeg River is unacceptable. If and when things go badly wrong, how are future generations expected to redress the situation?

Not only is entombment completely at odds with OPG and IAEA warnings that such an approach is not acceptable, but it also flatly contradicts the current AECL decommissioning plan that was fully reviewed, approved, and licensed in 2002. The approved AECL plan calls for a return of the WR-1 property to green field status. The radioactive structure is to be carefully dismantled, and all radioactive waste materials are to be neatly packaged and labelled in robust leak-proof containers, to be eventually removed from the Whiteshell site and emplaced in a suitable off-site radioactive waste repository designed to safely store those materials indefinitely (i.e. for eternity).

In its 2017 Environmental Impact Statement (EIS), the consortium – operating under the name Canadian Nuclear Laboratories (CNL) – argues that since there is as yet no designated radioactive waste repository to receive decommissioning waste, the official 2002 plan has to be scrapped. This is not necessarily so. The radioactive remains of the WR-1 reactor can be packaged as prescribed and stored on site until such a repository is ready, which may not be in the foreseeable future, if ever. It is an ideal situation for employing the principle of Rolling Stewardship. Manitoba citizens, including First Nations people with no links to the nuclear industry, could be employed, educated, and trained in the necessary techniques to monitor the waste and safeguard it in an ongoing intergenerational way.

By contrast, the SNC-Lavalin (et al.) entombment plan has not yet been reviewed, approved or licensed. It is evidently designed more for the convenience of the consortium than for the security of future generations. Nevertheless, the CNSC approvals process has already begun, based on the 2017 EIS. On what basis and with what rationale will the already approved AECL plan be set aside? Clearly, the CNL proposal would make Rolling Stewardship virtually impossible.

The Canadian Nuclear Safety Commission (CNSC)

The CNSC is widely regarded as a captured regulator, playing a supportive role to the nuclear industry. As stated in the Final Report of the Expert Panel on Impact Assessment (section 3.1.1):

"A frequently cited concern was the perceived lack of independence and neutrality because of the close relationship the NEB and CNSC have with the industries they regulate. There were concerns that these Responsible Authorities promote the projects they are tasked with regulating. The apprehension of bias or conflict of interest, whether real or not, was the single most often cited concern by participants with regard to the NEB and CNSC as Responsible Authorities. The term "regulatory capture" was often used when participants described their perceptions of these two entities."

www.canada.ca/en/services/environment/conservation/assessments/environmental-reviews/environmental-assessment-processes/building-common-ground.html

It is a sobering fact that, in the entire 19-year history of the agency, CNSC Commissioners have never once refused to grant a licence when requested to do so by one of its licensees. See www.ccnr.org/CNSC_licence_refusals_2017.pdf .

In 2008, when CNSC Chairwoman Linda Keen tried to enforce a safety-related regulatory requirement related to the NRU nuclear reactor at Chalk River, she was fired by the Harper government. The episode was tinged with inappropriate pressures, similar to those recently used on Jody Wilson-Raybould when she was Attorney-General of Canada. SNC-Lavalin reportedly played a role in coaxing the government to fire Linda Keen as head of this "independent agency".
See www.cbc.ca/news/canada/nuclear-safety-watchdog-head-fired-for-lack-of-leadership-minister-1.748815

The CNSC reports to the Minister of Natural Resources (NRCan), a federal cabinet member whose job it is to support and promote the expansion of the nuclear industry. Witness for example the NRCan Road Map for deploying Small Modular Reactors in Canada, released in November 2018. The Road Map details federal government plans to subsidize the private development of an entire new fleet of nuclear reactors that could be deployed to accelerate resource depletion in the North and also to be sited in remote small communities including indigenous communities. The Whiteshell and Chalk River properties would be made available to private industry as "testing grounds" for these Small Modular Nuclear Reactors (SMNRs). The Ontario First Nations Chiefs in Assembly passed a resolution opposing the initiative. Is the CNSC going to go against the avowed policy of the Minister to which it reports by not licensing these SMNRs?
See www.ccnr.org/COO_resolution_SMRs_2018.pdf and www.ccnr.org/Ottawa_SMR_plans_2018.pdf .

Lack of a Federal Government Policy on Decommissioning Waste

There is no meaningful government policy regarding decommissioning waste or indeed any radioactive waste produced by nuclear reactors, except in the case of irradiated nuclear fuel (which is covered in the Nuclear Fuel Waste Act). The "Radioactive Waste Policy Framework" on the NRCan web site consist of exactly 143 words, equivalent to four tweets, and is entirely vacant on the subject of decommissioning waste.

See www.nrcan.gc.ca/energy/uranium-nuclear/7725

CCNR has written to Prime Minister Justin Trudeau asking him to initiate a wide-ranging public consultation process with First Nations and other Canadian citizens in order to develop a policy on the long-term management of radioactive wastes that we can all be proud of. There has been no meaningful response to this request.

See www.ccnr.org/Trudeau_pack_5_e.pdf .

If I can be of any further assistance please do not hesitate to contact me.

Best wishes,

Gordon Edwards, PhD, President,
Canadian Coalition for Nuclear Responsibility,
Scientific Advisor to Physicians for Global Survival.

www.ccnr.org

(514) 489 5118 [office in home]
(514) 839 7214 [cell]

NUCLEAR WEAPON TESTING

Another source of radiation is the testing of nuclear weapons. These occurred first in the atmosphere and release a tremendous amount of radiation world wide. Dr. Ursula Franklin in Canada and in St. Louis Missouri US became the "tooth fairies" and collected babies' teeth to measure the amount of Strontium 90 that was being taken into the diet of babies, through breast milk and contaminated milk in the food chain.
https://en.wikipedia.org/wiki/Baby_Tooth_Survey
http://mse.utoronto.ca/news/remembering-professor-emerita-ursula-m-franklin-1921-2016/
https://magazine.utoronto.ca/people/faculty-staff/warrior-for-peace-ursula-franklin-stacey-gibson/

http://www.nuclear-risks.org/en/hibakusha-worldwide/alamogordo.html

Alamogordo, USA

Nuclear weapons test site

The world's first nuclear explosion took place near Alamogordo on July 16, 1945. This detonation marked the beginning of the "nuclear age," epitomized by weapons of inhumane destructive power. Since the first detonation in Alamogordo, more than 2,000 nuclear test explosions have led to the radioactive contamination of the entire Earth.

History

Alamogordo is a small town in southern New Mexico. Located in the nearby Jornada del Muerto desert, the U.S. Army's White Sands Missile Range was the site of the world's first nuclear explosion. The so-called "Trinity" Test was carried out as part of the Manhattan Project, a nuclear weapon research operation begun in

1939. The project took place simultaneously in several locations: the weapons were developed in Los Alamos, New Mexico; uranium-235 was enriched at Oak Ridge, Tennessee; and plutonium-239 was produced at Hanford, Washington. The desert near Alamogordo, New Mexico was chosen as the test site.
On July 14, 1945, the world's first nuclear bomb, a plutonium implosion device code-named "The Gadget" was installed on top of a 30 m tower. The construction was equivalent to the one used for the "Fat Man" bomb, which was dropped on Nagasaki only a few weeks later. Scientists and military officers observed the test from a distance of 10–32 km.
On July 16, 1945 at 5:29:45 am the "Gadget" was detonated, with an explosive power equivalent to 20 kilotons of TNT, causing a bright flash of light, a mushroom cloud that grew to a height of about 12 km, and a shock wave that was felt 250 km away from Ground Zero. "Now I am become death, the destroyer of worlds" were the famous words of J.R. Oppenheimer upon seeing the explosion. Trinity was the first of more than 2,000 nuclear tests, which contaminated the world's atmosphere with radioactive particles known as nuclear fallout.

Health and environmental effects

The explosion of the bomb, containing about 6 kg of plutonium, caused a radioactive plume which drifted northeast at a speed of about 16 km/h, spreading radioactive white powdery fallout over an area of about 160 x 50 km, reaching as far as Albuquerque or Santa Fé. Because the Trinity Test was treated as a military secret, citizens were not warned beforehand, nor were they evacuated after the test.
After the detonation, five field teams measured radiation levels in the area. Exposure rates in residential areas were recorded with up to 20 Roentgen per hour, which roughly corresponds to 175 mSv/h – more than 600,000 times the natural background radiation (0.00027 mSv/h) or the equivalent of about 8,700 chest x-rays per hour. In addition to this external radiation, about 4.8 kg of plutonium was found in soil, plants and animals in the area. Plutonium poses a serious danger to health because of its toxicity as a heavy metal and internal irradiation from alpha particles at cell-level after ingestion or inhalation.
In 2010, the Los Alamos Document Retrieval and Assessment Project (LAHDRA) of the U.S. Centers for Disease Control and Prevention published their final report on radioactive exposure. They found that people were exposed to levels of up to 1,000 mSv in the first two weeks after the blast (10,000 times natural background radiation) and were also exposed to internal radiation through ingestion of contaminated fluids and food. There is, however, a lack of studies evaluating the internal doses of residents.
Moreover the U.S. government never undertook an epidemiological study to assess the link between nuclear fallout and cancer rates in the affected regions. Nevertheless, community organizations report a rise in the incidence of cancer and autoimmune diseases in families living in the affected areas.

Outlook

While the U.S. government offered monetary compensation to people whose health had been affected by nuclear detonations at the Nevada test site, people affected by the tests near Alamogordo did not receive official recognition as "Downwinders" and were never given any compensation. Organizations such as the Tularosa Basin Downwinders Consortium are attempting to raise awareness of increased rates of cancer and autoimmune diseases in the region around the Trinity test site and are working for the affected population to be included in federal compensation programs. The Downwinders of Alamogordo are also casualties of nuclear weapons – they are also Hibakusha.

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Bikini and Enewetak Atolls, Marshall Islands

http://www.nuclear-risks.org/en/hibakusha-worldwide/bikini-and-enewetak-atolls.html

Nuclear weapons test sites

Nuclear testing on the Bikini and Enewetak atolls left entire islands uninhabitable, exposed thousands to high levels of radioactivity and contributed to global nuclear fallout.

History

The atolls of Bikini and Enewetak are part of the Marshall Islands and were occupied during WWII first by Japanese and later by U.S. forces. The islands were chosen by the U.S. for the first nuclear explosion after the bombings of Hiroshima and Nagasaki. On July 1, 1946, after forcibly evacuating all islanders, "Test Able" was detonated over a fleet of captured ships in order to test the effect of a nuclear bomb on enemy navies. Of the 78 vessels, 5 were sunk and 14 destroyed; one third of the animals, which had been placed on the ships, died from the blast. Sailors were ordered to scrub the fallout from the decks, exposing them to high doses of radioactivity. As decontamination was unsuccessful, many of the ships were scuttled in the Pacific.

Altogether between 1946 and 1958, the Bikini and Enewetak Atolls were host to 67 nuclear explosions with a total yield of about 214 megatons. The most devastating was the 15 megaton "Castle Bravo" hydrogen bomb test in 1954, the largest nuclear yield ever achieved by the U.S. – more than 1,000 times more powerful than the Hiroshima bomb. Nuclear fallout reached halfway across the globe – from Australia to the U.S. and Europe.

More than 400 nuclear tests were conducted worldwide before the Limited Test Ban Treaty of 1963 put an end to atmospheric testing. By that time, high amounts of radioactive strontium-90 had been found in children's teeth; a strong indication of the extent to which the entire world population had been irradiated by nuclear weapons testing.

Health and environmental effects

A review of the dosimeters worn by servicemen during "routine" nuclear tests found radioactive exposition doses of up to 600 mSv during a two week mission. This dose corresponds to about 7,500 times natural background radiation (approximately 0.09 mSv over the course of two weeks) or the equivalent of 30,000 chest x-rays (0.02 mSv). Internal radiation exposure was not considered in this review.

But not all tests were "routine": In 1954, the "Castle Bravo" test exceeded the expected yield by 200 % and spread radioactive fallout over more than 11,000 km², contaminating several inhabited island including Rongerik, Rongelap and Utrik, as well as a Japanese fishing vessel. Many islanders and the Japanese crew suffered acute radiation sickness from external radiation. Inhabitants of contaminated islands were evacuated a few days after "Castle Bravo," but long-term studies showed increased levels of cancer, especially of the thyroid, most likely due to internal radiation with iodine-131.

While radioactive iodine is among the most dangerous acute radioisotope spread by nuclear tests, the most significant long-term sources of radioactivity are long-lived radioisotopes such as cesium, strontium and plutonium, which were deposited over the islands by fallout. They can cause cancer through radioactive emissions inside the body once ingested or inhaled.

The atoll of Enewetak was decontaminated after the cessation of nuclear tests, with all radioactive debris sealed under an eight meter high concrete sarcophagus, dubbed "Cactus Dome." The Bikini atoll on the other hand was deemed too contaminated for clean-up and the indigenous Bikinians had to be relocated several times, even coming close to starvation when they were sent to islands which did not yield any crops. Even in 1994, the International Atomic Energy Agency (IAEA) still found the Bikini atoll to be too radioactively polluted for resettlement, with animal and plant life still highly contaminated.

Outlook

After conducting more than 1,000 nuclear tests, the U.S. stopped their nuclear test program in 1992, but has still not ratified the Comprehensive Test Ban Treaty (CTBT) which prohibits nuclear test explosions.

In 1986, a 150 million dollar trust fund was set up in order to compensate Marshallese people who were exposed to fallout from nuclear testing. However, about 40 % of the affected people died without receiving their full compensation, which was in any case very little, prompting the president of the Marshall Islands to send a petition to the U.S. Congress in 2000, calling for further decontamination projects, a more inclusive compensation scheme and better health surveillance. The petition fell on deaf ears, and many islanders took legal action, but were rebuked by the U.S. Supreme Court in 2010. While their government has filed a law-suit against the nuclear weapon states in the International Court of Justice for their failure to comply with their obligation to disarm under the Non-Proliferation Treaty, the Hibakusha of the Marshall Islands continue their fight for recognition and compensation.

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Emu Field, Australia http://www.nuclear-risks.org/en/hibakusha-worldwide/emu-field.html

Emu Field, Australia

Nuclear weapons test site

After testing its first nuclear weapons off the west coast of Australia in 1952, the UK sought to test its newer models on land. In 1953, the British detonated two "Totem" nuclear bombs at Emu Field, exposing a large population to radioactivity.

History

For their nuclear tests, the Australian government gave the UK a flat sandstone plateau in the Great Victoria Desert, called Emu Field. Due to a lack of weapons-grade plutonium-239, attempts were made to fill nuclear bombs with a higher proportion of plutonium-240. While cheaper and easier to produce, plutonium-240 is prone to spontaneous fission, which increases the risk of an uncontrolled nuclear chain reaction. The purpose of the "Totem" trials was to determine the acceptable limit of the amount of plutonium-240 in a nuclear weapon. Local Aboriginal groups such as the Pitjantjatjara, Tjarutja and Kokatha were not asked before testing commenced on their traditional lands. On October 15, 1953, Totem 1 was detonated at Emu Field, causing a cloud of radioactive dust to shoot up to 4,500 m. The plume drifted towards the East as so-called black mist, exposing people at nearby places such as Coober Pedy, Twelve Mile, Coffin Hill, Ernabella, Kenmore Park, Everard Park, Granite Downs and Mabel Creek to high levels of radioactivity. By the time the plume reached the Australian coast near Townsville three days later, the second nuclear bomb, Totem 2, was detonated, producing an 8,500 m-high mushroom cloud. The explosion was felt as far as 500 km away. After the Totem tests, the UK abandoned Emu Field. Future nuclear testing was performed on the Montebello Islands and at the permanent test site in Maralinga (see the corresponding poster in this exhibition).

Health and environmental effects

The use of nuclear weapons contaminated great tracts of Aboriginal land, causing detrimental medical, psychological and social effects. In 1985, a Royal Commission was set up in order to investigate the effects of British nuclear testing in Australia. Its final report stated that Totem 1 was fired under wind conditions that would knowingly produce unacceptable levels of fallout and did not take into account the existence of people downwind of the test site. Measures undertaken by the army to ensure that people were informed about the tests and left the affected areas were deemed inadequate. The Commission stated that fallout from Totem 1 on inhabited regions exceeded the proposed limits and resulted in high radiation exposure for local Aboriginal people. At least 45 members of the Yankunytjatjara tribe experienced signs of acute radiation sickness (vomiting, peeling skin, bloody diarrhea, headaches) and more than half died soon thereafter. Similar effects were reported by the tribe of Kupa Piti Kunga Tjuta. A study estimated the total number of cancer deaths for all British nuclear tests in Australia to be 35. The study made clear, however, that these calculations did not take into consideration the two groups most acutely affected by radioactive exposure: Aboriginal people and the personnel directly involved in the tests. Other factors that were never taken into consideration were the increased susceptibility of children to radioactivity and the poor health status and distinctive lifestyle of Aborigines, which also led to a high vulnerability: lack of clothing and footwear, the practice of cooking and eating in unsheltered locations, and a diet liable to biological magnification of radioactivity.

Outlook

Nuclear weapons tests were continued on Australian soil until 1963. The overall impact of the radioactive exposure on account of these tests will never be known. The health effects on the test personnel and the heavily exposed Aboriginal people were never systematically studied. The Royal Commission also stated that no meaningful epidemiological research had been undertaken regarding health effects to the Australian population and that "there is now little prospect of carrying out any worthwhile epidemiological study of those involved in the tests nor of others who might have been directly affected by them." The suffering of the Hibakusha of Emu Field is ignored by the British government. They must not be forgotten.

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Fangataufa and Moruroa, French Polynesia
http://www.nuclear-risks.org/en/hibakusha-worldwide/fangataufa-and-moruroa.html

Nuclear weapons test sites

Nearly 200 nuclear tests were conducted on Fangataufa and Moruroa atolls, severely contaminating the environment of the archipelago and exposing its population to dangerous radiation levels.

In Ekker, Algeria
http://www.nuclear-risks.org/en/hibakusha-worldwide/in-ekker.html

Nuclear weapons test site

At its Algerian nuclear test site, In Ekker, France performed 13 underground nuclear detonations, causing vast radioactive contamination of soil, air and possibly even underground aquifers, and directly exposing hundreds of people to radiation. To this day, the casualties have not been properly compensated and the extent of radioactive contamination has not been assessed.

Kiritimati and Malden, Kiribati
http://www.nuclear-risks.org/en/hibakusha-worldwide/kiritimati-and-malden.html

Nuclear weapons test sites

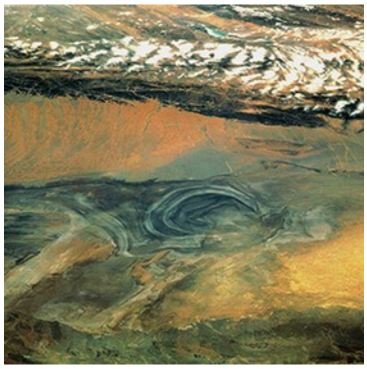
A total of 33 nuclear detonations were conducted on two atolls of the Republic of Kiribati by the UK and the U.S. in the 1950s and 1960s. Thousands of islanders and servicemen were subjected to radioactive fallout and now suffer from radiation effects.

Lop Nor, China

http://www.nuclear-risks.org/en/hibakusha-worldwide/lop-nor.html

Nuclear weapons test site

Between 1964 and 1996, the People's Republic of China conducted 45 nuclear tests in Lop Nor, a lake region in the Western province of Xinjiang. For the ethnic minority of the Uighurs, who live in this region, radioactivity-induced diseases and malformations have become a major health issue.



Maralinga, Australia

http://www.nuclear-risks.org/en/hibakusha-worldwide/maralinga.html

Nuclear weapons test site

Between 1952 and 1957, the United Kingdom conducted seven major and hundreds of minor nuclear tests at the Maralinga Test Site in Southern Australia. Nuclear fallout from the explosions contaminated large parts of the region and exposed many people to high levels of radioactivity. To this day, the casualties of these tests are denied recognition, medical care and compensation.

History

Without consulting parliament, Australia's prime minister Robert Menzies permitted the UK to conduct nuclear tests on Australian soil in 1952. After preliminary testing on the Montebello Islands and in the desert around Emu Field, Maralinga was declared a joint British-Australian nuclear test site in May 1955. Seven major nuclear tests were performed here, with yields ranging from one to 60 kilotons of TNT equivalent. By comparison, the Hiroshima bomb had an explosive yield of about 13–15 kilotons.

Under the code-name "Operation Buffalo," four bombs were exploded in 1956, in order to investigate the effects of nuclear radiation on animals, servicemen and civilians. In 1957, three more bombs were detonated at Maralinga as part of "Operation Antler." These nuclear detonations produced varying fallout patterns, which contaminated the entire Australian continent. Official fallout measurements were incomplete and were concealed from the public and, often, from the government.

In addition, approximately 600 minor tests of nuclear weapon components and sub-assemblies, the disposal of radioactive waste from the tests, and the effects of accidents have to be considered when assessing the total impact of nuclear testing at Maralinga. In total 24.4 kg of plutonium, 101 kg of beryllium and 8,083 kg of uranium were dispersed by the winds over a distance of up to 100 km, contaminating an area of about 450 km². The Maralinga Test Site was closed in 1967. Two clean-up operations failed to remove radioactive contamination, however, and the site remains uninhabitable to this day. Plutonium-239 has a half-life of 24,000 years.

Health and environmental effects

As with previous British nuclear weapons tests at Emu Field, the local Aboriginal population bore the brunt of radiation exposure. Before the tests began, the region of Maralinga was inhabited by Pitjantjatjara and Yankunytjatjara, with other Aboriginal groups often passing through the area. During the tests, many of them came into contact with fallout in the form of "black mist." The warning signs in English were usually incomprehensible to the Aborigines. Studies on the health effects of radiation on the Aboriginal populations were inconclusive due to inadequate identification and follow-up of the affected population.

An attempted clean-up operation in 1990 tried to bury contaminated soil below the surface, but instead stirred up thousands of tons of contaminated dust, which was dispersed by the wind. As a result of this fallout, additional exposure for Aborigines in most of the region is estimated to be 5 mSv per year, while people in the most affected 120 km² are believed to be exposed to an additional 65 mSv per year. According to the BEIR VII report, such doses would lead to 10 to 130 excess cases of cancer per 10,000 people.

Servicemen were also significantly affected by radiation exposure. In the 1970s, veterans described the lack of protective clothing and recalled flying through plumes of radioactive fallout in unpressurized aircrafts. The Department of Veterans Affairs conducted a study between 1982 and 2001 and found a significant increase in cancer rates (23 %) and cancer mortality (18 %) among veterans of the nuclear tests, compared to the population as a whole.

Outlook

The uninhabitable and contaminated land around Maralinga was symbolically returned to the Tjarutja people in 2009, but those affected have not received any compensation. The burden of proof lies solely on the side of the claimants, who face difficulties in gathering evidence for their cases: hospital records are not available and dosage records are incomplete or have been removed from the archives. The indigenous population faces even more bureaucratic hurdles in their fight for recognition and compensation. To this day, epidemiological studies on the affected population have not been performed and the British and Australian governments seem unwilling to accept responsibility for the health impacts of nuclear testing. The Australian affiliate of the International Physicians for the Prevention of Nuclear War found the right words in a hearing before the Australian Senate: "Justice delayed is justice denied." This simple truth applies to Hibakusha around the world – including the Aborigines and veterans of Maralinga.

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Nevada Test Site, USA

Nuclear weapons test site

More than 1,000 nuclear detonations at the Nevada Test Site between 1951 and 1992 dispersed massive amounts of radioactive particles across the Earth, leading to widespread contamination and exposing the world's entire population to dangerous radioisotopes.

History

The Nevada Test Site, located about 105 km northwest of Las Vegas, was the largest and most important nuclear weapons test site in the U.S.. From 1951 until 1992, a total of 1,021 nuclear tests were conduc-

ted on the 3,500 km² site: 100 above and 921 below ground. These tests released an estimated 222,000 Peta-Becquerel (Peta = quadrillion) of radioactive material into the atmosphere.
According to declassified documents of the Federal Civil Defense Administration, many of the tests were conducted specifically in order to determine the effects of nuclear fallout on the American public. As scientists found radioactive strontium in deciduous teeth of children in the U.S. and as rates of childhood leukemia and other cancers increased, public pressure began to grow to stop nuclear weapons testing. In 1963, President Kennedy signed the Limited Test Ban Treaty, which put an end to atmospheric tests at the Nevada site. Underground nuclear testing continued until 1992, however, and accidents continued to occur frequently: on December 18, 1970, for example, the underground "Baneberry" test of a 10-kiloton bomb released a plume of radioactive dust, which caused radioactive fallout to rain down on the test site personnel for many hours. An estimated total of 247 PBq of radioactive material was released, including 3 PBq of iodine-131. The radioactive plume continued to deposit fallout over northeast California, northern Nevada, southern Idaho and some eastern sections of Oregon and Washington.

Health and environmental effects

In the 1950s, people living close to the test site were encouraged to watch the nuclear tests from their porches. Many of the so-called Downwinders report setting their alarm-clocks so that they would not miss the early-morning detonations. Many were given radiation badges by the Atomic Energy Commission, so that their exposure dose could be recorded for field studies on the effects of nuclear fallout. Due to prevailing wind currents, the inhabitants of Utah were among those most affected by radioactive fallout. Radioactive particles such as iodine-131 can enter the body through contaminated air, food or drink and can lead to cancer once incorporated. Children in the small town of St. George, Utah may have received thyroid doses of up to 1.2–4.4 Sievert. Subsequent epidemiological studies have shown a significant rise in the incidence of leukemia and thyroid cancer in the populations living downwind from the nuclear testing site.
According to the National Cancer Institute, the U.S. population was exposed to a total dose of 4,000,000 Person-Sievert of iodine-131 through the nuclear weapon tests in Nevada – about 500 times the total radiation dose of Chernobyl (7,300 PSv). A study published in 1999 estimated that the expected cases of thyroid cancer due to the Nevada nuclear weapons tests amount to 10,000–75,000. Another report, published in 2006, found that 1,800 radiation-related leukemia deaths could be expected in the U.S. as a result of the Nevada nuclear weapons tests. Despite these alarming findings, no routine thyroid cancer screenings are undertaken in the affected regions.

Outlook

Until today, the Nevada Test Site remains contaminated with an estimated 11,100 PBq of radioactive material in the soil and 4,440 PBq in groundwater. The U.S. has not yet ratified the Comprehensive Test Ban Treaty of 1996. In 1990, the Radiation Exposure Compensation Act was passed in order to compensate Downwinders for diseases that could be traced back to radiation exposure. Due to bureaucratic hurdles and a lack of large-scale scientific research, many of the casualties of nuclear weapons testing are finding it difficult to actually receive compensation. The Hibakusha of Nevada feel left alone with the legacy of nuclear testing.

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Novaya Zemlya, Russia
http://www.nuclear-risks.org/en/hibakusha-worldwide/novaya-zemlya.html

Nuclear weapons test site

From 1954 to 1990, the islands of Novaya Zemlya were used by the Soviets to conduct atmospheric and underground nuclear tests. Decommissioned nuclear weapons and nuclear submarines were also scuttled around the islands, turning the entire region into an environmental disaster zone.

Reggane, Algeria
http://www.nuclear-risks.org/en/hibakusha-worldwide/reggane.html

Nuclear weapons test site

The French army conducted four atmospheric nuclear tests near Reggane, Algeria in 1960 and 1961, contaminating the Sahara desert with plutonium, exposing soldiers, workers and local Tuareg to radioactive fallout, and causing long-term health effects like cancer, infertility and genetic mutations.

Semipalatinsk, Kazakhstan
http://www.nuclear-risks.org/en/hibakusha-worldwide/semipalatinsk.html

Nuclear weapons test site

The story of Soviet nuclear testing at Semipalatinsk is a cautionary tale of how "national security" can be used to justify willful deception that jeopardizes public well-being and the health of future generations. In Semipalatinsk, the local population was exposed to high levels of radioactivity from nuclear weapon tests for several decades.

History

In 1949, the Soviet military conducted its first nuclear explosion at the Semipalatinsk Test Site, a 19,000 km² zone in the steppes of Kazakhstan. Over a forty year period, the USSR detonated 467 atomic and thermonuclear devices at Semipalatinsk – 120 atmospheric tests and 347 underground tests – with little regard for the local population or the environment.

In 1990, IPPNW teamed up with Kazakh poet Olzhas Suleimenov's Nevada-Semipalatinsk Movement for demonstrations that ultimately persuaded Mikhail Gorbachev to declare a nuclear testing moratorium.

After declaring its independence in 1991, Kazakhstan officially closed the Semipalatinsk site, and renounced the world's fourth largest arsenal of nuclear weapons, which it had inherited from the USSR.

On a global scale, more than 2,000 nuclear weapon tests were undertaken on dozens of test sites. The consequence of this madness was worldwide contamination with radioactive fallout, exposing people all over the planet to increased levels of radioactivity.

Health and environmental effects

Since the closure of the Semipalatinsk Test Site, various studies have been conducted to determine the medical, social and environmental impacts of radioactive contamination. Despite incomplete knowledge of the extent of the damage, there is widespread agreement that the local population has suffered greatly. Several thousand square kilometers of land remain contaminated for generations to come. No one knows for sure about the condition of water supplies and soil throughout the region. Local officials say that hundreds of thousands of people from the region, possibly as many as 1.5 million, were affected.

A number of genetic defects and medical conditions, ranging from cancers and impotency to birth defects and congenital malformations, have been attributed to the test fallout. Along with an epidemic of babies born with severe neurological damage, major bone deformations or missing limbs, there have also been significantly increased rates of hematological disorders, such as leukemia. A 2008 study by Kazakh and Japanese doctors found that the population surrounding Semipalatinsk received more than 500 mSv of radiation in one exposure – doses similar to those of the Hibakusha of Hiroshima and Nagasaki, or the equivalent of about 25,000 chest x-rays.

In one village, which was engulfed by a radioactive cloud after the first nuclear test in August 1949, 90 % of its inhabitants received an external effective dose of up to 1,400 mSv during the first year alone. In the most heavily contaminated areas, people received an estimated effective dose of 2,000 mSv during the years of testing – enough to cause symptoms of acute radiation disease. Based on these dose estimates, we can anticipate that between 14 and 20 % of those exposed would develop cancers as a result of nuclear testing. The Japanese-Kazakh study even found cancer rates in the affected regions in Eastern Kazakhstan that were 25–30 % above the national average. The scientists also found a higher likelihood of mental deficiencies in children born to parents who were exposed to the radioactive fallout.

The Semey Oncology Center observed a significant rise in malignant tumors among the local population, especially lung, stomach, breast, and thyroid cancers. The Institute of Radiation Medicine and Ecology in Kazakhstan reported a direct link between radiation exposure and gene defects in families living in villages near the test site. This was supported by findings of the University of Leicester, UK, which was able to show in 2002 that people in Semipalatinsk who were exposed to high doses of radiation had an 80 %

higher rate of DNA mutations than control groups, and even the children of those directly exposed to fallout had rates that were about 50 % higher.

Outlook

In 2009, the UN General Assembly unanimously adopted a resolution calling on the international community to support Kazakhstan in tackling the profound health, environmental and socio-economic challenges facing the Semipalatinsk region and its population. In response, numerous UN agencies, donor countries, non-governmental organizations, and medical and scientific institutions have helped to establish projects to address the legacy of nuclear weapons testing in Kazakhstan and ease the suffering of the Hibakusha of Semipalatinsk. August 29, the day that the Semipalatinsk Test Site was officially closed in 1991, is commemorated each year as the International Day against Nuclear Tests.

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DEPLETED URANIUM

Depleted Uranium is shot at our enemies in tank destroying munitions and bunker busting bombs. Some people feel that this plays a role in the Gulf War Syndrome.
https://www.ncbi.nlm.nih.gov/pubmed/11259733
https://www.ncbi.nlm.nih.gov/pubmed/16981628
https://en.wikipedia.org/wiki/Gulf_War_syndrome#Depleted_uranium
^ *Jiang, G. C.; Aschner, M. (2006). "Neurotoxicity of depleted uranium: Reasons for increased concern". Biological Trace Element Research.* ***110*** *(1): 1–17. doi:10.1385/BTER:110:1:1. PMID 16679544.*

Basra, Iraq
http://www.nuclear-risks.org/en/hibakusha-worldwide/basra.html

Depleted Uranium battlefield

The use of Depleted Uranium (DU) ammunition during the Gulf War of 1991 caused the local population to be exposed to radioactive uranium dust. This could potentially explain the significant rise in cancer and congenital malformations documented in the southern Iraqi city of Basra after 1991.

Fallujah, Iraq

http://www.nuclear-risks.org/en/hibakusha-worldwide/fallujah.html

Depleted Uranium battlefield

The use of depleted uranium in the war on Iraq in 2003 has led to exposure of the local population to radioactive uranium dust. This could potentially explain the significant rise in cancer and congenital malformations documented in Fallujah after 2003. In addition, soldiers who were in contact with the radioactive ammunition also have increased morbidity rates.

ACCIDENTS

Yet another cause of radiation release is an accident. There have been two American nuclear submarines at the bottom of the ocean; Thresher and Scorpion.

https://en.m.wikipedia.org/wiki/USS_Thresher_(SSN-593)

https://en.wikipedia.org/wiki/USS_Scorpion_(SSN-589)

Chazhma Bay, Russia

http://www.nuclear-risks.org/en/hibakusha-worldwide/chazhma-bay.html

Nuclear Submarine Accident

In August 1985, an explosion on a Soviet nuclear-powered submarine caused a massive release of radioactivity in Chazhma Bay. More than 290 people suffered from radioactive exposure and much bay and waterfront were contaminated. The accident was kept secret for many years. The surrounding ocean was also used by the Soviet navy as a nuclear waste dump, adding further to the radioactive contamination of the water. The full extent of environmental damage and health effects may never be fully known.

Goiânia, Brazil

http://www.nuclear-risks.org/en/hibakusha-worldwide/goiania.html

Radiation accident

The accident in September 1987 in Goiânia was one of the most serious radiation accidents in history. The opening of a radiotherapy machine containing cesium-137 led to the direct irradiation of 249 people. Four people died a short time later; at least 21 suffered severe external radiation damage. The long-term effects of the accident were never examined. Decontamination of the affected neighborhoods was only performed superficially.

Palomares, Spain

http://www.nuclear-risks.org/en/hibakusha-worldwide/palomares.html

Accident involving nuclear weapons

In 1966, four hydrogen bombs were dropped near the Spanish city of Palomares, when a U.S. B-52 bomber crashed into another plane in mid-air. The non-nuclear explosives of two of the bombs detonated, spreading radioactive plutonium across a vast area. Forty years later, contaminated soil still continues to be found near the crash site.

History

On January 17, 1966, a U.S. B-52 bomber collided with a tanker plane in mid-air during refueling. The crash occurred about 9,500 m above the small Spanish fishing community of Palomares. At that time, the B-52 bomber was carrying four Mark 28 thermonuclear bombs, which plummeted to the ground together with the plane. The parachutes on two bombs failed to deploy. They went down on the eastern and western edges of the town, causing the chemical explosives to detonate upon impact. By a stroke of luck, the nuclear warheads did not detonate, but the explosion spread radioactive material, including uranium and plutonium, across the fields of Palomares. Clouds of plutonium dust were blown over the fields, contaminating large stretches of land. The third hydrogen bomb was recovered relatively intact, while the fourth bomb was only recovered from the ocean floor 80 days later. After this accident, flights with nuclear weapons were prohibited over Spanish territory. Regular patrol flights with nuclear warheads were gradually reduced, and after a second crash involving a nuclear armed plane in Thule, Greenland in 1968, this dangerous practice was finally abandoned.

Health and environmental effects

As toxic heavy metals and radioactive alpha-emitters, plutonium and uranium and their short-lived decay products cause severe health problems when ingested, inhaled, or absorbed through cuts in the skin. Scientists from Princeton University developed a model to calculate the expected health effects of the accident. As most of the plutonium was turned into an aerosol by the explosions, it could be transported over large distances by the wind. It is important to note that the ensuing dispersion effect did not decrease the total mortality for the population. While each individual's risk is reduced through dispersion, the total number of cancer deaths remains approximately the same, since more people come in contact with the dangerous substance and their individual risks add up. The scientists calculated that about 2.85 cancer deaths would result from each mg of inhaled plutonium. The National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation issued an even higher estimate: 6 to 12 cancer deaths per mg.

In the aftermath of the accident, the U.S. undertook a massive clean-up operation for around $80 million and shipped about 10,000 cubic meters of contaminated soil to a U.S. nuclear waste facility. 1,600 people were involved in this mission, 20 % of whom were later found to be contaminated with plutonium. The rushed clean-up effort further aggravated the situation by burning contaminated tomato, bean and cabbage crops, spreading radioactive contamination even further. It was never publicly admitted how much plutonium was left in the ground after the end of clean-up operations.

Vast quantities of plutonium have also contaminated the western Mediterranean, where scientists found increased concentrations of radioactive plankton as late as 2003. In 2006, high levels of radiation were detected in snails from this region. U.S. and Spanish research institutions have been conducting annual health check-ups of the 1,500 residents of Palomares. Financed by the U.S. government, these check-ups have found no medical consequences related to the accident. Critics argue, however, that no independent epidemiological studies have been perfomed.

Outlook

With a half-life of 24,000 years, plutonium remains in the environment for thousands of generations to come. Despite the clean-up efforts, radioactive material continues to be found near the crash site, including two trenches filled with radioactively contaminated soil, which were discovered in 2008. The main concern is that plutonium decays into other radioactive components like americium, a gamma-emitter, which can harm people over large distances. In 2010, the U.S. government ceased the annual payments to Spain. It is unclear whether the annual health check-ups will continue. Additional long term environmental effects may yet be identified. The true extent of the effects caused by the accident will most likely never be known. The people of Palomares are also Hibakusha – they are also living with the radioactive legacy of nuclear weapons.

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There is also a case in Canada:

https://en.wikipedia.org/wiki/1950_British_Columbia_B-36_crash

https://www.introtoglobalstudies.com/2012/10/broken-arrow-lost-nuclear-weapons-in-canada/

where a nuclear bomb went missing near Smithers British Columbia.

Thule, Greenland
http://www.nuclear-risks.org/en/hibakusha-worldwide/thule.html

Accident involving nuclear weapons

The crash of a U.S. Air Force B-52 bomber with nuclear weapons on board contaminated a large areas of land and the surrounding waters with radioactive plutonium. Inhabitants, rescue- and clean-up workers were exposed to high levels of radiation.

History

On January 21, 1968, a U.S. Air Force B-52 bomber, carrying four hydrogen bombs, was flying a routine patrol mission over Greenland and Baffin Bay. In the 1960s, up to twelve U.S. nuclear bomber planes were on so-called airborne alert 24 hours a day. This operation, code-named "Chrome Dome," was supposed to demonstrate an effective response capability in the case of a Soviet nuclear attack. On this day, however, a fire broke out in the cabin, six hours after take-off. The crew was forced to evacuate the plane, which crashed on the ice, roughly 13 km south of the U.S. airbase at Thule, Greenland. One crew member died in the crash, six others survived. Luckily, a nuclear explosion did not occur, but the bombs' non-nuclear high explosives fully detonated upon impact, blowing the bombs apart and spreading a total of 10 Tera-Becquerel (Tera = trillion) of radioactive plutonium over an area of 7.68 km². Uranium, americium and tritium were also released. Some of the pack ice melted and sank to the ocean floor, carrying with it radioactive isotopes released by the blast. It is estimated that a total of 5 Giga-Becquerel (Giga = billion) of radioactive plutonium polluted the waters of nearby Bylot Sound as a result. A cloud carrying radioactive isotopes drifted south, contaminating an area around the settlement of Narssarssuk, about seven km from the crash site. The incident was designated a "Broken Arrow" – a U.S. military term that describes a major accident or loss of a nuclear weapon. Greenland is a territory of Denmark, which has declared itself nuclear-weapons free. Following large demonstrations in Denmark, the Danish government issued a strong protest note.

Health and environmental effects

Directly after the accident, fishing and hunting were forbidden in the area. Several radiological and environmental studies conducted by Danish and American scientists in the aftermath of the crash showed increased plutonium levels in the pack ice, in seawater, ocean-sediments and algae as far as 17 km away from the accident site.

Cleanup operations were undertaken under the code-name "Project Crested Ice" in order to remove blackened ice from around the crash site. It is claimed that 90 % of the plutonium was removed and 147 freight cars of radioactive waste were shipped back to the U.S., leaving about one TBq of in the ice around Thule.

Plutonium is a highly toxic heavy metal, which can cause severe damage to the kidney, liver or lung cancer when only a few micrograms are ingested or inhaled. Such ingestion is a relevant health risk for the indigenous Inughuit people living in the region, whose diet consists largely of fish and sea mammals, the meat of which is contaminated with plutonium. Especially the inhabitants of nearby settlements like Narssarssuk are affected. Epidemiological studies on their health status were never undertaken.

However, Danish workers assisting in the clean-up reported a significant number of cancer cases and deaths among their colleagues. A 1995 survey found 410 deaths due to cancer out of a sample of 1,500 workers. A similar follow-up study on U.S. workers was never performed, despite the fact that they were more heavily exposed to radioactive material than their Danish colleagues.

Outlook

Following the accidents at Palomares and Thule, regular patrol flights of bombers armed with nuclear bombs were suspended in 1968. In 1996, the Danish Government agreed to pay a compensation of 50,000 Danish crowns per person to the affected workers. In 2008, the BBC published research concluding that one of the four nuclear bombs had not been recovered. However, this is refuted by Eric Schlosser, who says only part of one of the bombs was never found. More than four decades after the accident, not all the documents concerning the accident and its possible health effects have been released and no epidemiological investigations have been undertaken to ascertain health effects on the local population or the U.S. clean-up crews, affected by the radioactive contamination. These people are also casualties of the nuclear bomb – they are also Hibakusha.

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ATOMIC BOMBS

Finally, is the ultimate disaster of spreading radiation. This is dealt with another topic but I'll just briefly mention it here. The world is still precarious with North Korea (DPRK), India and Pakistan over Kashmir currently and over water in the future, Middle East and the Ukraine.

Hiroshima, Japan
http://www.nuclear-risks.org/en/hibakusha-worldwide/hiroshima.html

Atomic bombing

On August 6, 1945, the U.S. detonated the atomic bomb "Little Boy" over the city of Hiroshima. Of the 350,000 citizens, about 140,000 had died by the end of the year. The surviving "Hibakusha" suffered from the late effects of radiation, including increased incidence of cancer.

History

During World War II, the U.S. produced three nuclear bombs. After the successful Trinity Test on July 16, 1945, the U.S. detonated the remaining two bombs over Japanese cities. A uranium bomb called "Little Boy," was dropped on Hiroshima on August 6, 1945, a plutonium bomb called "Fat Man," on Nagasaki on August 9. In Hiroshima, the T-shaped Aioi Bridge, in a populated commercial and residential area, was selected as the target. The bomb detonated at an altitude of 580 m with an explosive force equivalent to about 15,000 tons of TNT.

Health and environmental effects

The nuclear detonation released enormous amounts of energy, roughly 50 % of which was blast energy. The pressure wave caused by the explosion demolished almost all buildings within a 2 km radius around the hypocenter, including the major hospitals. Ear-drums and lungs burst even at a distance of several kilometers, while the wind reached velocities comparable to large hurricanes and parts of buildings. Vehicles and dead bodies hurtled as deadly projectiles through the ravaged streets. About 35 % of the energy was released in the form of heat and led to a giant fire storm, which quickly engulfed the entire inner city. Most buildings within a radius of two kilometers fell victim to the flames. With temperatures of up to 3,000–4,000 °C around the hypocenter, all living things burned to ashes and only "nuclear shadows" remained on the pavement. Uncovered skin burned within a radius of 3.5 km. People hiding in bunkers or cellars died from carbon monoxide poisoning or suffocation. The remaining 15 % of the total energy was released in form of radioactivity.
From a total of 298 medical doctors, only 28 survived the nuclear explosion. Together with about 130 nurses and 28 pharmacists, they were the only ones able to provide first aid to the survivors. Most of the deaths in the first two weeks occurred due to burns, external injuries and acute radiation exposure. From the third to the eighth week, people exposed to more than 3 Sievert (Sv) of radiation died from organ failure, bloody diarrhea and vomiting or bone marrow depression with anemia, immunodeficiency and bleedings. According to conservative estimates, at least 45,000 people died on the first day after the bombing. By the end of 1945, this number had risen to about 140,000. The exact number of casualties will never be known, however, because it is not known how many people were staying in the city during the final days of the war. Also, documents were lost in the flames; whole families perished, leaving no one to account for missing relatives; and the

entire social system collapsed after the nuclear bombing, further complicating mortality assessments.
The first long-term effects of external radiation to be observed were keloid scars and cataracts. Starting in 1947, a non-linear increase of leukemia was noted. Leukemia incidence peaked in the first half of the 1950s and gradually declined after that. The relative risk of leukemia is presumed to be about 16 times higher for people who received 2–3 Sv of radiation as compared to the general population. Until today, leukemia incidence in Hiroshima is slightly higher than in the rest of Japan. On the other hand, the incidence of solid tumors is continually increasing as survivors are getting older, as is the incidence of myelodysplastic syndrome. While at first mainly thyroid cancer showed a rising incidence, cancers of the breast, stomach, large intestines, skin, liver, gallbladder, ovary and urinary bladder soon followed. The epidemiological Life Span Study (LSS), begun in 1950, showed that the incidence of cancer was proportional to the radiation exposure dose. Also, the incidence of cancer was higher in people exposed at younger age. According to the LSS, the estimated risk of solid cancers is about 1.5 times higher in the survivors of the bombing than in the general population.
Besides cancer, other diseases with higher incidence in the survivors cohort were benign tumors, endocrine disorders, hypertension and stroke, as well as heart and liver disease. Since the frequency of chromosomal aberrations was shown to increase with radiation dose, it can be used as a "biological dosimeter." In case of intrauterine exposure, increases in microcephaly and mental retardation were noticed in offspring of survivors.

Outlook

The Japanese term for the survivors of the nuclear bombings is "Hibakusha." Most of the Hibakusha still alive today were exposed to radiation at a very early age so that detrimental long-term effects and increased morbidity rates can still be expected to occur in this population. But much is still unknown. The effects of internal radiation from nuclear fallout were not accounted for in the LSS, for example. Also, because the study was only begun in the year 1950, radiogenic effects of the first five years after the bombing, especially those pertaining to perinatal morbidity and mortality, were never properly assessed. Finally, some Hibakusha groups are accusing the government of covering up the health effects of radiation on future generations for political reasons.

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Nagasaki, Japan
http://www.nuclear-risks.org/en/hibakusha-worldwide/nagasaki.html

Atomic bombing

On August 9, 1945, the U.S. detonated the nuclear bomb "Fat Man" over the Japanese city of Nagasaki, with a population of more than 240,000. The bombing resulted in the immediate deaths of 22,000 people. Those who survived the attack were left without help as hospitals and vital infrastructure had been completely destroyed. More than 64,000

people had died as a result of the bombing by the end of the year. Many of the survivors still suffer from long-term radiation effects today.

History

Just three days after the atomic bombing of Hiroshima, which had caused an estimated 45,000 casualties and had left 91,000 people injured, a second, nuclear-armed B29 bomber started from the U.S. base on the island of Tinian. This time, the intended target was the industrial city of Kokura. Due to bad weather conditions, the pilot rerouted the plane to the secondary target site: Nagasaki, an important cultural hub and a harbor city with Mitsubishi factories.
The atomic bomb, nicknamed "Fat Man" due to its plump design, weighed about 4.5 tons, measured 4.5 meters in length and had the explosive capacity of about 22,000 tons of TNT. "Fat Man" was dropped over the densely populated city at 11:02 am local time and exploded about 500 m above ground.

Health and environmental effects

Elevations between the two rivers of Nakashima and Urakami roughly divided Nagasaki in two parts, each named after its river. Because Nakashima, in the eastern part of Nagasaki, was protected by a chain of hills, it was not completely destroyed. Nevertheless, the damage in Nakashima was by no means small. More than 18,000 buildings were damaged, almost 13,000 completely destroyed. In the suburb of Urakami, more damage was caused by the shock wave than in Hiroshima.
The explosion caused a giant fireball, completely vaporizing everything within a radius of about 1 km. The ensuing heat wave was strong enough to ignite fires and cause major burns as far as 5 km from the hypocenter. The fire also sucked out the oxygen from the surrounding area, so that people hiding in basements and bunkers died of asphyxiation.
A shock wave followed, which turned parts of buildings, vehicles, wooden beams, glass shards, animals and even people into projectiles, flying at speeds of more than 150 km/h. Tens of thousands of people suffered from poly-traumatic fractures, penetrating trauma from flying debris and crushed organs in addition to burns. Eardrums and lungs ruptured many kilometers from the hypocenter.
Those who survived the fires and the effects of the detonation suffered from gamma-radiation emitted by the nuclear explosion. Exposure to more than 1 Sievert of radiation led to acute radiation sickness with severe burns, bloody diarrhea and vomiting, bleeding, immunodeficiency, anemia, blindness and damage to the central nervous system. Even far away from the hypocenter, people were exposed to radioactivity through plutonium-laden "black rain." The inhalation or ingestion of this nuclear fallout, or of contaminated food and water, led to severe internal radiation. Genetic mutations and radiation-induced cell damage led to a high prevalence of miscarriages, still-births, cancers, thyroid diseases and cardiovascular diseases in the survivors.
The electromagnetic pulse caused by the nuclear detonation destroyed electric communication and power systems throughout the city. This was to prove fatal to the survivors, as health and emergency services were practically wiped out as a result.
According to official Nagasaki statistics, the total death toll from the atomic bombing amounted to about 73,000, with 74,000 people injured and 120,000 suffering from long-term effects of the blast and the radiation.

Outlook

The full extent of the Nagasaki bombing may never be known. Most still-births, malformations and deaths in the first years after the bombing were simply not examined. Corpses were quickly burned due to the chaos after the blast, fear of epidemics and the absence of scientific and medical infrastructure and personnel. Scientific research began in 1950 and has been performed largely by the U.S.-based Atomic Bomb Casualty Commission and the Radiation Effects Research Foundation

(RERF). Their studies found leukemia rates up to seven times higher than in control populations, as well as increased rates in almost all other cancers. These studies did not examine the long-term effects of low-level radiation and the connection of radiation to non-cancer diseases and are thought to underestimate the full extent of radiation-induced morbidity and mortality. Even today, the Hibakusha of Nagasaki still suffer from the atomic explosion that took place several decades ago. The chapter on Nagasaki is still not closed.

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CONCLUSIONS

I feel that we should leave uranium in the ground like we had done with asbestos in Canada.

We should thus have a moratorium on uranium mining.

We should let nuclear power plants be closed after their expiration, not extending their life span. Jobs will still be provided in the decommissioning.

We need to get rid of all nuclear weapons.