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SUMMARY OF HEALTH AND ENVIRONMENTAL IMPACTS OF NUCLEAR TESTING AT THE SEMIPALATINSK TEST SITE

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Atmospheric tests by the former Soviet Union at the Semipalatinsk Test Site resulted in significant radiation doses to nearby settlements, though there are differences in various accounts about the number of people exposed and the doses received. Testing was conducted with high levels of secrecy; data on exposure of local people apparently began to be collected only in 1956 when a surface burst test caused "an emergency situation"; no protective measures for the exposed population were undertaken except for an evacuation of about two weeks some nearby residents in 1953 (Vakulchuk et al. 2014, p. 10). Various accounts are in agreement that communities near the test site suffered significant exposures to radiation over the atmospheric testing period that lasted from 1949 to 1962. There is also evidence of significant fallout hundreds of kilometers from the test site.

Various Estimates of Health Impacts

The official Tsyb Commission, appointed in 1989, estimated that average exposures to people in nearby villages from the very first test ranged from 20 millisieverts to 1.6 Sv, with the total population dose being about 2,500 Sv, or an average of 400 mSv per person to almost 6,300 people in the villages of Dolon, Kainar, Sanhal, Karual, and Semyonovka (based on Tsyb Commission data in IPPNW and IEER 1991, Chapter 6). This implies almost 300 excess cancers and almost 150 excess cancer deaths from just the first test at the Semipalatinsk test site, not including people who lived farther away than the closest villages (using risk estimates in the 2006 report of the United States National Academies known as the "BEIR VII" report – BEIR VII 2006).

Kazakh Professor Saim Balmukhanov presented a broader estimate of exposed people at a 1990 European regional conference of International Physicians for the Prevention of Nuclear War. According to his data, between 100,000 and 200,000 people were exposed to less than 0.1 Sv, 30,000 to 40,000 to an average of 1.6 Sv and 1,000 people in the nearby village of Dolon to 2.8 Sv (IPPNW and IEER 1991, p. 95). Using 0.05 Sv for the first set of people, this population dose estimate would be about 66,000 Sv, resulting in an estimated 7,500 excess cancers in the region. The cancer mortality in the village of Dolon would be expected to be nearly double the normal rate of roughly 20 percent.

A third estimate can be made from data compiled by a commission appointed in 1990 by the USSR Congress of People's Deputies. This commission estimated that in the nearby population of 10,000 people, cancer deaths had increased by 39 percent (as quoted in IPPNW and IEER 1991, p. 97). This implies an average individual dose of about 1.4 Sv. This is consonant with the average dose of 1.6 Sv to 30,000 to 40,000 people though, obviously, the two estimates of the numbers of people exposed to this level differ substantially.

A detailed cohort study was published in 2005 examining the medical records of 19,545 exposed and relatively unexposed people in order to compare medical outcomes, including cancer mortality. The authors' estimates of exposures were between 20 mSv and about 4 Sv, with an average of 630 mSv to an exposed population of nearly 10,000 people. Significant increases in total solid cancer deaths were found, with risks per unit of exposure exceeding those in the Hiroshima-Nagasaki cohorts. Significant increases were also found in many specific cancers including stomach and lung cancer, and, in the case of women, breast and esophageal cancer (Bauer et al. 2005).

Non-cancer Impacts

Both the Tsyb Commission and the 1990 Commission of People's Deputies found elevated levels of non-cancer health impacts as well. According to the latter report, as quoted in IPPNW and IEER 1991, p. 99,

- the average life expectancy in the oblast [region] decreased by three years compared with 1970;
- a certain increase by 1.5 to 4.5 times of the average spontaneous level of chromosomic changes in the lymphocytes of the peripheral blood system was detected;
- 40 to 50 percent of the examined people showed an immunological status down to the lowest level of the norm;
- from 1986 to 1988 the birth defects in children increased from 6.4 percent to 8.6 percent. Fatal birth defects increased from 2.3 percent to 7.3 percent;
- there was a steady growth in cases of nervous disorder among children suffering from mental retardation;
- the analysis of the situation in the areas adjacent to the test site showed an increase in suicides by 2.5 times compared with all Soviet Union averages;
- every nuclear test caused a dramatic increase in the number of people seeking help at local medical facilities of the city and oblast.

These kinds of non-cancer impacts are to be expected especially among children whose mothers were exposed to radiation doses of hundreds of millisieverts to a few sieverts during pregnancy. For instance, the International Commission on Radiological Protection estimated that there would be an excess severe central nervous system defect in the form of "severe mental retardation" from exposure prior to 25 weeks of pregnancy for every 2.5 Sv of exposure, with no threshold (ICRP 1986, p. 20 and p. 31).[1] There were two ventings from underground nuclear tests at the Semipalatinsk Test Site in 1987.

The tests impacted a larger population than the estimates discussed above. Vakulchuk et al. (2014) cite estimates of the exposed population as being between half-a-million and one million people, who lived within 160 kilometers of the Semipalatinsk Test Site. In some cases, even more distant populations appear to have been seriously affected by hots spots:

[1] Discussion of risks of radiation exposure and some related research issues in the early part of pregnancy can be found in Makhijani 2022.

> [There was] an emergency situation caused by a surface nuclear detonation on 16 March 1956, the radioactive cloud of which reached the city of Ust-Kamenogorsk, 400 km from the explosion epicentre. The city's population was exposed to nuclear fallout with radiation doses so high as to cause acute radiation poisoning. In response, the Soviet leadership established a special medical institution and hospitalized 638 persons suffering from radiation poisoning[2]. No information about the fate of these people is available, however. (Vakulchuk et al. 2014, p. 10)

This experience of serious distant impacts is not surprising in view of the fact that research in recent decades both from civilian accidents and atmospheric testing has established the importance of hot spots, including distant hot spots in human exposure. For instance, the beta radiation deposition in Almaty in 1962 (known as Alma Ata at that time) over 800 km from Semipalatinsk was 16,000 megabecquerels per square kilometer compared to a measurement of just 8 MBq/km^2 in 1988 (IPPNW and IEER 1991, Table 12, p. 102). Population doses and health impacts from these intense distant hot spots remain to be estimated.

Vakulchuk et al. (2014) also report high infant mortality and an increased rate of congenital malformations, also to be expected for pregnant women at the levels of exposure that have been estimated for people near the test site (Makhijani 2022). Reviewing the various studies up to about 2013, Grosche et al. (2015) concluded that

> …data are available for more than 100,000 persons forming a large cohort which needs to be further investigated. Furthermore, the range of external doses as described in the study of cardiovascular diseases (i.e. 0-630 mGy) is wide enough to conduct meaningful health studies. Lastly, the data from the 3-generation studies are of high interest to study transgenerational effects. Overall, this line of research has great relevance not only for the region of Central Asia but also to countries around the world affected by nuclear testing.

The total explosive power of the tests at the Semipalatinsk Test Site was about 6.6 megatons (compiled from Mikhailov 1996). Using standard coefficients for strontium-90 and cesium-137, an estimated 266,000 and 425,000 terabecquerels, respectively, of these radionuclides would have been present in fallout due to these tests. More than three-fourths of these amounts would have decayed away since that time. Almost all the unfissioned plutonium-239, roughly 170 kilograms, still remains in the environment due to dispersal in atmospheric testing fallout.

Environmental Contamination

The more than 300 underground tests have left a vast legacy of underground contamination (IPPNW and IEER 1991, p. 102). The total amount of residual plutonium underground is estimated to be almost 800 kilograms (IPPNW and IEER 1991, p. 103).

About 100 underground tests vented significant amounts of radioactivity, including two in 1987 and one in 1989. The ventings in 1987 were detected in the city of Semipalatinsk; in one case, on May 7, 1987, the radiation levels were 35 to 50 times natural background radiation. After a 1989 venting, radiation levels at the village of Chagan were more than 300 times background (IPPNW and IEER 1991, p. 103).

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[2] Symptoms of acute radiation sickness signify exposure to more than 0.3 Gy.

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