

Assessing the Harm from Nuclear Weapons Testing and Production

Prepared for the Vienna Conference on the Humanitarian Impact of Nuclear Weapons

Arjun Makhijani, Ph.D.

Institute for Energy and Environmental Research

December 8-9, 2014

Vienna, Austria

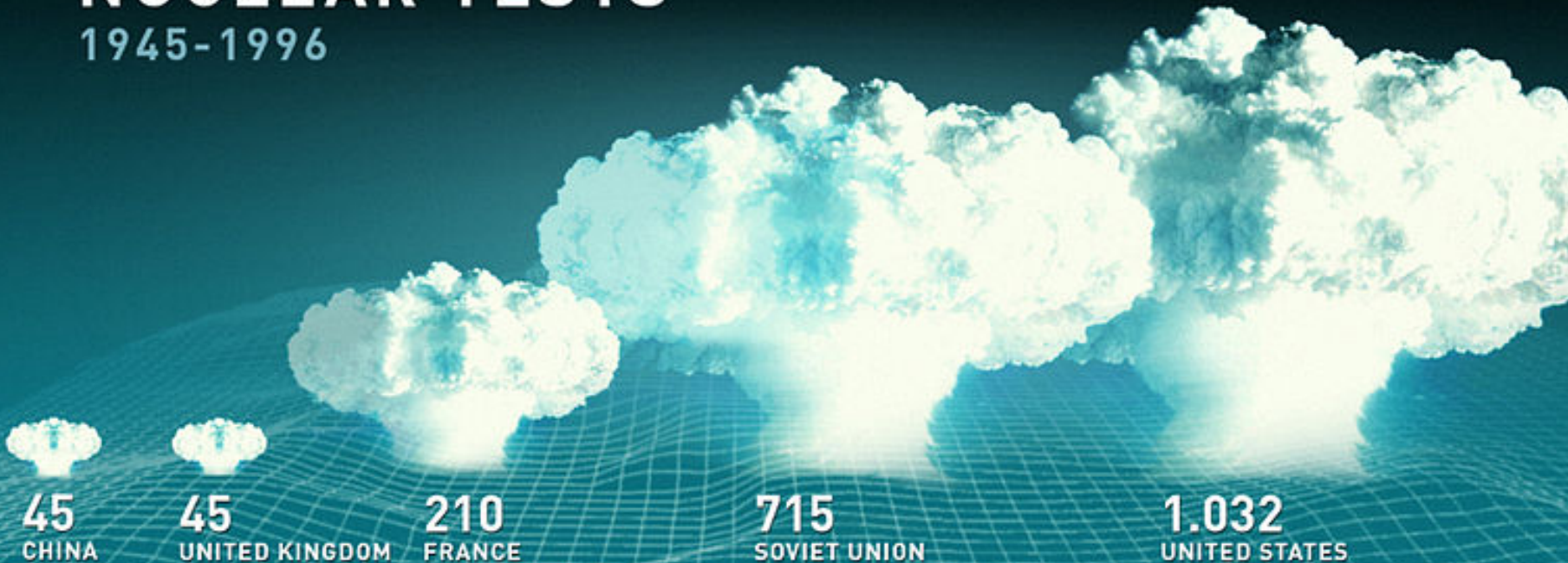
Types of harm: overview

- Uranium mining and milling (much of it in non-nuclear weapon states, like Democratic Republic of Congo, Namibia, then-Czechoslovakia, then-East Germany, Canada, Australia....)
- Weapons materials production (uranium processing and enrichment, plutonium, and tritium), production reactors, reprocessing (including creation of liquid, highly radioactive wastes), waste storage (often leaky) and disposal
- Nuclear weapons fabrication
- Nuclear weapons testing (including Hiroshima and Nagasaki, which are officially are classified by the U.S. as nuclear tests)

Total tests: 2,055, including India 3, Pakistan 2, North Korea 3. Devices fired 2,474.

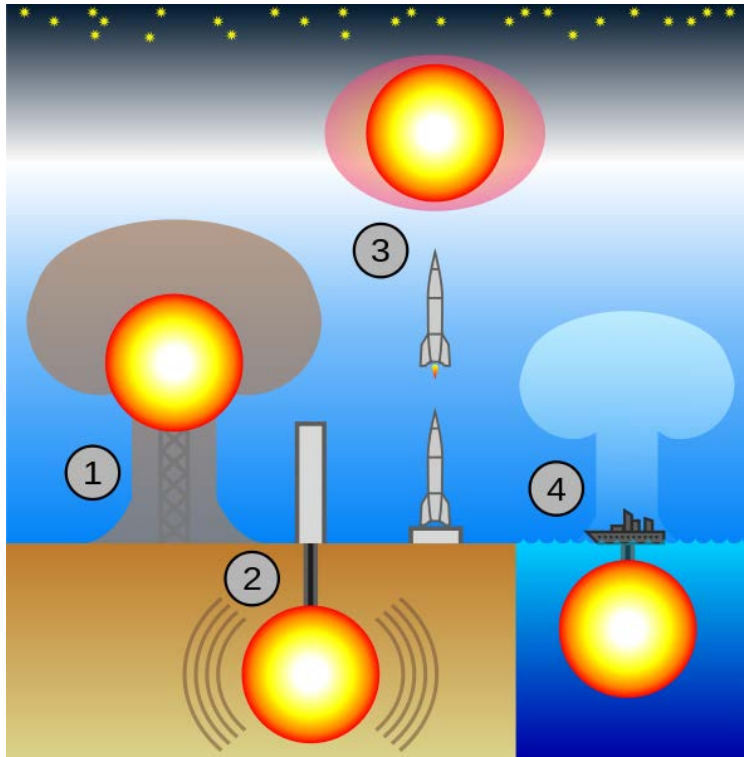
NUCLEAR TESTS

1945-1996



Nuclear testing: more detail

Types of nuclear testing



Source: For types of testing: Wikimedia Commons at http://commons.wikimedia.org/wiki/File:Types_of_nuclear_testing.svg

Underwater test example: Test Baker

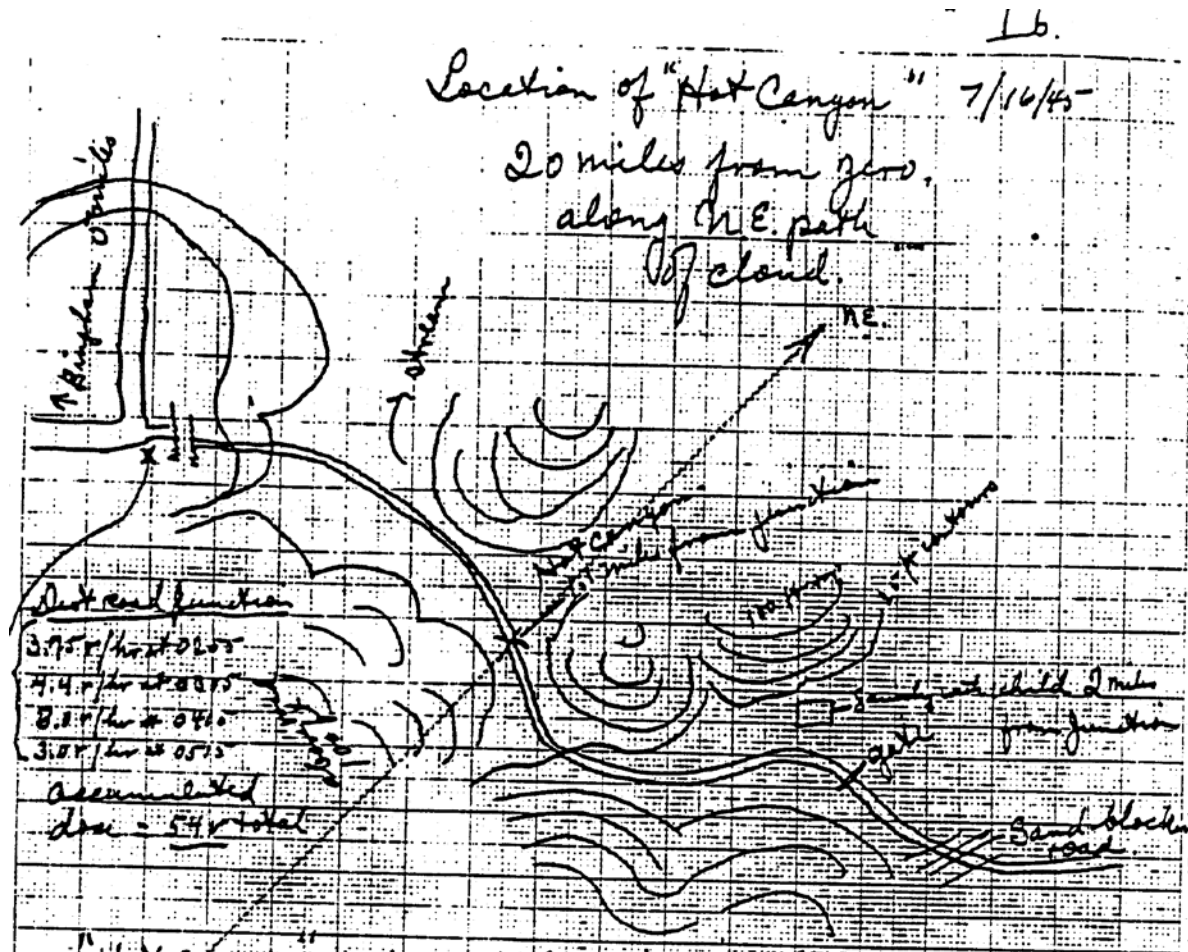


Source: For Test Baker: U.S. Dept. of Defense at http://en.wikipedia.org/wiki/File:Operation_Crossroads_Baker_Edit.jpg

Some damage estimates: Atmospheric testing: all powers

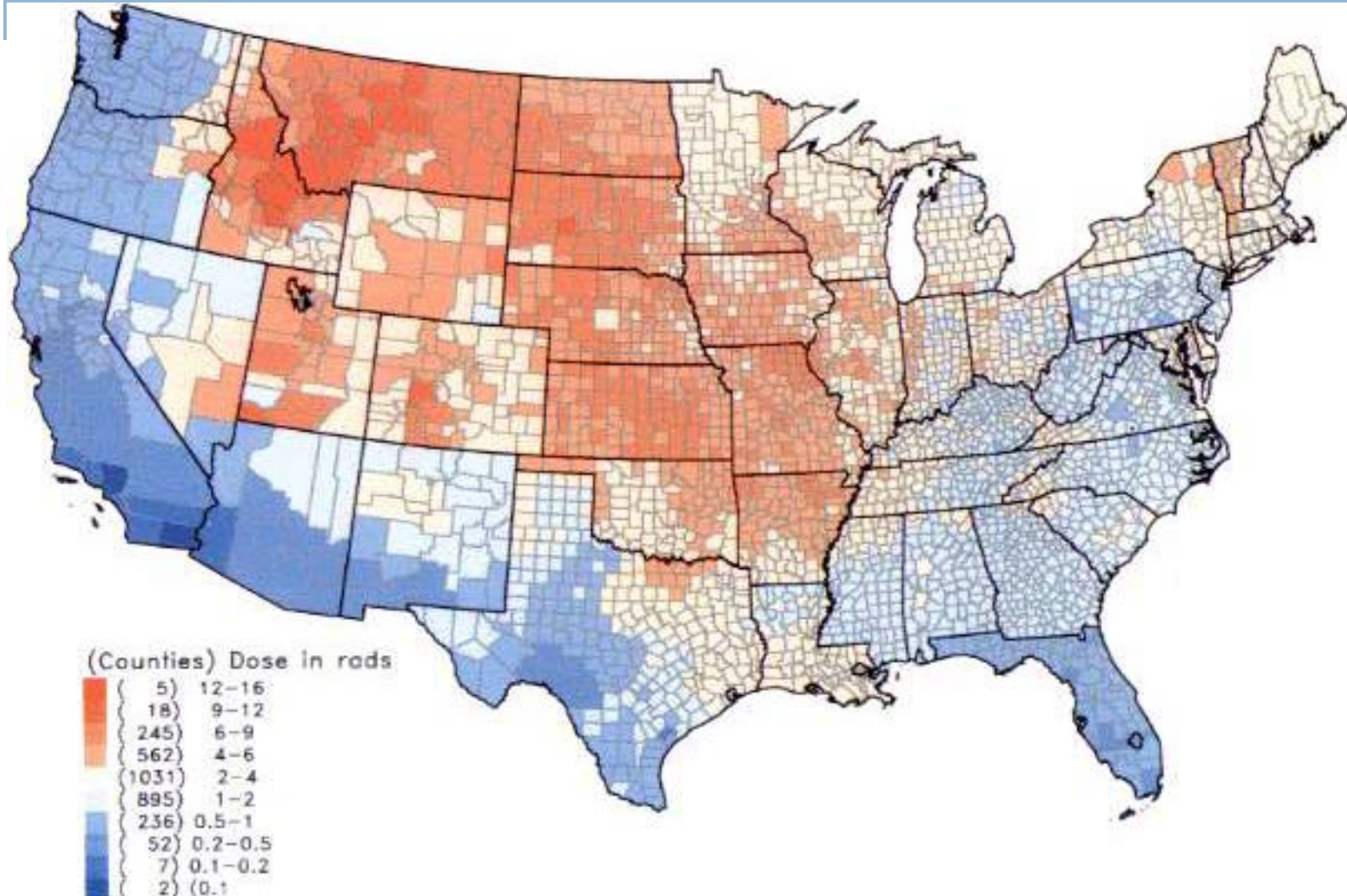
- Strontium-90 inventory: 250,000 TBq (decay corrected)
- Cesium-137: 400,000 TBq (decay corrected)
- Carbon-14: 400,000 TBq; minimal decay so far
- Plutonium-239: 4,200 kilograms; minimal decay so far
- Estimated cumulative radiation doses to global population to the year 2000: 5.44 million person-Sieverts
- Corresponding cancer incidence cumulative to the year 2100: (using 0.11 cancers per person-Sv): about 600,000 (rounded). Risk is greatest in the 30 to 60° N latitude band
- Nevada testing: I-131 release: 5.6 million TBq (150 million curies). USA alone: 11,300 to 212,000 thyroid cancers (incidence); females, especially children, at greater risk.
- Female risk of thyroid cancer for exposure as an infant is 70 times that of a 30 y male per unit of intake.
- University of California alumni magazine, *California Engineer*, estimated in 1960 that US testing would produce ~6,000 babies with major birth defects worldwide. Calculation method unknown.
- Global test megatonnage: 2.75 times US total. Atmospheric ~ 2x U.S. total. But difficult to extrapolate health harm from US assessments.

Trinity test fallout map. Dose rates up to 44 mSv/hour @30 km from site



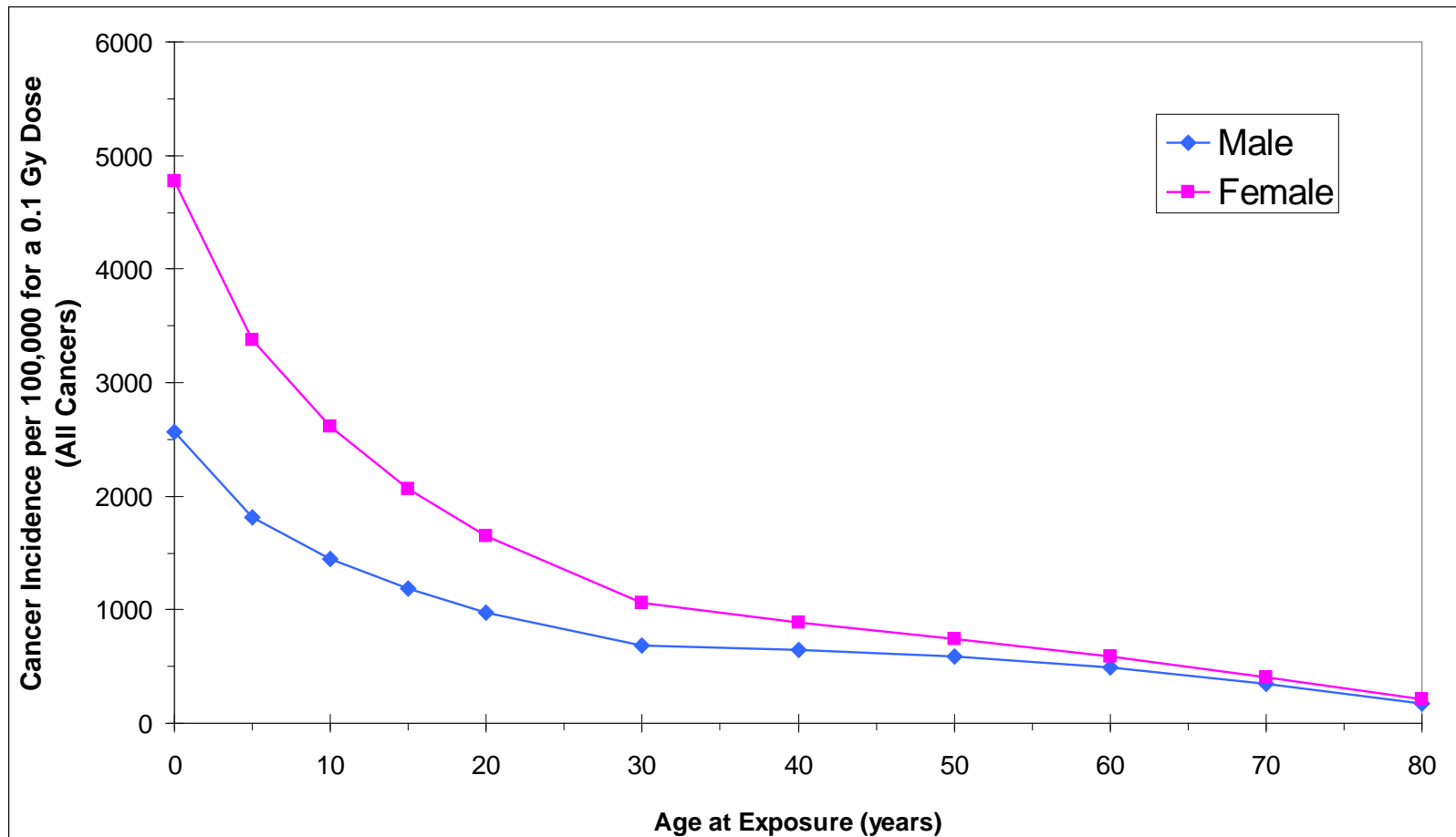
Stafford L. Warren, memorandum to Major General Groves, re: Report on Test II at Trinity, 16 July 1945 (July 21, 1945) on IEEER website at http://ieer.org/wp/wp-content/uploads/2003/07/14_staffordmemo_trinity_1945.pdf

Iodine-131 doses from Nevada atmospheric testing: heaviest in milk-drinking children



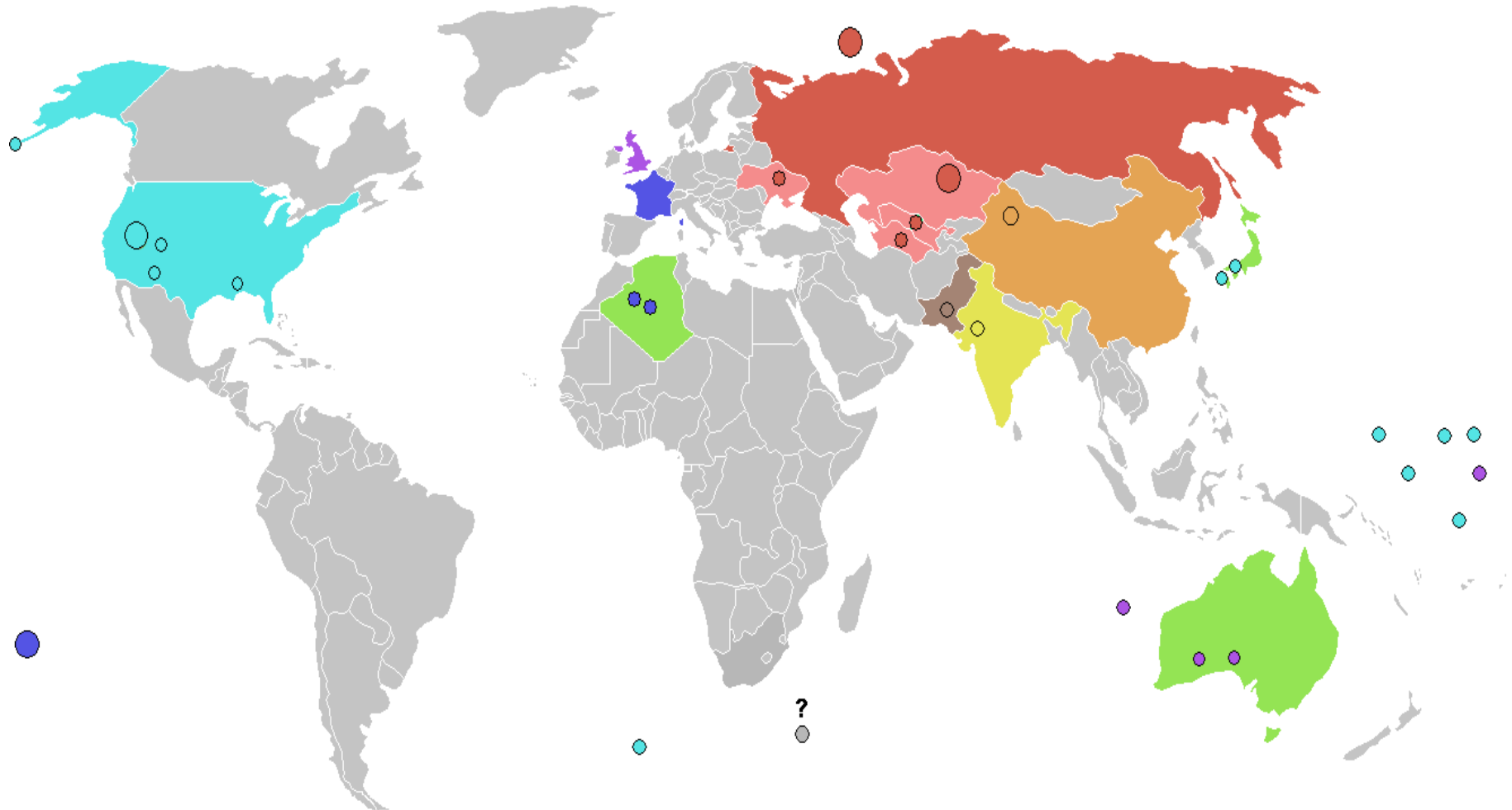
National Cancer Institute (October 1997), at <http://www.cancer.gov/cancertopics/causes/i131/nci-reports>. Figure ES.1. Per capita thyroid doses resulting from all exposure routes from all tests, at <http://www.cancer.gov/i131/fallout/exesumfig1.html>.

Cancer risk, by age and sex



Source: Arjun Makhijani, Brice Smith and Mike Thorne. *Science for the Vulnerable: Setting Radiation and Multiple Exposure Environmental Health Standards to Protect Those Most at Risk*. Takoma Park, MD: Institute for Energy and Environmental Research, October 19, 2006, at <http://ieer.org/resource/press-releases/science-vulnerable-setting-radiation>. Figure 6 (p. 38)

Main nuclear testing locations (2,055 tests: USA: 1,032, USSR: 715, France: 210, UK: 45, China: 45, others: 8). Explosions = 2,474. **Mainly tribal or colonial land**



Source: Roke, Wikimedia Commons, at http://commons.wikimedia.org/wiki/File:Nuclear_use_locations_world_map.PNG

Other damage: uranium mining, high-level wastes

Rossing mine, Namibia



Source: Ikiwaner, Wikimedia Commons, at http://commons.wikimedia.org/wiki/File:Arandis_Mine_hochformat.jpg

Mayak: Lake Karachay, Techa River, Soviet Union



Source: JanRieke, Wikimedia Commons at http://commons.wikimedia.org/wiki/File:Satellite_image_map_of_Mayak.jpg.
Based on NASA World Wind screenshot.

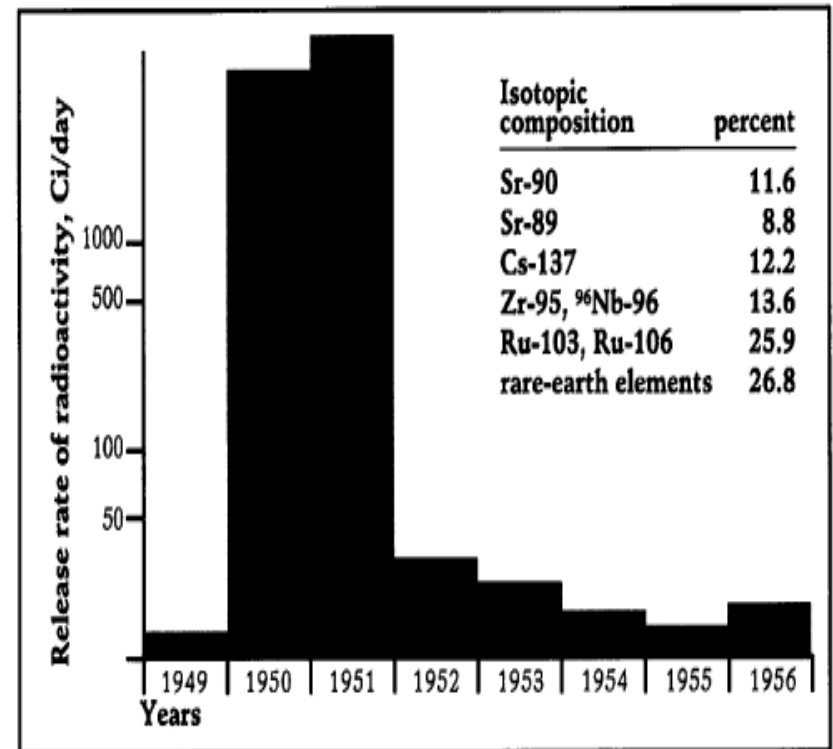
Mayak, Soviet Union. High-level waste discharged into the Techa River, 1949-1956

Residents of Muslyumovo on the Techa River, 1992



Photo by Robert Del Tredici / the Atomic Photographers Guild, as found in *Plutonium: Deadly Gold of the Nuclear Age*, Figure 3.5 (p. 77)

Total ~150,000 TBq (in 2014
~10,000 TBq)



Source: Radioactive waste discharges: *Plutonium: Deadly Gold of the Nuclear Age*, Figure 3.4 (p. 73)

Accidents: high-level waste explosion, southern Urals, 1957; Sr-90 radioactive trace

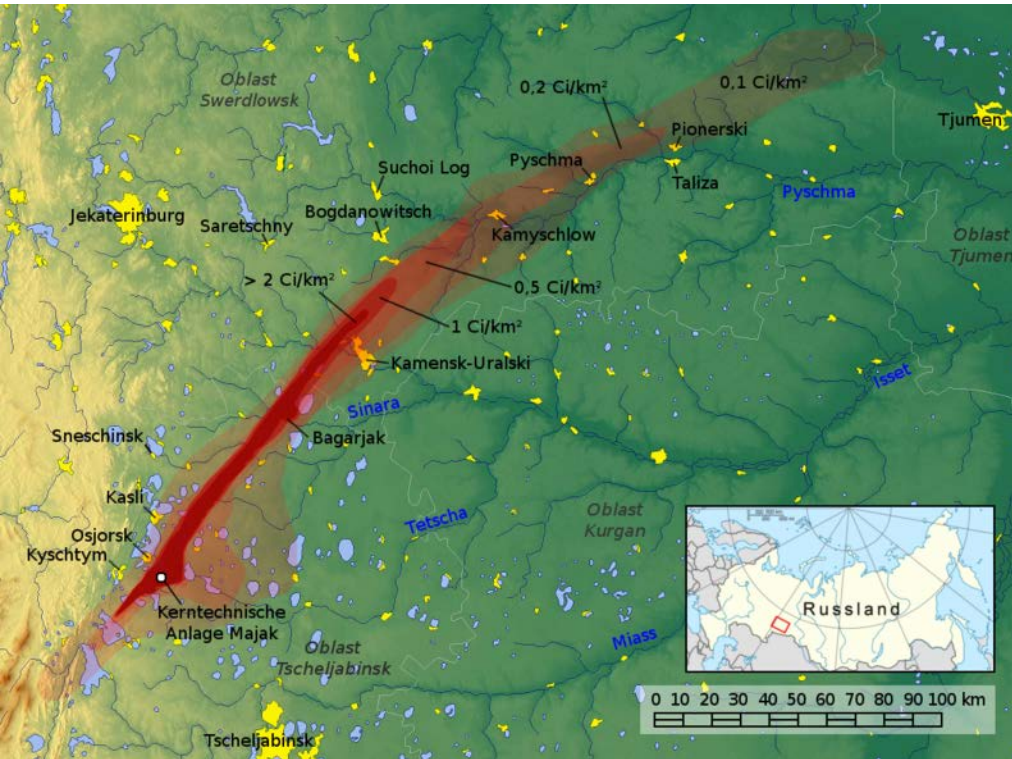


Image source: Jan Rieke, using maps-for-free.com, Wikimedia Commons, at <http://en.wikipedia.org/wiki/File:Ostural-Spur.png>

- $\sim 15,000 \text{ km}^2$
- \sim abandon farming on $\sim 60,000$ hectares
- Public not informed but at least 22 villages evacuated
- CIA knew in 1959 but did not publicize, despite the cold war
- Collective dose estimate: 1,300 person-Sv
- Cancer incidence: ~ 140

Testing and nuclear war strategy, 1947 insights, U.S. Joint Chiefs

From official evaluation of 1946 underwater Test Baker at Bikini:

- “We can form no adequate mental picture of the multiple disaster which would befall a modern city, blasted by one or more bombs and enveloped by radioactive mists. Of the survivors in the contaminated areas, some would be doomed by radiation sickness in hours, some in days, some in years. But, these areas, irregular in size and shape, as wind and topography might form them, would have no visible boundaries. No survivor could be certain he was not among the doomed, and so added to every terror of the moment, thousands would be stricken with a fear of death and the uncertainty of the time of its arrival.”

Accountability

- There has been some accountability in the form of publication of documents, compensation programs for workers and downwinders, and studies about the extent of damage, as for instance in the United States.
- But for the most part, accountability and transparency are still lacking, as is a full assessment of the extent of the damage.

Summary

- Every nuclear weapon state has harmed the health of its own people and its environment in the name of national security and usually without informed consent or open discussion of the risks.
- Every state that has had atmospheric testing has contaminated the world, notably the Northern Hemisphere and the non-nuclear uranium mining countries.
- Thousands of sites contaminated, many severely, some irretrievably.
- Millions of workers involved (US, Britain have compensation programs)
- Human experiments, in the US, including plutonium injections, radioactive cereal fed to children, irradiation of prisoners up to early 1970s. US established official inquiry in 1994. But others?
- Much is still unknown and deeply secret, though variable across nuclear weapon states. Those not parties to the NPT have been the most closed.
- Danger is not passed: liquid high-level waste at many sites, buried plutonium-containing waste, deep injection into aquifers (Krasnoyarsk, Idaho). For example, Hanford projected to contaminate groundwater to more than drinking water limit for thousands of years AFTER cleanup.

Resources

- California Engineer editorial (April 1960), reprinted in *California Engineer*, v. 68, no. 3 (1990), p. 23.
- Institute of Medicine and National Research Council: *Exposure of the American People to Iodine-131 from Nevada Nuclear-Bomb Tests*. National Academies Press (1999), at http://www.nap.edu/openbook.php?record_id=6283&page=72.
- IPPNW-IEER: *Radioactive Heaven and Earth* (1991), at <http://ieer.org/resource/health-and-safety/radioactive-heaven-and-earth>.
- IPPNW-IEER: *Plutonium: Deadly Gold of the Nuclear Age* (1992), at <http://ieer.org/resource/reprocessing/plutonium-deadly-gold-nuclear>.
- IPPNW-IEER: *Nuclear Wastelands*, MIT Press (1995 and 2000).
- Arjun Makhijani: *A Readiness to Harm*, *Arms Control Today* (2005), at http://www.armscontrol.org/act/2005_07-08/Makhijani.
- Arjun Makhijani, Brice Smith, and Mike Thorne: *Science for the Vulnerable: Setting Radiation and Multiple Exposure Environmental Health Standards to Protect Those Most at Risk*, IEER (2006), at <http://ieer.org/resource/press-releases/science-vulnerable-setting-radiation>.
- National Cancer Institute. *Estimated Exposures and Thyroid Doses Received by the American People from Iodine-131 in Fallout Following Nevada Atmospheric Nuclear Bomb Tests*. (October 1997), at <http://www.cancer.gov/cancertopics/causes/i131/nci-reports>
- Natural Resources Defense Council: *Nuclear Weapons Databook Series*, Westview Press, at <http://www.nrdc.org/publications/printonly.asp>.
- U.S. Joint Chiefs of Staff. 1947. *The evaluation of the atomic bomb as a military weapon. The final report of the Joint Chiefs of Staff Evaluation Board for Operation Crossroads*, enclosure to Joint Chiefs of Staff. Document number JCS 1691/7, Record Group RG 218, Modern Military Branch, National Archives, Washington, DC.
- Stafford L. Warren, memorandum to Major General Groves, re: Report on Test II at Trinity, 16 July 1945 (July 21, 1945) on IEER website at http://ieer.org/wp/wp-content/uploads/2003/07/14_staffordmemo_trinity_1945.pdf