



**Prize Winner**

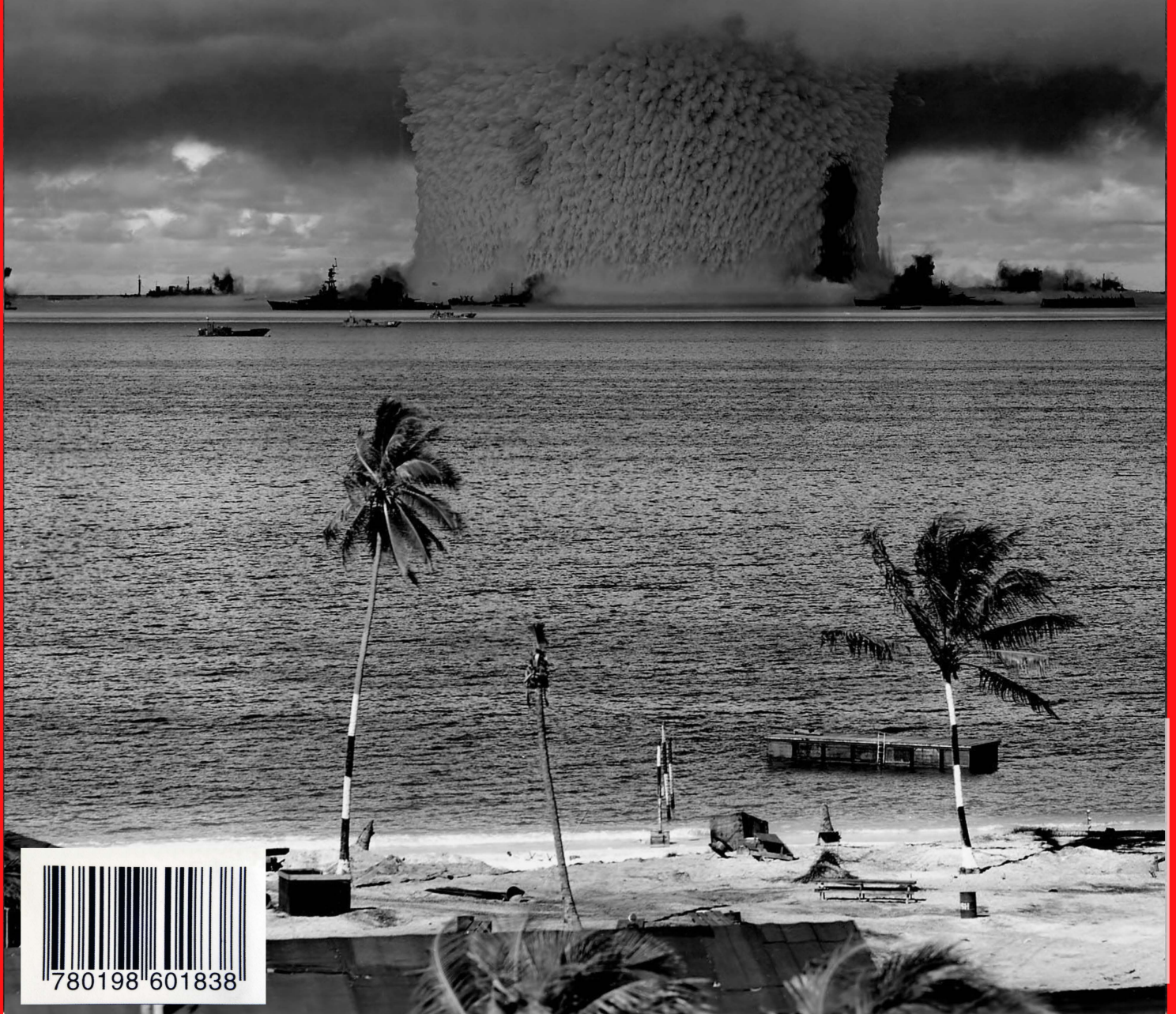
**Science Writing  
Year 11-12**

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# TIME BOMBS





# THE SOCIAL, ECONOMIC AND ENVIRONMENT CONSEQUENCES OF NUCLEAR BOMB TESTING IN THE MARSHALL ISLANDS.

“More than any other place, the Marshall Islands is a victim of the two greatest threats facing humanity — nuclear weapons and climate change,” said Michael Gerrard, a legal scholar at Columbia University’s law school.

**B**etween 1946 and 1958, the United States dropped 67 nuclear bombs on the Marshall Islands, equivalent to 1.6 Hiroshima-sized bombs every day for almost twenty years (Zak, 2015). This article discusses the science behind nuclear bombs and the devastating consequences that these nuclear tests had on the Marshall Islands.

## Science Understanding

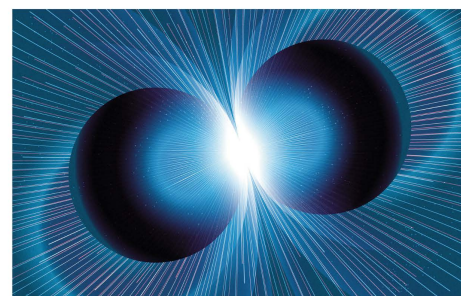
The atomic bomb was designed for war. There are two types of nuclear bombs, atomic bombs and thermonuclear bombs. On the 6th and 9th of August 1945, the US dropped atomic bombs on the Japanese cities of Hiroshima and Nagasaki leading to the end of World War Two. The first thermonuclear (hydrogen) bomb was exploded on 1st November, 1952 at the small island of Eniwetok in the Marshall Islands (Campaign for Nuclear Disarmament, n.d.). The destructive power of the bomb which was detonated on Eniwetok was approximately worth 10 million tonnes of TNT and was approximately 665% more powerful

than Hiroshima. The blast produced a light brighter than a thousand suns and a heatwave was felt 50 kilometres away (ibid). To fully understand the extent of these bombs, the physics of nuclear bombs must be understood.

Atoms are comprised of protons, neutrons and electrons. Stable atoms have an equal number of protons, neutrons and electrons, whereas unstable atoms have excess internal energy in the nucleus (due to excess neutrons). The atom will either emit these excess particles, known as radioactive decay, or split the nucleus into smaller parts, known as nuclear fission (Freudenrich & Kiger, 2022). During nuclear fission, a neutron collides with a uranium atom and splits it, releasing a large amount of energy in the form of heat and radiation. More neutrons are also released when the uranium atom splits which results in these neutrons repeating this process and colliding with other uranium atoms (US Energy Information Administration, 2022). All nuclear weapons and power plants use nuclear fission as it releases strong electromagnetic radiation (in the form of X-Rays), which create the high temperature and pressure needed to ignite

fusion (Union of Concerned Scientists, 2018).

The second reaction which occurs in a nuclear bomb involves nuclear fusion. The energy from the initial fission explosion is used to “fuse” two isotopes of hydrogen (deuterium and tritium) to create helium (Ash, 2019). A large amount of energy is released when these two isotopes fuse together to form helium because a helium atom has much less energy than the isotopes of these two atoms combined, and thus this excess energy (ibid). Referring to Figure 1, the energy released by the weapon creates a fireball that reaches several tens of million degrees Celsius —temperatures in the same range as the sun (which also runs on fusion) (Union of Concerned Scientists, 2018).



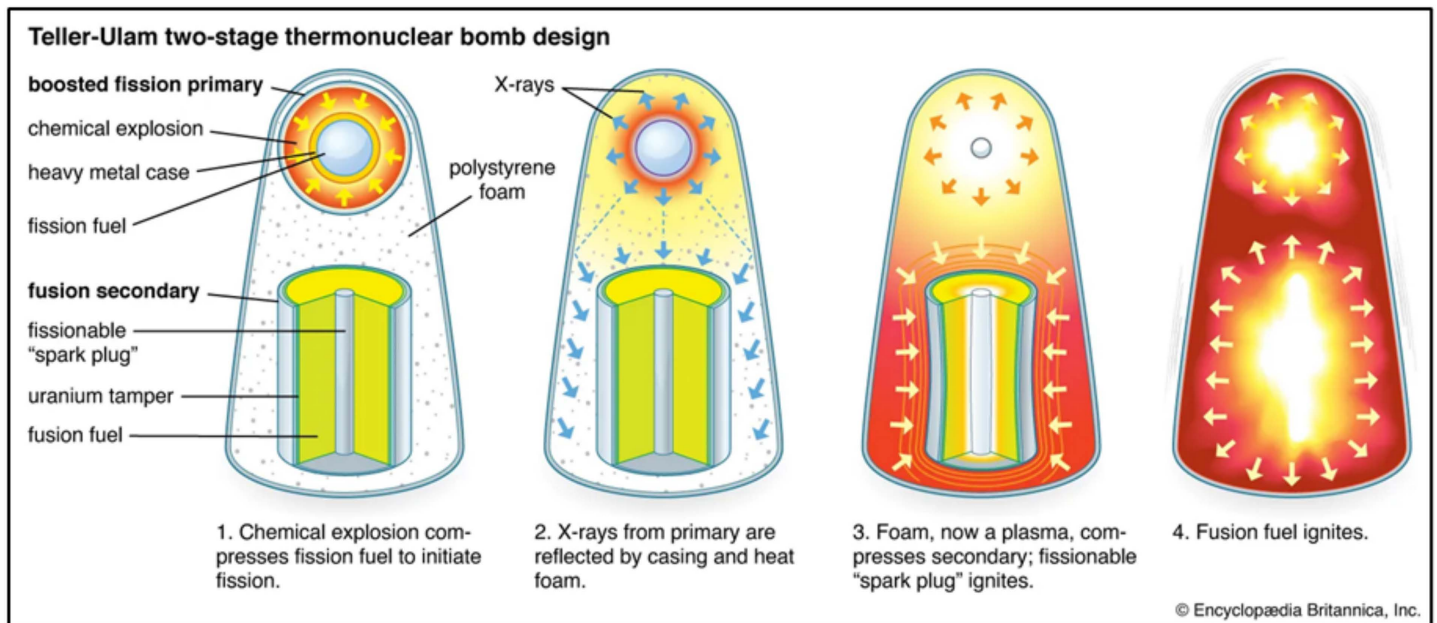


Figure 1 - Fission and Fusion in a Thermonuclear Bomb (Britannica, 2022)

## Environmental Impact

On the 1st March 1954, the most destructive nuclear bomb, named "Bravo Test", was detonated on Bikini Atoll. Bravo vaporised the islands, left a mile-wide crater on the atoll, and generated heavy radioactive fallout across a 1.3 million hectares, including 22 populated atolls (Johnston & Takala, 2016). To this day, Bravo is known as "the largest and dirtiest nuclear weapon the US ever detonated: dwarfing the radioactive releases of Chernobyl and Fukushima" (Johnston & Takala, 2016). At the bottom of Bravo Crater, which is seeping into ocean water, radiation levels for plutonium-239, plutonium-240, americium-241, and bismuth-207 exceeded predicted levels (Cartier, 2019). Long-lived radioisotopes like plutonium and americium may contaminate the ocean ecosystems for centuries, affecting coral regrowth and repopulation by bacteria and sea life (Cartier, 2019). The team found unsafe radioactivity levels not just in the air, soil, and water but in the fruit, too. The radioisotope cesium-137 is easily absorbed by food crops, including coconuts and pandanus, both important commercial and domestic crops in the Marshall Islands (Cartier, 2019).

A trio of studies published in Proceedings of the National Academy of Sciences of the United States of America found that in several locations in and near testing sites, ambient radiation levels as well as radioactivity levels

in ocean sediments and food remain higher than maximum exposure limits (Cartier, 2019). Researchers found that gamma radiation levels on Bikini Island were nearly twice the radiation exposure limit for relocation agreed on by the U.S. and Marshallese governments in 1994 (Cartier, 2019). On Rongelap's Naen Island they were nearly 3 times the limit (Cartier, 2019).

In November 1952, the "Ivy Mike" thermonuclear bomb was dropped on Elugelab and completely vaporised the island (Brumfield, 2019). This was not an isolated occurrence and several other islands had also pulverised and disappeared as a result of nuclear testing (Brumfield, 2019). The complete disappearance unnaturally altered the land formation of these atolls, adversely impacting the underwater and land ecosystems and food chains.

With the vast amount of testing that occurred in the water the coral reefs of the islands were virtually decimated and the habitat in which they sustained (Gutwald, 2017). While there are no exact numbers on the number of species present today, we know of 126 coral species that existed before the tests and 42 that have not grown back (Gutwald, 2017).

In the 1977, the US Military built the Runit Dome as a temporary measure to contain the radioactive materials from the bombs (Lubofsky, 2019). More than 3.1 million cubic

feet or 35 Olympic-sized swimming pools of radioactive material lie in a bomb crater with only an 18-inch-thick concrete cover (refer to Fig. 2) (Rust, 2019). This dome is known to the locals as "The Tomb" as it contains radioactive and debris, including lethal amounts of plutonium (Rust, 2019).

Due to weathering, the concrete covering the tomb is beginning to crack and the rising sea level is seeping radioactive waste into fresh water supplies and groundwater aquifers, destroying crops and creating water shortages (Piantanida, 2022). Moreover, in 1958, the United States dumped 130 tonnes of radioactive soil from its atomic testing grounds in Nevada into pit located in the Marshall Islands, where the next bomb "Fig" was detonated (Rust, 2019). The radioactive soil and fallout from Fig polluted the ground soil, making it uninhabitable for flora and fauna.

## Social Impact

The tests most gravely affected four atolls in the north of the nation: Bikini, Enewetak, Rongelap and Utirik (Rapaport & Hughes, 2022). Today only Enewetak and Utirik have substantial permanent populations; refugees from Bikini and Rongelap are still unable to return home safely (Rapaport & Hughes, 2022). One in three Marshallese have been forced to relocate to other islands, Hawaii, Arkansas, Washington, Oregon, and other areas with modest support, as a result of the



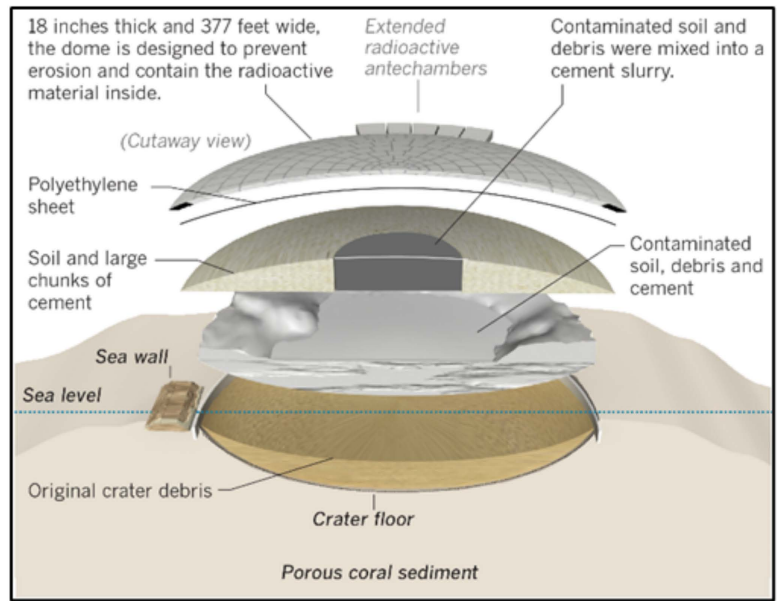
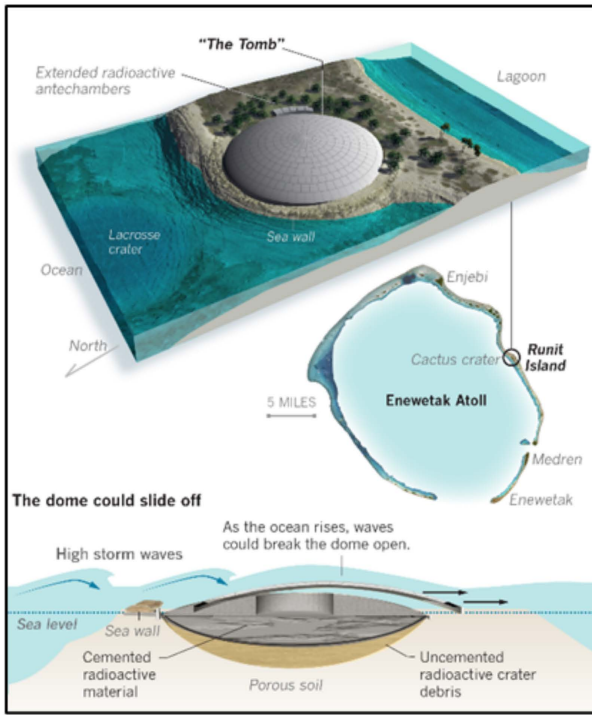


Figure 2 - Annotated Diagrams of Runit Dome (Rust, 2019)

radiation-caused sicknesses, contamination of food and water and as climate change refugees (Saltzman, 2020).

Radiation poisoning, birth defects, leukaemia, thyroid and other cancers became prevalent in exposed Marshallese, with the exposed Marshallese becoming “subjects of a medical research program” and atomic refugees (O’Brien, 2021). In 2005, the National Cancer Institute reported that the risk of contracting cancer for those exposed to fallout was greater than one in three (Atomic Heritage Foundation, 2019). Many adults developed cancerous thyroid nodules, two or three decades after the testing ended and 55% of all

cancers are a result of the nuclear fallout (Atomic Heritage Foundation, 2019).

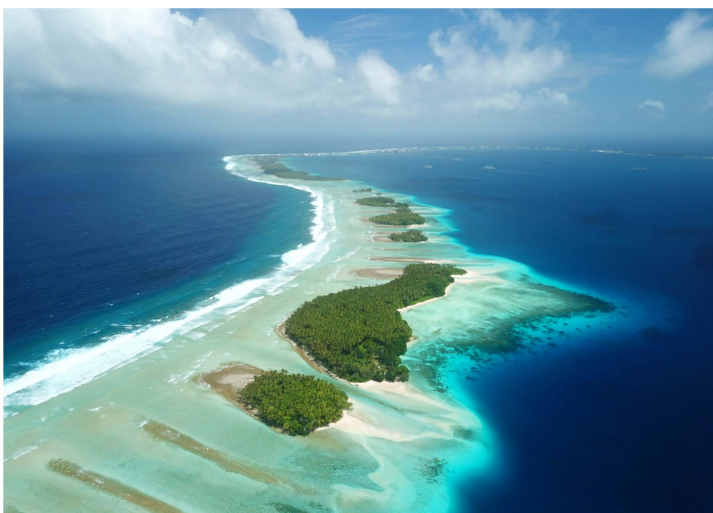
A Times review of thousands of documents, and interviews between officials, found that the American government withheld key pieces of information about the Runit dome’s contents and its weapons testing program before the two countries signed an agreement in 1986 releasing the U.S. government from further liability and as a result many Marshallese leaders no longer trust U.S. assurances of safety (Rust, 2019).

## Economic Impact

The tribunal, established by the United States

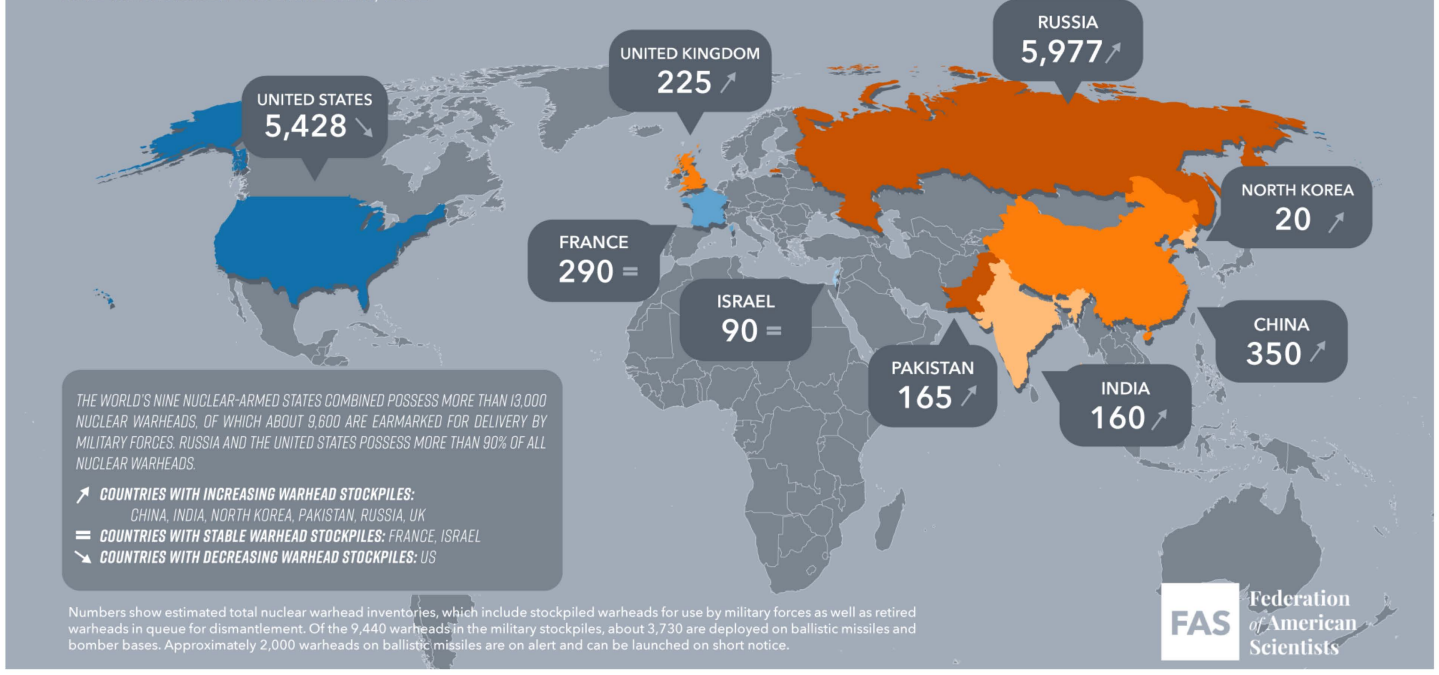
and the Marshall Islands in 1988, concluded the United States should pay \$2.3 billion in claims, but Congress and U.S courts have refused and the U.S. provided just \$4 million compensation (Rust, 2019). The US ambassador to the Republic of the Marshall Islands stated that the US has already paid more than \$600 million for the resettlement, rehabilitation and radiation-related healthcare costs of communities affected by the nuclear testing, and with inflation, the number is closer to \$1 billion (Rust, 2019).

The decimation of the islands resulted in critical hunting practices lost. Prior to nuclear testing, the main food sources of the



# ESTIMATED GLOBAL NUCLEAR WARHEAD INVENTORIES, 2022

Hans M. Kristensen and Matt Korda, 2022



Clockwise from top: Global Nuclear Inventories; Maps of Marshall Islands; Mushroom cloud from nuclear explosion ion Bikini Atoll; Runit Dome; Republic of Marshall Islands Flag.



Marshallese were wild caught fish, taro, breadfruit and tropical fruits (McElfish et al., 2019). However, the nuclear testing destroyed and contaminated much of these food sources and the Marshallese converted to a Western diet. This drastic change in diet has resulted in negative health outcomes such as diabetes, heart conditions and cancers, which has put further economic pressure on their healthcare systems.

## Conclusion

Currently, with the disputes happening all over the world, the risk of nuclear war is becoming real. The President of Russia, Vladimir Putin, has already threatened to deploy nuclear warfare. The nuclear tests in the Marshall Island were utterly inhumane and catastrophic, but it has equipped the United States with the

most powerful nuclear weapons and should hopefully deter other countries from attacking the United States and its allies with nuclear weapons. The Marshallese people and other affected communities have reported for decades just how dangerous nuclear weapons are. Hopefully countries with nuclear weapons will heed to their warnings before it is too late for humanity and our planet!



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