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Data deluge

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1 In the brave new world created by the dropping of the first atomic bombs on Japan in August 1945 and the subsequent development and testing of ever more powerful nuclear weapons by the nuclear powers, radioactive strontium (or strontium-90), a by-product of nuclear explosions, soon emerged as a substance of particular popular, political, and strategic concern. Strontium-90, I suggest, can serve as a tracer to understand what it meant to live in a nuclear world.[1] This article pursues a more modest aim. It considers the data collection programs that responded to and highlighted the issues surrounding the element. More specifically, it will focus on three data collection programs that established strontium-90 as a global pollutant while representing three different strategies to construct the global dimension — an early secret data collection program, code-named Project Sunshine, conducted by the US Atomic Energy Commission, taking advantage of the US diplomatic and military networks around the globe; a data collection project organized by the UN at an inter-governmental level; and finally the Baby Tooth Survey, mounted by a group of concerned citizens and public-minded scientists in St. Louis, MO, to reconstruct the effects of the world-wide weapons testing activity on the local children. Data collection in all three programs was traversed by cold war tensions but ultimately helped to turn

the tide on nuclear weapons testing and led to the signing of the first partial atomic test ban treaty in 1963.

2 All three data collection efforts have already received historical attention, yet viewed together under a historical and historiographical lens, they invite us to rethink the categories of the «local» and the «global» as they were articulated around the problem of radioactive fallout in the 1950s and 1960s.[2] In particular, the three projects suggest that the global dimension could be assembled by both geographically expansive as well as by intensive local data sampling over a period of time that tracked the effects of the remote weapons testing activity. Especially the latter case collapses the categories of the local and the global as commonly understood. Yet before we look closer into these programs and the articulation of radioactive strontium as a global pollutant, we need to ask, what is strontium? And what made it so notorious that at the dawn of the atomic age the element regularly made front-page news?

1. Strontium-90 and fallout

3 Strontium-90 is one of several isotopes of the alkaline earth metal strontium, a chemical element with the atomic number 38. It has similar properties as its two vertical neighbors in the periodic table, calcium and barium. While strontium is found naturally and is today mostly used in toys that glow in the dark, in fireworks, toothpaste, and in drugs to strengthen the bones, radioactive strontium is exclusively produced by nuclear fission. Thus, its history only starts in the 1940s and is wrapped up tightly with nuclear weapons testing and the development of nuclear energy more generally.

4 Uranium fission produces well over two hundred isotopes of thirty-four elements (Stannard, 1988, p. 299). The half-life of the fission products, their accumulation in various parts of the body and their cancer-inducing effects were investigated in animal experiments since the early 1940s under the auspices of the Manhattan Project, the secret crash project, led by the US in collaboration with Britain and the support of Canada, to develop the atomic bomb before Nazi Germany would do so. In these experiments, strontium-90 quickly emerged as the radioisotope that raised most concerns. The main reasons for this were its half-life of nearly twenty-nine years —a long period in relation to the human lifespan, in addition to the fact that as an analogue of calcium it readily accumulates in bone tissue. Because of the slow metabolic turnover of bone tissue, once embedded in the bone, strontium, like other «bone seekers», is retained for a long time and acts as an internal emitter. The animal experiments during the wartime project indicated that strontium-90 was a potent carcinogen, leading to high incidences of leukemia and bone cancer (Stannard, 1988, pp. 317–319). For all these reasons, researchers agreed early on that ingested strontium-90 would represent the most serious long-term hazard from radioactive fallout (Hacker, 1994, pp. 181–182). There were other radioisotopes from fallout that were biomedically relevant, notably iodine-131 that accumulates in the thyroid gland and cesium-137 that seeks out muscle tissue. Yet iodine-131 has a half-life of only eight days while cesium, although longer-lived than strontium-90 with a half-life of thirty-three years, is excreted rapidly from the body. These characteristics made these substances seem less of an issue (Pirie, 1958; Stannard, 1988, p. 305). Other biologically

relevant fission products like for instance carbon-14 were completely overlooked initially (Herran, 2022, pp. 71–76).

5 At this time, researchers were considering hypothetical scenarios of weapons deployment and attempts to determine «practical limits» for using atomic weapons. Yet the realization that the hundreds of test explosions conducted by the atomic powers at the time (US, Britain, and France), and especially the move to testing hydrogen bombs that produced not just local but global fallout made it clear that the problem of strontium-90 was much more acute and wide-spread.[3] The first maps detailing the problem showed that the contamination of strontium-90 appeared in bands of equal concentration that spun the globe. Moreover, the highest strontium concentrations were recorded in the northern hemisphere, far away from the atomic testing grounds in the Pacific. This realization shifted attention from short-time high-dose exposures to long-term low-dose exposures encountered by people all over the world. This set in motion wide-scale monitoring efforts as a way to assess and manage the situation. Project Sunshine was the first of these projects.

2. Project Sunshine—collecting data on an international scale

6 In 1953 the Atomic Energy Commission (AEC) and the RAND Corporation, in collaboration with Manhattan Project veteran and inventor of the radiocarbon dating technique Willard F. Libby from the University of Chicago, launched a secret project code-named Sunshine— possibly an allusion to the fact that RAND was located in Santa Monica, in the sunshine state—to assess the worldwide levels of strontium-90 already produced from nuclear weapons testing. The project was designed to fill in data for a theoretical model of global strontium-90 transport, drawn up to establish the biological limits of nuclear warfare, a quest pursued as part of Project Gabriel, another AEC-sponsored project. Project Gabriel, the first comprehensive study of radioactive isotope released by test explosions, had established that strontium-90 would represent the greatest threat to human life even if at that time the AEC was still claiming that fallout was harmless. Project Sunshine followed the first thermonuclear explosions that spewed toxic plumes of chemicals high up into the stratosphere from where it spread much more widely.

7 As part of the Sunshine Project, infant bone samples from India, Japan, South Africa, and South America were collected, mostly without the parents' consent or knowledge or under the pretense that they were tested for their natural radium content.[4] Plant and soil samples were also collected and tested for their strontium-90 content. According to one of the participants, on account of its «vast geographic dimensions» and the variety of scientific phenomena considered in the study, including physical, chemical, and biological investigations of the air, the oceans, and the earth, Project Sunshine rivaled «the most comprehensive scientific studies ever undertaken» (Eisenbud, 1957, p. 237). To collect data on a world-wide scale Libby and his collaborators strongly relied on the far-reaching diplomatic and military networks of US power in the world. Nevertheless, because of the reliance on this network and the secret nature of the project data collection was rather haphazard (Higuchi, 2020, pp. 29–30).

8 As part of the project, researchers introduced a new unit of measurement, the Sunshine Unit, equivalent to one pico curie per gram calcium, to report radiation measurements. There was some backlash against the sunny name of both the project and the unit that cast the subject in inappropriately bright terms. The unit was eventually replaced with the Strontium unit and later with the Maximum Permissible Concentration Unit (Stannard, 1988, p. 976). The measurements indicated a large uniformity in strontium-90 levels already deposited in different locations in the world.

9 Project Sunshine remained secret initially. Yet following the infamous US Castle Bravo test detonation on Bikini Island in 1954 that caused wide-spread contamination in the Pacific and is widely seen as a watershed moment for the realization that fallout put food supplies at risk, the AEC felt compelled to start releasing the data.[5] Seemingly recognizing the limitations of Project Sunshine, performed under the aegis of one interested nation, in the conclusions of his first article, Libby, who publicly continued to downplay the effects of fallout, called for a truly international effort under the aegis of the UN to further pursue the issue:

> It is clear that the peoples of the world are extremely interested in radioactive fallout because of the bearing that the new phenomenology of the nuclear age has on everyone's life. For this reason we must understand radioactive fallout in all its intricacies. It is to be hoped that the study will be a co-operative, international one. The United Nations Scientific Committee on Effects of Atomic Radiation offers an ideal forum for the discussion and consideration of the problem. From these deliberations will come further suggestions, ideas, appraisals, and statement of the problem. The methods developed in this country for measurement and all the data collected are available to everyone (Libby, 1956, pp. 961–962).

10 At the time Libby made the case for an UN-led effort to assess the global fallout problem, a UN committee responsible for studying the issue had already started getting to work.

3. UNSCEAR—an intergovernmental effort spanning the world

11 The UN Scientific Committee on Atomic Radiation (UNSCEAR) was established by the General Assembly of the United Nations in 1955 with the mandate to assess and report levels and effects of exposure to ionizing radiation. It issued their first report on the issue in 1958, and regularly thereafter. In contrast to Project Sunshine and the third data collection project we will be discussing, UNSCEAR was not focused exclusively on strontium data and instead collected data on ionizing radiation exposure more broadly. Yet because of the concerns surrounding strontium-90, the element also figured prominently in the reports.

12 The original committee was composed of senior scientists and accompanying diplomats from fifteen designated UN Member States, namely Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, Egypt, France, India, Japan, Mexico, Sweden, the UK, the US, and the USSR. Considering the list of countries in more detail, we see that it included the three nuclear powers (the US, the USSR, and the UK), France and Canada that had advanced nuclear programs, strategic providers of uranium such as Czechoslovakia, Belgium (through its colonies in Congo), and Australia, and six not-aligned countries, namely India, Brazil, Egypt, Argentina, Mexico and Sweden, plus

Japan, the only country that had suffered from nuclear bombings and again through the Castle Bravo test explosion that had led to widespread nuclear pollution in the Pacific. Introducing the work of the new Committee, the UN Secretary-General Dag Hammarskjöld proclaimed that UNSCEAR would "help move the subject [of atomic fallout] out of the area of emotional sensationalism and place it squarely on the solid footing of scientific knowledge". This, in turn, would change "unconsidered fear into sober precaution".[6]

13 Despite this rather high-minded proclamation, it was clear at the time that the creation of UNSCEAR was to deflect more radical proposals calling for an immediate end to all test explosions as a first step to nuclear disarmament, a proposal advanced by India and other non-aligned nations.[7] Furthermore, by the time the UN committee was created, the National Academy of Sciences in the US and the Medical Research Council in the UK were already working on independent reports on the hazards of nuclear radiation created by the fallout problem and by the use of nuclear technologies for both military and civilian uses more generally. Against this scenario, the International Committee of Scientific Unions had asked its members to sponsor an independent study on the issue, but the nuclear powers preferred a committee of scientists designated by national governments.

14 Given this context, we can understand what has been reported in the literature, that the constitution and the early activities of UNSCEAR were characterized by competing and sometimes conflicting agendas of the nuclear powers. The transnational network of radiation monitoring set up under UNSCEAR could be used to counter reports on the damaging effects of radiation produced by various activists' group while concealing the methods for detecting atmospheric radiation used to gain information on foreign nuclear tests, hence the tactic of "unscare" and "conceal" (Herran, 2014).

15 However, I would like to suggest that this is not the whole story. Undoubtedly, the US and the UK delegations came prepared to the first UNSCEAR meetings, because of their deep investments in questions of nuclear power but also because they had already issued national reports on the hazards of nuclear fallout. The data collected for these efforts (including data from Project Sunshine that became public now) were made available to UNSCEAR. Indeed, they presented 53% of the material examined and strongly informed the first UNSCEAR report (Herran, 2014, p. 77).[8] However, there were other voices in the UN committee coming from not-aligned countries of the Global South such as India but also the Scandinavian countries that argued that they suffered the brunt of the fallout problem while they were not themselves involved in atomic testing. Starting with the second report (1962), UNSCEAR increasingly sided with these more concerned voices for both scientific and moral reasons. UNSCEAR then painted a far more alarming picture of global fallout than the US and British officials had done (UNSCEAR, 1958; UNSCEAR, 1962; Higuchi, 2020, pp. 111, 192–193).

16 Beyond the political problems affecting the work of the UNSCEAR national delegations, data collection across geographical, political, and cultural boundaries posed endless, seemingly more technical challenges on what to measure, how to measure, and how to compare collected data. UNSCEAR relied to a large extent on national data collection efforts, but what was a problem in one country was not necessarily so in another. For instance, the strontium content in milk was a concern in many Western countries but did not play a role in Asian diets. And while potatoes had a similar strontium content in various geographic regions, the calcium content varied widely, making it more difficult

to compare how much strontium would be absorbed. For these and similar reasons, the measurement of strontium in bones was considered to be a better indicator for the uptake of strontium in organisms, but bones were not so easy to come by. Furthermore, bone collection needed to be standardized for the data to be comparable. A further problem was how to account for seasonal variation or geographic hot spots and how to extrapolate data to regions where no data were available. Overall, much more data were available from the US than from large areas of Africa and Asia and large part of the Pacific, making any notion of the "global" rather porous (Herran, 2014, p. 78). In an effort to improve data collection, the World Health Organization and other UN agencies were also tasked with some of the sampling.

17 For the measurement of fallout in the atmosphere, the gummed film method, pioneered at the Nevada test site, was widely adopted even if some countries, like for instance Japan, resisted abandoning the methods they had developed. The US method consisted in literally catching fallout on adhesive film placed on a stand. The films were collected, burnt, and the ashes analyzed for the presence of radioisotopes by means of a beta-radiation detector. Although commendable for its simplicity, the method did not work so well for H-bombs that delivered radioactive particles to the stratosphere where radiation became more rapidly diluted. Nevertheless, in an effort to persuade researchers from other nations to adopt the method, the US supplied standardized films and offered to analyze and process the data (Herran, 2014, p. 79).

18 UNSCEAR scientists also introduced novel methodological approaches to assess the human and environmental impact of nuclear testing. In an address marking the fiftieth anniversary of the creation of UNSCEAR, Hans Blix, a veteran of UN nuclear diplomacy, highlighted two such approaches. As the individual radiation dose caused by nuclear testing for individuals would generally have been very low, UNSCEAR introduced the concept of "collective dose" that allowed to calculate the overall impact of testing on a world-wide scale. In addition, it introduced the concept of "commitment of doses to future generations" that allowed UNSCEAR scientists to take into account the long-term burden of radionuclear pollution of the environment. According to Blix, this introduced the idea, now widely shared if not necessarily practiced, that every generation has the duty to leave the world "in as good or better condition" than when it is entrusted with it.[9]

19 The UNSCEAR reports highlight the challenges but also the opportunities of a data collection project conducted on an international and inter-governmental level. Undoubtedly, the 1962 report that strongly argued for a "final cessation of nuclear tests" for the benefit of present and future generations played an important part in setting the stage for the nuclear powers and other nations to sign the Limited Test Ban Treaty that prohibited all test explosions except for those conducted underground (UNSCEAR, 1962, p. 35).[10] Nevertheless, at least in the US, an avowedly local data collection project, if with a global scope, helped more effectively swing public opinion and the Kennedy Administration in favor of a test ban treaty. This was what came to be known as the Baby Tooth Survey, launched by the Greater St. Louis Citizens' Committee on Nuclear Information.

4. The Baby Tooth Survey—a local project with a global scope

20 In 1958, Herman M. Kalckar, a biochemist at the National Institutes of Health at Bethesda, Maryland, published a paper in *Nature* suggesting that deciduous teeth in children could be used to assess the amount of radioactive strontium absorbed by young children in their bones (Kalckar, 1958). The article responded to a growing awareness that children were at special risk of accumulating strontium-90 from fallout in their bones. If deciduous teeth, which have a similar chemical composition to bones, instead of bones gained from autopsies could be used to test for strontium-90, it would open up a much easier and faster route to study the problem.[11]

21 Kalckar envisaged an international effort that would see public health agencies of every nation, including especially the Commonwealth, China, India, the US, and the USSR—possibly under the aegis of the UN, organizing a large-scale collection of milk teeth, carefully labeled in respect to date of appearance and shedding, age of the child and provenance, and test for radioactivity. "Thousands of countings", he emphasized, "performed on a decentralized basis in individual communities and collected on a national basis, would be essential, both to ensure the validity of the results and to assure a widespread sense of active participation on the part of the people of many nations" (Kalckar, 1958, p. 283).

22 While the International Milk Teeth Radiation Census suggested by Kalckar would not come to pass, the newly formed Greater St. Louis Citizens' Committee for Nuclear Information (CNI) eagerly seized on the idea to start such a project on a local scale. The committee had been founded by a group of engaged citizens and scientists in the spring of 1958 with the aim of providing accurate information on nuclear hazards to the local population. Among the founding members were Edna Gellhorn, a one-time suffragette, co-founder of the National League of Women Voters, and an active member of the Women's League for Freedom and Peace, and Barry Commoner, professor of plant physiology at Washington University in St. Louis and anti-nuclear testing activist, as well as other colleagues from physics, biology, and the School of Medicine critical of the nuclear arms race. The (failed) 1956 presidential campaign of Adlai Stevenson from the Democratic Party based on a platform focused on the demand of a nuclear test ban treaty provided inspiration for the formation of the group. A passionate talk by the Nobel Laureate and anti-nuclear activist Linus Pauling at the University of Washington in St. Louis had also stirred people to action. Nevertheless, in their first meetings, and not without spirited debate, the group decided that the Committee would not be an activist group but an educational organization that would provide citizens with reliable scientific information in the nuclear field so that everyone could make their own informed decisions, thus laying the basis for what Commoner termed a "nuclear democracy" (Sullivan, 1980, p. 16).[12] A widely distributed bi-monthly newsletter with thoroughly researched yet highly readable articles tackling all aspects of the nuclear world fulfilled this aim. The Baby Tooth Survey spoke strongly to the group's mission as it promised to shed scientific light on a problem of great public concern while directly engaging the community.

23 During the early 1940s, Kalckar had been a research fellow at the Washington University School of Medicine in St. Louis. But rather than this direct link between former colleagues, it was the combined support of active citizens and public-minded

scientists that made the project possible. The Committee for Nuclear Information was already looking into a recent report from the US Public Health Service that indicated that the milk in St. Louis had the highest strontium-90 content of five cities included in the survey. The St. Louis Dairy Council had asked for an assessment of the survey and further studies. The baby tooth study promised to provide exactly that. Furthermore, there was a great sense of urgency to start the study as the teeth young children were shedding in the late 1950s had still been formed before the H-bomb testing and thus provided an important baseline. The ambitious goal was to collect 50,000 deciduous teeth per year (Reiss, 1961). The Washington University School of Dentistry, in collaboration with the Saint Louis University School of Dentistry, successfully applied for an initial five-year grant from the National Institute of Dental Research of the US Public Health Service to conduct the strontium-90 analyses of the teeth while the Committee for Nuclear Information became responsible for the massive effort of collecting the teeth. A large group of volunteers reached out to dental offices, local schools, libraries, malls, churches, and social groups like Boy and Girl Scouts, distributed tooth collection forms, and awarded donors of their teeth with a certificate and a button, featuring a cartoon child's face with a gaping-tooth smile that proudly proclaimed: "I gave my tooth to science". Local newspapers, radio, and television stations also collaborated in getting the word out and informing the public about the aims of the campaign. There was some McCarthyist pushback against the project for its supposed pro-communist tendencies, but Washington University resisted the critique and continued to support the project.[13]

24 During the project more than 300,000 teeth were collected, most from the St. Louis area, but also some from other cities that could be used as a comparison. Other cities, in the US and abroad, including in Canada, Germany, the USSR, the Golf States, and Japan, also started their own teeth projects but none was as extensive and long-standing as the St. Louis one. A form, attached to the envelope for the tooth, asked for the child's date of birth, the date when the tooth was lost, where the mother had lived during her pregnancy, where the child had lived during its first year, the duration of the breast or formula feeding, and the kind of milk used for feeding (Reiss, 1961, p. 1669). Volunteers sorted and filed the mailed-in teeth and accompanying forms, attaching numbers to the teeth and filing the record cards separately. The teeth were then sent to the dental laboratory for sorting according to type, cleaning, and analysis. Teeth were analyzed in batches fulfilling certain testing criteria. Analysis of the strontium-content was outsourced to an isotope testing laboratory and the results were statistically evaluated. In addition, bones and teeth from stillborn infants were analyzed to settle the question if teeth were indeed a good indicator for the absorbed strontium-90.

25 The first results of the Baby Tooth Survey, presented by physician Louise Reiss, the first director of the study, in a prominent article in *Science* in Nov 1961, confirmed that deciduous teeth were indeed a good indicator to monitor strontium-90 uptake in the body as postulated by Kalckar (Reiss, 1961). The study also indicated that incisors were the most suitable teeth for monitoring for both scientific and psychological reasons, as they are the first teeth that children lose, and that a batch of about 5,000 teeth per year collected on a continuing basis from a particular area (thus a significantly smaller collection effort as the one started at St. Louis), could provide good data for the uptake of radioactive strontium through diet. Most notably, the data published in this and following articles as well as regularly reported in the CNI newsletter indicated that strontium-90 content in baby teeth had risen significantly—one hundred times between

1945-64—and that the level of radioactive strontium rose and fell with atomic bomb tests. This temporal connection most powerfully linked the remote testing events to the local baby tooth samples.

26 Members of the Scientific Advisory Group of the Baby Tooth Survey made sure the Kennedy administration was aware of the study. They also testified in Congress during the congressional debates on the test ban treaty. The results of the study were widely reported in the press and in response women across the US campaigned against the nuclear arms race and for children's health. In a show of force, in November 1961 they participated in a one-day protest, known as the Women Strike for Peace (Feldman, 2017, pp. 144–148). The study showing the dramatic effect of global fallout on children in the Mid-West, far away from the actual test sites, amplified by the women's activism, has been credited consistently with having helped persuade President Kennedy and the American Congress to sign and ratify the test ban treaty of 1963 (Jack & Steinhardt, 2014) (Higuchi, 2020, p. 138).

27 The test ban treaty led to a rapid decline of all fallout indicators. The St. Louis scientists were keen to continue examining the teeth to track these changes, especially considering the average seven year-delay between the formation of the teeth, when most of the strontium is accumulated, and their loss in early childhood. Yet they faced increasing difficulties in securing the necessary funds and in 1972 the study closed down. Nevertheless, the collection had an afterlife.

28 For analysis the teeth had to be crushed into a powder, the decay and fillings removed, and the probes placed in liquid solution. Teeth were tested in batches, and the remaining material discarded as medical waste. Yet in the early 2000s several cartons with about 100,000 intact teeth from people born between 1945–1965 (so-called baby boomers), all in their little manila envelopes complete with the relevant metadata, were found in a remote storage area of the Washington University School of Dentistry. By that time the CNI had long closed its offices. The teeth found a new home with the Radiation and Public Health Project, started by health researcher Joseph Mangano with much the same mission as the CNI, namely "to conduct research on health hazards of nuclear power, and educate citizens and officials on results".[14] More than sixty years on, the teeth are being used for epidemiological studies, linking strontium-90 content in the teeth to cancer incidences developed by the once brave child donors, thus in many ways closing the circle. Another study tests the level of metals in the teeth and the health impacts later in life.

29 Despite the apparent success of the Baby Tooth Survey, another nuclear time bomb, unbeknown to the CNI, was ticking. During the Manhattan Project, Mallinkrodt Chemical Works in downtown St. Louis became the designated firm for the refinement of uranium from the Congo before it was sent on to Oak Ridge for enrichment.[15] St. Louis's contribution to the secret wartime project was reported in the local newspaper the day after Truman's announcement of the bombing of Hiroshima. What remained undisclosed at the time was the massive nuclear waste problem the continuing uranium refinement activity in the city was producing. Yet by the 1970s concerned citizens started noticing unusually high numbers of cancer cases among young adults in certain neighborhoods bordering a local creek. The consequences of this massive contamination are still the subject of scientific studies, costly lawsuits, cleaning up efforts, and much human suffering.

Conclusions

30 It has often been argued that the problem of radioactive fallout was too tightly bound up with questions of national security to spark an environmental movement. Chemical pollution as exposed by Rachel Carson in her *Silent Spring* was sufficiently removed from strategic consideration to be able to start a wider discussion (Watkins, 2001, p. 303). Yet significantly, radioactive strontium was the first chemical mentioned by Carson (1965, p. 6). Meanwhile, the earth scientists seeking for a geological marker ("the golden spike" in their parlance) that would define the transition of the Holocene to the new geological era of the Anthropocene agreed that the artificial radionuclides spread worldwide by the thermonuclear bomb tests from the early 1950s represented the sharpest and globally most synchronous of these signals. They settled on plutonium (rather than strontium that they also considered) as the actual marker. Being less soluble than strontium, it is less likely to be metabolized when ingested but is readily absorbed into geological sediments. The specific isotope chosen as the marker, plutonium-239, has a half-life of 24,000 years. Although the proposal to introduce a new epoch was in the end voted down by the International Commission on Stratigraphy, the identification of plutonium from fallout as the potential global marker remains significant.

31 The three data collection projects described here employed different strategies to define the problem of global fallout. The Sunshine Project, conducted by the US, and the UNSCEAR project put their effort into sampling on an extended geographic scale. Yet as Paul Edwards reminds us for the case of world-wide weather and climate data, some computation and modeling needs to happen to make data points global (Edwards, 2013). In the Sunshine and the UNSCEAR Project this was achieved through plotting the sampling spots and the resulting readings on a world map and drawing isolines around the globe. This produced the dramatic maps showing the world-wide distribution of fallout.[16] The atmospheric circulation that distributed radioactive debris around the world could also be investigated using the same radionuclides released by nuclear weapons testing as tracers. This, in turn, led to the realization of the "irreducible interrelation of human production and biosphere" that the postwar era brought about, together with the new conceptualization of the world as a (fragile) system that needed to be managed and protected (Elichirigoity, 1999, p. 7; van Munster & Sylvest, pp. 1–19; Boudia, 2007).

32 The Baby Tooth Project in many respects relied on these first world-wide representations of the fallout problem. Yet instead of scaling up, it addressed the thread of global fallout by staying rigorously local. A set of contingent conditions allowed the Baby Tooth Survey to take root in St. Louis. By showing that children in Missouri, far away from the actual test sites, were exposed to fallout in a way that systematically reflected the global events, the study powerfully demonstrated the local impact of these broader events. The way the St. Louis study worked was not by standing in for all other places but by showing in detail the effect of global fallout on one vulnerable local population.[17] Global fallout here affords a "new articulation of the global and the local" (Masco, 2006, p. 1), one in which the local can gain a wider meaning or become exemplary, not unlike in microhistory that sees the micro or local study as a different approach to the global.[18]

33 In the case of global fallout, it was the collective force of the three fundamentally different and yet interrelated projects that despite their respective limitations and the friction between them, came to define the problem of global fallout and ultimately changed the discourse on what were acceptable risks. This led to consequential policy changes at the time. Nevertheless, the effects of the global fallout of the 1950s and 1960s and later nuclear disasters are still very much with us as we are reminded by the continuing life of the baby teeth collected in the cold war era. The question what radioactive risk is acceptable is as urgent as ever.

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NOTES

1. On radioisotopes as historical tracer, see Creager (2013); on experiencing and living in a nuclear world, see Masco (2006), Brown (2017), Houdart (2017), Bensaude-Vincent et al. (2022).

2. The connection between the nuclear world and the assembling of the global dimension after World War II has been widely discussed; for a useful introduction see van Munster & Sylvest (2016), including especially the editors' introduction (pp. 1-19) and the contribution by Masco (pp. 44-70). On the making of global data with special emphasis on weather and climate data, see Edwards (2013). I thank Néstor Herran for sharing a chapter of his habilitation where he discusses the same three data collection projects considered in the essay, and for meeting and talking about our common interests. The focus of his analysis is on radioactive surveillance and its role as a precursor to environmental monitoring; see Herran (2022, pp. 57–76).

3. On the concept of *fallout* as an invention of the nuclear age and as a more general emblem of industrial modernity («the age of fallout»), see Masco (2016).

4. For a historical perspective on the testing of human bodies for exposure to workplace and environmental pollutants, see Creager (2018).

5. Libby started publishing results of the Sunshine Project in 1956 (Libby, 1956); another series of studies performed under the same project heading by researchers at the Lamont Geological Laboratory at Columbia University were published in *Science* a year later, followed by regular updates (Kulp et al., 1957; Eckelmann et al., 1958; Kulp et al., 1959; Kulp et al., 1960). On the Castle Bravo test as watershed moment for the realization of the accumulation of radionuclides in the food chain, see Hamblin & Richards (2015).

6. As quoted by Higuchi (2020, p. 109).

7. United Nations Scientific Committee on the Effects of Atomic Radiation, Historical Milestones, 1955: The UNSCEAR established; https://www.unscear.org/unscear/en/about-us/historical-milestones.html, accessed 23 February 2024.

8. For the two reports see Medical Research Council (1956) and National Academy of Sciences (1956). On the communication between the working groups of the two countries, see Hamblin (2007).

9. Hans Blix, Address at the reception to mark the 50th Anniversary of the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), Vienna, 30 May 2006. https://unis.unvienna.org/unis/en/pressrels/2006/unisinf146.html; accessed 22 September 2024.

10. On the more complex strategic considerations underlying the Limited Test Ban Treaty, see Divine (1978) and Higuchi (2020, pp. 162–189).

11. The realization that children were more susceptible to and faced higher risks from environmental contaminants than adults only slowly set in in the second half of the twentieth century; see Wargo (1998).

12. On Commoner's social and environmental activism, see Egon (2007).

13. See Sullivan (1980, pp. 53-54) as well as the film, *Silent Fallout: Baby Teeth Speak* by Hideaki Ito (Japan, 2023).

14. The Radiation and Public Health Project, https://radiation.org/ (home page), accessed 16 February 2024.

15. See the documentary *The First Secret City*, produced by Alison Carrick and C.D. Stelzer (2015). For more information on the film see https://firstsecretcity.com/, accessed 2 March 2024.

16. See for example UNSCEAR (1958, p. 229).

17. On scalability and its perils, see Tsing (2021).

18. On microhistory see for instance Levi (1991) and Revel (1994); see also de Chadarevian (2009).

ABSTRACTS

In the atomic world ushered in by the detonation of the first atomic bombs over Japan in 1945, radioactive strontium (or strontium-90), a by-product of nuclear explosions, soon emerged as a substance of popular, political, and strategic concern. This article considers three data collection programs that established strontium-90 as a global problem while representing different strategies to construct the global dimension — a secret data collection program, code-named Project Sunshine, conducted by the US Atomic Energy Commission taking advantage of the US diplomatic and military networks around the globe; a data collection project organized by the UN at an inter-governmental level; and the Baby Tooth Survey, mounted by a group of concerned citizens and public-minded scientists in St. Louis, Missouri, to reconstruct the effects of the world-wide weapons-testing activity on the local children. All three data collection programs were traversed by cold war tensions but ultimately helped to turn the tide on nuclear weapons testing and led to the signing of the first partial atomic test ban treaty in 1963. While the single projects have already received historical attention, viewed together they invite us to rethink the categories of the «local» and the «global» as articulated around the problem of global fallout.

Dans le monde atomique inauguré par l'explosion des premières bombes atomiques sur le Japon en 1945, le strontium radioactif (ou strontium-90), un sous-produit des explosions nucléaires, est rapidement apparu comme une substance suscitant des préoccupations populaires, politiques et stratégiques. Cet article examine trois programmes de collecte de données qui ont fait du strontium-90 un problème mondial tout en représentant différentes stratégies de construction de la dimension mondiale : un programme secret de collecte de données, connu sous le nom de code « Project Sunshine », mené par la Commission américaine de l'énergie atomique en tirant parti des réseaux diplomatiques et militaires des États-Unis dans le monde entier ; un projet de collecte de données organisé par les Nations unies à un niveau intergouvernemental ; et la Baby Tooth Suvery, « enquête sur les dents de lait », mise en place par un groupe de citoyen·nes concerné·es et de scientifiques soucieux·ses de l'intérêt général à Saint-Louis, dans le Missouri, pour reconstituer les effets des essais d'armes à l'échelle mondiale sur les enfants de la région. Ces trois programmes de collecte de données ont été traversés par les tensions de la Guerre froide, mais ont finalement contribué à inverser la tendance en matière d'essais d'armes nucléaires et ont conduit à la signature du premier traité d'interdiction partielle des essais atomiques en 1963. Bien que ces projets aient chacun déjà fait l'objet d'une attention historique, considérés ensemble, ils nous invitent à repenser les catégories du « local » et du « global » telles qu'elles s'articulent autour du problème des retombées globales.

INDEX

Keywords: global fallout; strontium-90; Project Sunshine; UNSCEAR; Baby Tooth Survey
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