

Fukushima and the Transnationality of Radioactive Nuclear Contamination. “Visualizing Radiactivity” and its Impacts on Humanity

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When Fukushima 1 Nuclear Power Plant (NPP) was torn apart by several explosions, whether due to technical failings in correspondence with the earthquakes, tsunami or a combination of both, it not only dispersed radioactive contaminant but also exposed the bonds connecting people’s lives with nuclear power.

Over the two and a half years since then, the corruption, inadequacies and mendacities at the centre of the sovereign power structure that has prevailed in Japan since 1945 have become ever more visible. This essay first introduces the foundations of this structure, exploring how the long-standing relationship between Government and major private electric utilities in Japan informs the present crisis, noting in particular the ramifications of decisions being made within this structure at the individual level in present and projected effects to human health. Following consideration of the effects of radiation on human health, the discussion then turns to visual and local testimonies of the effects of other radiological events – Hanford, Hiroshima and Nagasaki, Chernobyl and Iraq – so as to offer a comparative assessment of the Fukushima disaster. While mindful of the difficulty in arriving at an absolutely conclusive position on these conditions, enough evidence has now accumulated to make a realistic assessment of the human health impact, and to discern how public understanding has been, and continues to be, confused. Finally, given that the Fukushima disaster is distinguishable from other radiological events in scale and type of contamination, this essay argues that far-reaching change is called-for in the current legal standards and institutional responses which have been governed thus far by mid twentieth century power relations.

I The Priorities of Sovereign Power

Over nearly 70 years of the ‘postwar system’, nuclear power has steadily become synonymous with the political order in Japan and deeply integrated it within its international institutional frame. Its introduction into Japan by a consortium of young politicians and captains of industry (via the 1953-4 Eisenhower Atoms for Peace campaign) helped to solidify bilateral political and corporate relations between the US and Japan, within the wider geopolitical re-formation. As part of the reconstitution of interlocking zaibatsu-government relations from 1949 on, with the base value of a successful democracy in ‘free Asia’ commensurate with continuous construction and centralized energy production (or ‘plutonium economy’) in all aspects of the nation (the signature LDP policy of *doken kokka* or ‘construction state’),² the destruction of the natural environment was seen as a necessary

contingency in the essential practice of resource extraction, production and construction for optimizing economic growth and containing political tensions.

Following the formation of the US Atomic Energy Commission (AEC 1954) and Japan Atomic Energy Agency (JAEA 1955), the International Atomic Energy Agency (IAEA) was established in 1957. Article 2 of its foundational mandate referred to the promotion of 'safe, responsible development of uranium resources' and the mission to 'accelerate and enlarge the contribution of atomic energy to peace, health and prosperity world wide'. Just as Japan eagerly committed itself to the 'peaceful use of nuclear power', so too did signatory nations to the nuclear club agree to the IAEA assuming the role of key promoter of the nuclear industry worldwide. In 1959, the WHO agreed to the IAEA taking primary responsibility for reporting the health effects of nuclear radiation despite the heavy concentration of IAEA expertise in nuclear physics (28 May 1959, WHO WHA 12-40). Along with establishing radiation safety and environmental protection standards, the IAEA and other radiation protection authorities have consistently downplayed events and evidence and pathologised health concerns for low dose radiation as 'radiophobia', which it characterised as more hazardous than radiation itself. Their understanding of and response to the ongoing disaster at the Fukushima Nuclear Power Plant (NPP) is no exception.

As a sovereign industry, controlled by powerful forces in society, nuclear power in Japan came to influence foreign policy, national security and transnational ties. The insouciant over-confidence displayed by Tokyo Electric Power Company managers (TEPCO) in the first two years of the Fukushima nuclear disaster, was an expression of the long-held technical monopoly over nuclear power plants enjoyed by the Federation of Electric Power Companies of Japan. In a 2012 court action by Sunfield Nihonmatsu Golf Course for compensation over losses incurred due to forced closure as a result of high radiation levels, TEPCO argued that as a private contractor its responsibilities to the public were limited and that it was no longer the owner of radioactive matter released from the Fukushima Daiichi NPP. It claimed the materials were 'res nullius' (mushubutsu) – things belonging to no one, like mist or fish – and that it was owned by those whose land upon which it fell. In this case the radiation levels were equivalent to those in the Chernobyl exclusion zone (Cs137 235,000 bq/kg, Sr90 98 bq/kg). On the other hand, while apparently not of their concern, TEPCO lawyers counter-examined the technical accuracy of government dosimetry and their understanding of radiation effects, using the oft-cited pro-nuclear argument that 10 mSv of natural radiation is to be found in inhabited parts of the world with no ill health effects. Although the district court maintained the right of companies to file complaints, they held that the onus of decontamination rested on local and federal governments, and absolved TEPCO of the duty to compensate the golf company.³

Although both TEPCO and the central Government had received adequate forewarnings of the risk in 2008, both maintained for more than a year after the disaster that the tsunami and earthquakes were an 'unforeseeable force of nature' and 'beyond prediction'. They refused liability for damage caused from radioactive contaminant released beyond their respective private or national borders. Apparently, their position is supported by The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (1972) that limits liability to radioactive waste released into the sea from ships and not land-based sources.⁴ However, the 1996 Protocol to the 1972 Convention codifies the 'precautionary approach' and the 'polluter pays' principle. Rather than prohibit a certain list of hazardous materials, this Protocol shifts the Convention to include waste discharged from land as well by stating that anything not included on the said list, of which contaminant from

nuclear reactors is not a part, cannot be discharged into the ocean and must be managed on land. The case can be made that precautionary measures were insufficient and that the polluter was negligent in refusing to adequately store the materials.

In this sense, TEPCO and the Government have operated in tandem. While the national government took financial control of the utility, setting up a permanent government fund of 1 trillion yen (which includes public taxes and international donations) to protect the utility (offset costs) from insolvency and collapse,⁵ TEPCO managers continue to own and run the plant, assuming ultimate authority on nuclear-related operational issues including human and environmental health. A key functional problem underlying this position is that TEPCO is bound to recoup the costs it has incurred during the clean-up. At the same time, the Government can shift responsibility to TEPCO for the disaster when it is expedient to do so.

TEPCO is a major representative of a sovereign industry, which is regarded as too important to be allowed to collapse, existing in this sense beyond society. While technical problems posed by engineering operations, health safety limits, radiation detection methods, safety procedures and financial management have dominated public discourse, serious considerations of responsibility and ultimate causation have been either marginalised or rejected by the courts. Protecting its share price and profitability remains the ultimate priority of TEPCO qua corporation, resulting in the curtailing of its disaster operations on the basis of considerations of cost-effectiveness. This leads to slipshod safety procedures, including random and inadequate ocean and land-based measurements and hastily assembled and carelessly monitored temporary storage facilities (over 1000 tanks containing roughly 380,000 tonnes of highly contaminated water).

Even as it has failed and failed again, however, TEPCO has been bailed out by the Government so that it can continue to operate as a business. Regarded as 'too big to fail', the corporation has been granted immunity from either raw capitalist logic or due democratic process, while being encouraged to manage a portfolio that promises to provide returns in the broader effort to maintain the buoyancy of the nuclear industry. In this sense, the reality of molten radioactive metal sitting beneath the ruined plant is abstracted into a financial liability that is 'contained' to prevent any loss of confidence on the part of prospective investors. Neoliberal free market principles permit state intervention where there is opportunity for financial benefit, but otherwise adhere to strict economic imperative. Moreover, the issues are not restricted to Japan. Since the earliest days of the disaster, all three administrations have proactively canvassed prospective buyers for its nuclear technology exports. Confirmed buyers include Vietnam, Turkey, Saudi Arabia and the UAE, while negotiations with other central European and Asian buyers continue.⁶ Further, anticipating local obstruction, Hitachi and Toshiba have acquired or are acquiring nuclear plants overseas (UK) to expand their nuclear power operations.⁷

While ceding responsibility to corporate entities such as TEPCO allows the Government to limit its accountability, the toxicity of the materials handled by these corporations in terms of their long-term waste and propensity to penetrate the biosphere is far greater than the short-term economic gain they return through their use. The importance attributed to TEPCO as part of a transnational industry overrides the core international principles of fair trading and avoiding transnational pollution. The fact that adequate prior warning or consultation is not offered to those who are or will be affected, shows that both the state and corporation have reneged upon their responsibility to protect the rights of the civilian.

Instead, they privilege the corporation as a sovereign asset. This sort of corporate welfare at the expense of public health and well being suggests the degree of interests shared by state and corporate managers and the professional fluidity between them. This has been further aided by a distorted scale established in the late 1950s for weighing the dangers posed by radioactive contamination against the political and economic benefits of nuclear power.

Despite the seismic volatility of the archipelago, the concentrated investment, research, planning, construction and operation of the 54 nuclear reactors in Japan by the utilities, government, and cooperating international organisations that make up the transnational 'nuclear village' and its monolithic supply chain, suggests why radiation-related industries and agencies are being protected from liability for damage or cost overruns.

Prime Minister Abe's statement in Japan on 4 September 2013, followed by his performance as part of a final pitch to win the Olympics for Tokyo at the IOC meeting in Buenos Aires three days later, was intended to display decisive resolve toward the crisis. However, the discrepancy between representation and reality could not have been clearer. Abe assured the nation, and then the Olympic panel and an international audience that 'the [Fukushima] situation is under control. It has never done and will never do any damage to Tokyo'. He guaranteed, with a pledge of 47 billion yen (US \$500 million) toward the plant, that his government would stop the radiation-contaminated water leaks from the Fukushima Nuclear Power Plant (NPP) so that 'there would be no problem at all in 2020'.

In turn, Takeda Tsunekazu, the leader of the IOC bid claimed that life in Tokyo where people believed that the air and water quality was safe would continue as normal, as in most cities 'like Paris, London and New York', and that 'Fukushima' posed no risk to a 'great and safe Games'.⁸ Contrary to their belief that contaminated water had been contained within the 0.3km port housing of the NPP, ionising radiation had been dispersed (and was continuing to spread) throughout the Kantō area, and further into the ocean.



'I absolutely assure that health problems have not been a problem until now and will not be a problem in the future' – PM Abe Shinzo, IOC speech, 7 September 2013.

As contractors continue with 'decontamination' projects, the initial strategy adopted by TEPCO to cool the melted fuel with constant hydration and filtering of contaminated water stored in tanks (with the Advanced Liquid Processing System provided by French nuclear technology specialist company AREVA) has been constantly hampered by problems. It has also been the target of criticism by Gregory Jaczko, former head of the Nuclear Regulatory Commission, as well as groups such as Greenpeace and Physicians for Social Responsibility (PSR), for its inability to thoroughly remove radioactive isotopes.⁹

An initial offer of zeolite absorbent from Rosatom, the Russian nuclear power corporation, in the first few months after the explosions, repeated in August 2013, was rebuffed by TEPCO, presumably to favour its arrangement with AREVA.¹⁰ However, unless significant amounts of forested land is cleared and prepared at the site, contaminated water and soil storage is expected to reach the maximum space available by November 2013. The adoption of the decontamination method without planning the logistics for permanent storage facilities at the NPP, suggests that eventual discharge of contaminated water into the ocean or air has

been and remains anticipated by TEPCO.¹¹

II Human requirements for safety versus economic health

Beyond the concerns of contamination from melted radioactive fuel, public trust in the Government has also been a casualty of the Fukushima disaster. The Noda government (2 September 2011 – 26 December 2012) equivocated over the plan by the Kan administration to shut down nuclear power in Japan, and that plan was then emphatically revoked by the Abe government from December 2012. Instead, the latter, at least initially, vowed to export, restart and accelerate nuclear power-related production, reverting to and consolidating the LDP construction-state formula to boost economic growth.

The post facto raising of safety limits for radiation exposure on 19 April 2011 (from 1 to 20mSv) and reduction of the evacuation zone to less than 30 km from the NPP, driven by an unapologetic 'logic' of optimal growth, ignored the passage of radioactive concentrations beyond the official concentric circles emanating from the crippled plant. These were to denote the 20km mandatory exclusion zone (greater than 50mSv) and the 30km voluntary exclusion zone (20-50mSv).¹² The continued dispersal of radioactive contaminant from the stricken and leaking NPP, waste incineration, the relaxation of food testing and re-circulation of irradiated fish from the Fukushima coast (Sōma, Iwaki), and re-use of contaminated areas by fast food chains for cheap food production, for example,¹³ contributes to the creation of a surplus population of humans and other living beings through the bioaccumulation of radioactive materials. This means that due to institutional policies adopted with regard to the hazard of radiation, a certain portion of the population has been factored in as part of the 'costs' of maintaining nuclear power in Japan.

As techniques of persuasion and confusion continue to be insinuated into public consciousness ('Look forward with optimism!'; 'Ganbare Nippon!'; 'Kizuna!'), the popular nationalist drive to restore Japan to its glory days of the Meiji era, or to the Kishi administrative initiatives of the late 1950s, has made claims by affected citizens for compensated evacuation and health care more difficult. Redoubling its effort to stamp out 'baseless rumours' (fūhyō), the Abe government has pressed evacuees to return to their former residences. Despite a municipal government campaign to encourage residents to prioritise family, community and the land (the kizuna project), along with staged apologies, promotional drives for Fukushima produce, distribution of free dosimetry meters to potential returnees, decontamination and construction programs, and even miracle cures for cancer,¹⁴ the public are also being told to make their own decisions regarding the risks of radiation exposure.

However, the ability of those citizens from the mandatory or voluntary evacuation zones (160,000 in total) to make such decisions has been handicapped by the authorities' screening information. The same is true for those who have remained behind. They have been deprived of necessary detail and treatment concerning radiation levels in food, water and air, for sufficient protection against damage from myriad types of radionuclides.¹⁵

While sophisticated detection of radioactive matter is obviously essential (across the gamma-beta-alpha range in water, soil, air, organic and inorganic matter), the over-emphasis on a national 'can-do' positivity and on an economic solution by the Abe government distracts from realistic assessments and appropriate responses to the complex

problems at Fukushima. Decontamination for example, can cause serious damage to the lived environment,¹⁶ and there is little guarantee that mobile radioactive particles will not re-contaminate cleaned areas. Despite the US Atomic Energy Commission (AEC) having known since 1955 from its disastrous nuclear weapons testing in the Marshall Islands that radioactive material does not dissipate but moves in scattered pockets and streams in sea water,¹⁷ in 2013 the Japanese government and TEPCO continue to use a dispersal as decontamination method, both on land and into the Pacific ocean. The use of decontamination instead of evacuation and entombment of the reactors, has meant the award of significant contracts to construction companies to perform tasks whose true effectiveness are disputed. At the same time, general confusion prevails concerning the effects of radioactive materials, how they spread and how to protect against them.¹⁸

The subsequent creation of this surplus population in addition to those affected by the initial disaster is symptomatic of a crisis of late capitalism. In the same way that medical treatment of HIV and cancer now favours a managerial over a curative approach which benefits the pharmaceutical industry through long-term course prescriptions, monitoring and decontamination programs in Fukushima tend to defer the recognition of reality as part of the prescription. Similarly, the chronic illness caused by low-level radiation exposure leaves the person alive but in a permanently debilitated state.

The concerted attempt to assuage public anxiety seems to be aimed at gradually normalising radiation as part of everyday life – studied or transformed into industrial production in some way, but not accurately diagnosed and sufficiently treated. As the sovereign appetite for power increases in lieu of trans-national market competition, projected external threats and national policy transformation, stress fractures in the social and environmental fabric are developing of which the Fukushima disaster is just one example. As people ingest radioactive materials (hot metal particles) dispersed from the reactors as a by-product of a stressed sovereign industry, their health has been and is being sacrificed in exchange for the protection and expansion of sovereign life.

III An outline of radiation effects

While the public are being served variants of misinformation concerning radiation, from the universal common of natural background radiation for the creation of planetary life, to comparative doses of radiation in aircraft, X-rays, CAT scans and bananas (natural background potassium K40 radiation in bananas is 0.0117 Bq/kg) to psychosocial prescriptions of happiness (Dr Yamashita Shunichi, Fukushima Medical University), it is generally agreed that, prior to 1945, the human body had evolved to correct mutations from natural radiation exposure over time. Anthropogenic radioactive materials however, which have been produced by nuclear bombs or power plants cannot be balanced so easily, whether internally or externally exposed to the human body. When man-made uranium products enter the food chain, depending on the radionuclide the additional and unnatural burden of radioactive ionisation takes a long time to stabilise in the environment (generally 100,000 years).

Where once it was believed that hibakusha suffered illness only from the direct external flash and thermal wave from the atomic bombs over Hiroshima and Nagasaki, it only gradually became known that the chronic effects such as fatigue, cardiac abnormalities, various cancers, leukaemias, alopecia, skin lesions and rashes were also due to low-dose

internal radiation exposures.¹⁹

The US-led Atomic Bomb Casualty Commission (ABCC) longitudinal studies on hibakusha, used by the Atomic Energy Commission to establish the international formula for radiation exposure and safety standards, calculated the risk of cancer in direct proportion to the dose received (linear no threshold model). It concluded that any exposure below 100mSv/year (1 mSv = 1 X-ray), particularly internal exposure, would be negligible to human health. This calculation did not allow distinctions for gender, age, physiological differences, diet, period of exposure and ecological particularities in distribution.

It also disregarded all non-cancer, non-genetic, or non-fatal illnesses as being radiation-induced (auto-immune disease, fertility impairment or birth defects, or combination with other carcinogens). Although some authorities now recognize that this measurement understates risk by between 100 and 1000 times, this model formulated by the International Committee for Radiation Protection (ICRP) continues to inform international radiation policy (IAEA/UNSCEAR/WHO), and has been applied in calibrations for radiation emergencies at Windscale, Sellafield, Three Mile Island, Chernobyl, Fukushima, and elsewhere.²⁰ Even when the external dose rate is below the stipulated action level (external dose rate limit for sheltering is 100 μ Svh-1), radioactive particles may still be present in the air or water and pose risk of ingestion. In fact, on 27 May 2012, the UN Special Rapporteur on Fukushima Anand Grover released a report which was sharply critical of the approach taken by Japanese authorities, and pointed out that much had been learned about low dose radiation effects from the Chernobyl disaster.²¹

Although there is evidence that the danger has been understood ever since the early 1940s,²² in vitro and in vivo studies over the past 20 years have confirmed that uranium products, when ingested in micro-particles, can be genotoxic (damaging DNA), cytotoxic (damaging cells) and mutagenic (mutation inducing) to living beings.²⁴ They then embed in the cells, soft tissues, organs, blood and bones, and continue to emit regular low doses of radiation in specific areas as they decay (ionisation). The 'heat' from these emissions kills the affected cells or alters their biochemistry. This creates the conditions for disorders and diseases, mutation/genomic instability, and cancers and leukaemias.²⁵ When reproductive organs are so embedded, the damage to the sex cells therein is reproduced in the next generation. When embedded in the soft tissue of an embryo the activity of these products can impair birth, and cause defects (teratogenic defects). Even when these products are excreted they remain active and can continue to cause damage when re-absorbed by living beings.

Despite tight institutional control over national health statistics and health diagnoses at medical centres in affected areas, at the time of writing 43 children measured from Fukushima prefecture have been diagnosed with thyroid cancer, or are suspected of it. 18 were diagnosed with thyroid cancer from 210,000 children tested in Fukushima, up from 12 reported on 5 June 2013, and 25 other cases are suspected of developing into full-blown cancers.²⁶ Although the Fukushima Medical University has yet to release all its thyroid test data, the Eighth Fukushima Prefecture Health Management Survey between April and August 2012 showed 43% of 42,060 children tested presenting abnormal nodules and enlarged cysts on their thyroids.²⁷ This may be an underestimate given that the tests skimmed over small cysts (1-2mm), but is still a higher rate compared to the same illnesses

in the Chernobyl vicinity after that disaster.²⁸ In addition, Caesium has been detected in 70% of 85 children measured in the Ibaraki Prefecture Cooperative Association study,²⁹ and there have been numerous instances of symptoms typical of radiation poisoning, such as regular, prolonged, enduring and aggravated anaemia, rashes, lethargy, uncontrolled nose-bleeding, dizziness, nausea and headaches.³⁰

Conclusions by the WHO and UNSCEAR that the releases from Fukushima were much lower than those of Chernobyl and that there will be only a small absolute increase in health effects seem excessively optimistic. Firstly, the exact amount of radioactive material released from the Fukushima NPP is unknown because the corium (melted fuel) are yet to be located and cannot be measured, and the release of contamination has not yet been contained. The amount of Cs 137 alone released from the initial explosions (roughly 3.8×10^{17} Bq) warranted a Level 7 International Nuclear Event Scale (INES) code, while the estimated amount of all radioactive materials subsequently released into the air and sea over the following two years is 44.9 terabecquerels (TBq).

Secondly, Government health estimates have been scaled against the entire population.³¹ Given that the different metabolisms of pregnant women, children and adults have been exposed to radioactive contamination in excess of 250mSvy, whether accumulated or singular doses (the Chernobyl mandatory evacuation level was 5 mSvy, the voluntary evacuation level was 1mSvy, and the present European limit for nuclear plant workers is 5mSvy), it seems clear that the risks from Fukushima are being downplayed by the Government and the IAEA-affiliated radiation protection institutions.³³ From August 2013, the South Korean government responded by implementing selective bans on fish and food products from prefectures in Tōhoku, while the US Food and Drug Administration added new products to its import alert list revised from July 2013 (Import Alert 99-33) and Russia's Rosselkhoznadzor maintained its ban of imports from selected companies selling produce from 8 prefectures. The position adopted by TEPCO and the Government warrants a prima facie case of criminal negligence, and more broadly, points to the need for a review of international law concerning transboundary pollution to more effectively address the consequences of the Fukushima disaster and anticipate the dangers posed by similar events in the future.

IV Iraq, US, Japan: Hibakusha

It is instructive to refer to other sites of mass radiation exposures as comparators to the Fukushima disaster. For example, in 1998 and in 2003, a Japanese documentary team led by Kamanaka Hitomi visited Iraq (Basra, Fallujah) to trace the effects of radioactive materials dispersed during the first Gulf War of 1991 (Hibakusha: sekai no owari ni, 2003).

The documentary showed reports from medical doctors and affected families from 1998 onward of spikes in infant and child leukaemias (acute myeloid leukaemias specific to nuclear radiation) and serious birth defects in Basra and Fallujah, and cases suspected in other locations. They traced the source to depleted uranium munitions (DU) used by US and UK forces in Operation Desert Storm during the first Iraq War (1990–1991). DU is a uranium product derived from enrichment processing of uranium ore, which concentrates the isotope uranium 235 for use in nuclear bombs or nuclear power reactors. The mixture of radioactive waste from this is comprised mostly of U238 (others are Thorium and Proactinium) which

has a radioactive half-life of 4.5 billion years. In both the first and second (Operation Enduring Freedom, 2003) Iraq Wars, A-10 Warthog aircraft and armoured ground units (Abrams tanks and Bradley Fighting Vehicles) deployed rounds coated in solid uranium (4,500 grams), which dispersed 300 and 500 tonnes respectively of powdered DU into the local fields and water-ways.³⁵



'Approximately 2000 tonnes of DU' – screenshot from Kamanaka Hitomi (dir.), 'Hibakusha: Sekai no owari ni' (Group Gendai Films, 2003)

Under pressure from the UK and US governments and in contravention of its mandate in denying the risk from DU, the WHO delayed the release of its own commissioned report (2004) which cautions that inhalation of dust containing DU would affect the long-term health of Iraq's civilian population in the form of birth defects, congenital malformations and cancers.³⁶ The publication of a joint WHO-Iraqi Ministry of Health Report covering 10,800 households to measure the rate of congenital defects in Iraq due for release in November 2012 was also delayed, and only the first 'provisional' part of its three parts has so far been made public. The anonymous authors conclude that there is no evidence for an unusually high rate of congenital defects in Iraq.³⁷ The former Assistant Secretary General of the United Nations Hans von Sponeck also stated that the 'US government restricted WHO surveys from southern Iraq where depleted uranium had been used and caused serious health and environmental dangers'.³⁸

In January and February 2012, 11 researchers visited 711 houses (4,800 individuals) in Fallujah to survey for details of cancers, birth outcomes and infant mortality.³⁹ The study, entitled 'Cancer, Infant Mortality and Birth Sex-Ratio in Fallujah, Iraq 2005-2009', concluded that anecdotal evidence of a sharp rise in cancer and congenital birth defects was correct. Infant mortality (80 per 1,000 births) was much higher in Iraq than Egypt (19), Jordan (17) and Kuwait (9.7). They found a 38-fold increase in leukaemia, a ten-fold increase in female breast cancer and significant increases in lymphoma and brain tumours in adults. They report that the types of cancers were 'similar to [those found] in Hiroshima survivors who were exposed to ionising radiation from the bomb and uranium in the fallout', while the rate of illness was also much higher.⁴⁰ Many Iraqi women have been advised to not give birth to more children.

In addition, several studies have found that 30% of the 800,000 US military personnel who served in Operation Desert Storm later developed chronic illnesses from ingested DU fragments and the children of these veterans have also shown spikes in deformities. Loosely termed 'Gulf War Illness', these effects include chronic fatigue, cognitive impairment, autonomic dysfunction and nervous system damage.⁴² As the plutonium for the Nagasaki bomb was being produced in 1944-45 at the Hanford reactor, large plumes of aerosolized uranium products were released (550,000 Curies). People living near the Hanford reactor were exposed to dispersed material through absorption over a prolonged period. From talking with one family, Hida learned that in 1949 secret government tests (only revealed in 1984) had found a five-fold increase in cancers in communities near the plant and factories

in Hanford and Rocky Flats.⁴³ This is supported by the 'Petkau Effect' observed by Abram Petkau in 1972, which finds that regular low level radiation exposure can be more damaging over time than a one-off high dose of radiation. This was confirmed from investigations by Burlakova et al. in the early 1990s which observed changes at the cellular level in animals and humans after irradiation akin to the aging process.⁴⁴

Given that as early as 1941, as part of US military research into radiological warfare (1941-1974), uranium products had been found to be seriously harmful when ingested (dependent upon contact time, particle solubility, half-life, rate of elimination), the results from Hanford, Hiroshima and Nagasaki, Basra and Fallujah among other sites where uranium products have been used and dispersed suggest criminal negligence and/or crimes against humanity through the use of weapons of mass destruction (chemical, biological or otherwise) on two counts: the use of such weapons against civilians or combatants; and the degradation of the environment in the failure to protect individual entitlement to adequate conditions of life including health and well-being. The ecological distribution and remobilisation of fine DU further afield is also of serious concern. As those living in primary affected areas have most obviously experienced, exposure to NPP emissions downwind or downstream also gain heightened susceptibility to cancer and non-cancer related illnesses.

V Local testimonies

Dr Hida's thesis and the 'downwinder' theory may not be far-fetched.⁴⁵ Cornelia Hesse-Honegger, a Swiss scientific artist, has over 20 years collected and drawn 'true leaf bugs' (Heteroptera) from around fallout areas and the peripheries of nuclear power plants. Characterised by their remaining within their habitat, Hesse-Honegger describes these bugs as 'bio-indicators' (early warnings) because they are sensitive to radiation and develop much more rapidly than mice and humans.⁴⁶ Her field-work sites include Chernobyl, Switzerland (Aargau), Sweden, France (La Hague), Germany (Gundremmingen), Sellafield (Cumbria), Pennsylvania (Three Mile Island) and the Nevada desert.



Left: Soft bug (Miridae) from Gösgen, Switzerland ; Right: Scorpion fly (Panorpis Communis) from Reuenthal, Switzerland © Cornelia Hesse-Honegger

Her research suggests that the official 'low dose event' category for Chernobyl, and its estimate of 28-32 deaths from acute radiation and 15 subsequent deaths from thyroid cancer is mistaken and should be re-calculated.⁴⁷ Of the 16,000 bugs collected until 2007, she found a 30% increase in severe deformities (missing feeler sections, malformed wings, asymmetric body segments, ulcers, black spots, altered pigmentation), 10 times higher than the 1-3% norm. Rather than concentric circles used to measure the distance from the hypocenter as in the model used for Hiroshima, she found topography, wind direction and hydrology as determinants in radiation distribution.

In 2000, only after thousands of scientific studies conducted in the affected regions around Chernobyl over the 1990s did the UN Secretary General Kofi Annan announce that radiation dispersed from Chernobyl (100 times the amount from the atomic bombs in Hiroshima and

Nagasaki) had caused chronic illness in 7 million more people, and the premature deaths of 3 million children.⁴⁸ This contrasted starkly with IAEA recommendations (and the consensus of 'radioprotection authorities') that families continue life as normal in contaminated areas and that their illnesses were psychosocial.

Takeda Shimpei is one artist who has attempted to counter the prevailing narrative and to perceive more clearly the presence of radioactive contamination in everyday life in the Tōhoku area since the reactor meltdowns. Fukushima-born and New York based, Takeda is familiar with radiation issues through his previous engagements with hibakusha legacies. In contrast to mainstream symbolic images and information used to represent '3.11', Takeda sought to make an alternative and 'direct record' of the 'worst man-made nuclear accident in history'.

In 'Trace', which was initially shown at the Fukushima Biennale 2012, he collected soil samples from 12 different locations of historical and cultural value while traveling in the Tōhoku-Kantō area with hip-hop activist Shingo Annen and architect Keisuke Hiei (temples, shrines, battle sites, ruins, a hospital). Takeda used an 'auto-radiographic' process in which he exposed the soil samples to photo-sensitive materials in a light-sealed box over 6 months (gelatin silver halide film). The ionising products scattered on the soil permanently imprinted the film as decay continued. By minimising his interference in this way, like Hesse-Honegger, Takeda has devised an accessible way to record and display the chemical reaction inherent to the soil's active ingredients (mass-time-heat).



Takeda Shimpei, Nihonmatsu Castle soil sample, Fukushima prefecture, 'Trace' (2012).

This work also demands interpretation as a visual representation. Setting aside purely aesthetic considerations, the concrete scientific form of Takeda's work is strategically aimed at exposing the politicised conditions of life amid radioactive contamination. Takeda's images reflect the burning particles in the soil, which when ingested (through air, water or food) continue to burn within the body. As these materials continue to circulate in the biosphere, given the deep geological time of uranium products, the danger is that through repetition of the message that 'all is safe', radiation monitoring could become like weather readings, announced and accepted as a fact of life. In choosing not to separate and quantify the radiation amount and particle type, Takeda seems to have rejected reliance on radiation monitoring as an end in itself, and the erroneous, arbitrarily determined, radiation dose limits. Alive to the possibility that such measurements may be easily manipulated to represent a fictitious reality, the focus of 'Trace' is on manifesting radiation as undeniable materiality.

In addition, scientific studies on animals affected by distributed radioactive contamination in local areas in Tōhoku are also beginning to appear. The ornithologists Timothy Mousseau and Anders Møller, whose work on cataracts in birds in areas with high levels of ionising radiation (10 uSvh) around Chernobyl is well known, extended their studies to swallows surrounding the Fukushima NPP and found that these birds have nearly vanished, while those that survive have 'smaller heads and low breeding rates'.⁴⁹

Macaques, horses, mice and moss show similar effects. Wild macaques, which eat leaf buds

from the surrounding forests, show high levels of Cs137 in their muscle tissues (10,000-25,000 bq/kg March 2011; 500-1,500 bq/kg June 2011; 2,000 bq/kg Dec-Mar 2012).⁵⁰ Some have been fitted with GPS devices and dosimeters by Fukushima University researchers so as to collect and map levels as they comb the mountain forests in the no-entry zone of southern Minami-Soma. Of the 15 horses born at the Hosokawa ranch 20kms from the reactor in 2013, 14 lived between 1 week and 1 month.⁵¹ 4 adult horses also collapsed and eventually perished. The horses were diagnosed with liver failure (lack of red blood cell production). Fieldmice in their 52nd generation since the disaster sampled in early 2012 from a forest 30 km from the NPP1 (Kawauchi-mura forest, Ibaraki-ken) still showed genetic mutations 100 times the control and very high Cs137 levels (3100 bq), as did earthworms, leaves and soil from the same area.⁵² People are still growing rice in these areas, and are also returning to them. In early July 2013, moss on the roof of a building in Fukushima city 50kms from the NPP returned extremely high Cs137 concentration (1,785,216 Bq/Kg).⁵³



A dead horse at the Hosokawa ranch, 2013

In July 2013, the groundwater flowing beneath the NPP recorded the highest readings yet measured, a rise of 9000% since the beginning of the disaster (900 million Bq/m³ of all β particles- Sr, Cs, Tr, Pu). On 22 July, one day after the LDP and New Komeito won the national election, TEPCO operators admitted to a daily discharge of 300 tonnes of irradiated water into the sea (since upgraded to 400 tonnes),⁵⁴ and the leak of an additional 24 billion Bq of tritiated water from storage tanks into the ocean.⁵⁵ Aoyama Michio, Japan Meteorological Agency scientist, at the IAEA 2013 Scientific Forum reported 60 billion Bq of Cs137 and Sr-90 being released directly into the Pacific ocean from the NPP on a daily basis (900 billion Bq respectively per month). This was even greater than a recent estimate by Kanda Jōta, an oceanographer at Tokyo University of Marine Science and Technology, who calculated that the NPP is leaking 0.3 Tbq (300 billion Bq) of Cs137 per month.⁵⁶ Aoyama included the amount of water vacuumed from the port by Units 5 and 6 to cool the reactors, subsequently discharged north of the site.⁵⁷

Contrary to assurances from the nuclear industry, tritiated water (³H₂O, or 'heavy water') binds to the DNA and can cause great damage to life. There is no method yet discovered to remove Tritium once it has bonded with water.⁵⁸ In addition the total release from the reactors into the permeated basements has been revised upward to 276 PetaBq Cs-137 (40 percent of the reactor core inventory), and Strontium-90 from 23 to 33 PBq (4.4 to 6.3 percent of the reactor core inventory). This is roughly triple the total amount released into the air from the Chernobyl accident.⁵⁹

Despite all this, local government recently opened the public beach at Iwaki-shi (40 km from the NPP) for swimming, claiming that radiation levels are below the detectable limit (omitting the specific amounts or types of radiation they had tested).⁶⁰ This was decided knowing of high Cs137 concentrations in seaweeds, crustaceans and fish along the Tōhoku coast, and of TEPCO dumping of radioactive matter into the ocean.

This is also of concern given the known effects since 2011 on ocean wildlife further afield, including ringed seals and walrus along the Bering Straits, the Arctic coastlines of Russia, the Arctic wildlife sanctuary, Alaska and British Columbia. Necropsies of the seals have shown fluid on the lungs, white spots on the liver, and abnormal brain growths. Indigenous people living in British Columbia who rely on Skeena River sockeye salmon have also reported dramatically reduced numbers and ill-health of the fish returning from their ocean-going maturational phase to spawn up-river. The symptoms these animals are displaying in the form of bleeding lesions, alopecia, psoriasis, internal growths and lethargy indicate diseases consistent with radiation exposure which affects the autoimmune, lymphatic and endocrine systems. As the seals in these areas eat the ocean-going herring, tuna, greenling and salmon, their carcasses are then eaten by polar bears and birds.⁶¹ Further, large numbers of dead starfish have collected in the shallows and on the beaches of Vancouver Island. On 12 September 2013, a local diver witnessed large numbers of sunflower starfish (*Pycnopodia helianthoides*), that feeds mostly on sea urchins and snails, in various stages of disintegration on the sea floor. As he described, 'the arms just detach, and the central disc falls apart. It seems to happen rapidly, and not just dead animals undergoing decomposition, ... The bottom from about 20 to 50 feet [6 to 15 meters] was absolutely littered with arms, oral discs, tube feet, gonads and gills.'⁶²

If estimates are correct regarding increases in caesium levels in the entire Pacific Ocean well beyond the peak level during the nuclear weapons tests, these are preliminary findings of degradation of the ecosystem at a far greater scale than has been anticipated.

VI In sum

Abstract data is difficult to decode and easily manipulated for the untrained reader, but the visual testimonies of radioactive contamination by Kamanaka (Hibakusha), Hesse-Honegger (Heteroptera) and Takeda (Trace) render visible the apparently invisible damage to the biosphere. Testimonies of radiation-contaminated animals and plants emerging from local residents as well as scientific studies confirm such damage. Although context specific, these diverse cases indicate a common experience that transcends nationality and cultural particularity - a radioactive transnationality.

The obfuscation of the transnational nuclear industry on questions of radiation is presumably motivated by the sheer scale and intensive long-term investment in the nuclear production chain (uranium mining, nuclear power plant technology, national electricity production, military weapons production and use, decommissioning and nuclear waste storage) in which executives, politicians and bureaucrats are deeply embedded.

While funds for new military hardware, technological innovation, public works and public relations operations seem to be readily available to the Abe administration, it shrinks from the costs required to return the water, food and air to a 'safe' legal radiation limit (1 mSvy).⁶³ Despite being an advanced industrial nation, its government seems incapable of taking appropriate measures to protect people - closing all schools which measure above 1 mSvy in affected areas, assisting all citizens that wish to be evacuated from areas within a 80km radius from the NPP with sufficient subventions for their moving, living and schooling costs, preventing the consumption of contaminated foods nationally and internationally, providing a nationalised course of medical treatment commensurate with the actual danger posed by the toxicity of radiation exposure, and storing radiation contaminated materials.⁶⁴

Even if they are less clear on the structural and scientific reasons for it, many people in Japan seem to be well aware of the falsity of Abe's contention that the Fukushima NPP is under control.⁶⁵ The abstraction of material conditions to justify the protection of and maintain the confidence in sovereign assets and illusory growth, is incurring real and mounting costs in human and non-human life. If unchecked, this system will continue to do so into the future until exhaustion and potential collapse.⁶⁶ Either way, the situation is likely to get worse before significant change is achieved, which depends on the ability of people in Japan and the international community to grasp the urgency of the crisis and to demand an end to delay in preventing further contamination of the ocean and regenerating one of the most vital structures supporting life on the planet. In the short-term, the formula for measuring the risk posed by nuclear power must be re-adjusted to reflect the health of living beings in the biosphere as a non-negotiable factor. This will have immediate effects on public health, food safety and evacuation from contaminated areas. In the long term, while the debate over the choice of energy sources is critical, the systemic and astigmatic prioritisation of profit has to be revised, so that state-corporate interests can no longer hijack the core values which sustain life.

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Notes

¹ An initial version of this article entitled 'Limits in the Modern Episteme: Understanding Fukushima through visualising radioactivity' was presented at the Japanese Studies Association of Australia conference in July 2013.

² See Gavan McCormack, *The emptiness of Japanese affluence*, New York: M.E. Sharpe, 2001; and Jeff Kingston, *Japan's quiet transformation: social change and civil society in 21st Century Japan*, London and New York: Routledgecurzon, 2004, pp. 122-156.

³ The proprietor sued TEPCO for losses as the contamination led to its closure (45 kms from the Fukushima NPP). The TEPCO lawyers (Nagashima, Ohno and Tsunematsu) argued that they could not be held liable for that which was not their property. The court upheld the defence. The court also stated that golf course operations could be resumed because radiation levels on average were below 3.8 uSv/h, the yardstick for schoolyards set in April 2011. Iwata Tomohiro, 'TEPCO: Radioactive substances belong to landowners, not us', *Asahi Shimbun Weekly AERA*, 24 November 2011, [here](#).

⁴ See David Pacchioli, 'Absurd: Intentionally dumping Fukushima nuclear material into ocean from land "is not considered dumping" — Allowed under international law?', *Seafood Safety and Policy*, *Oceanus*, WHOI, Vol. 50, No. 1, Spring 2013, 14 May, 2013.

⁵ About 10 billion yen of the 25 trillion yen pledged for disaster recovery over several years has been reserved to offset costs for utility companies that were ordered to shut nuclear power plants in the aftermath of the Fukushima disaster. See 'Funds from disaster relief budget given to nuclear operators',

29 June 2013, [here](#).

⁶ John Holifena, 'Japan's PM Abe to push nuclear sales in Europe', JDP, 14 May 2013, <http://japandailyexpress.com/japans-pm-abe-to-push-nuclear-technology-sales-in-europe-1428791/>.

⁷ Uchiyama Osamu, 'Toshiba set to buy British nuclear power firm for 10 billion yen,' Asahi Shimbun, 6 October 2013, [here](#).

⁸ '[Japan's PM Abe: "Contaminated Water Problem Will Be Gone by 2020 Summer Olympics in Tokyo"](#),' Jiji Tsushin, 4 September 2013, [here](#).

⁹ See PSR, 'Nuclear Power and France: Setting the Record Straight', 16 September 2008, [here](#), Jeff McMahon, 'French System for Cleaning Fukushima Water Blamed for Leukemia, Polluted Beaches in Europe', 25 April 2011, [here](#).

¹¹ Mari Yamaguchi, 'Overflowing tank cause of new leak at Fukushima, Associated Press, 3 October 2013, [here](#).

¹² See Miguel Quintana, 'Radiation Decontamination in Fukushima: a critical perspective from the ground', The Asia-Pacific Journal, Vol 10, Issue 13, No 3, March 26, 2012 - See more [here](#).

¹³ 'Fish caught off the Fukushima coast to hit the market', 26 September 2013, [here](#); 'Yoshinoya to grow rice and vegetables in Fukushima,' 1 October 2013, [here](#).

¹⁴ For example, Kameda Medical Institute purchased a system for cancer treatment from Israel's IceCure Medical Inc., 2 October 2013, 'Innovative Israeli Cancer Treatment to be Tested in Japan', [here](#).

¹⁵ 'White Paper: Fukushima Health Survey Occupies Medical and Legal Conundrum', Simply Info, 8 November 2012, [here](#).

¹⁶ Winifred Bird, 'Fukushima nuclear cleanup could create its own environmental disaster: Decontaminating the Fukushima region to remove radioactive particles will not be possible without removing large amounts of soil, leaves and plants,' The Guardian, 9 January 2012, [here](#). The radiation safety standard of 100mSvy cited in this article are contested.

¹⁷ Robert Alvarez, 'Nuclear Tuna and NPR's Trivialization', Institute for Policy Studies, 31 May 2012, [here](#). See also, 'Fukushima radiation could be ocean risk', 26 January 2012, [here](#).

¹⁸ Alexey Yablokov, Vassily Nesterenko and Alexei Nesterenko, Mycle Schneider, Hirose Takashi, Koide Hiroaki, Helen Caldicott, Arnie Gundersen and Murata Mitsuhei among others, have argued that radiation and other problems are worse than either TEPCO or the Japanese government have admitted. The National Regulation Authority commissioner Fuketa Toyoshi also wondered if TEPCO's data could be relied upon at all. See Matt McGrath, 'Fukushima leak is 'much worse than we were led to believe'', 22 August 2013, [here](#); Jason Motlagh, 'The News From Fukushima Just Gets Worse, and the Japanese Public Wants Answers', 22 August 2013, [here](#).

¹⁹ Satoh C., Kodaira M., 'Effects of Radiation on Children,' Nature, 1996, 383: 226; Nakamura

N., 'Genetic Effects of Radiation in Atomic-bomb Survivors and Their Children: Past, Present and Future,' Journal of Radiation Research, 2006, 47 (Supplement): B67-B73.

²⁰ See 'Recommendations of the European Committee on Radiation Risk: Health Effects of Ionising Radiation Exposure at Low Doses for Radiation Protection Purposes Regulators', Brussels, 2003, [here](#).

²¹ Thierry Ribault, 'UN Special Rapporteur Anand Grover on Fukushima: A Stunning Report Brushed Aside by the Japanese Government', Japan Focus, 10 June 2013, [here](#).

²² Between 1939 and 1941, scientists in the Manhattan Project observed that 'fission products' emitted photon and particulate radiation, and from studying their metabolism they found that radiation was harmful when ingested as well as to the embryo, and that Strontium was a Calcium analogue and had carcinogenic effects that was harmful to the unborn. In October 1943, a subcommittee of the S-1 Committee for 'Use of radioactive materials as military weapons' comprising of Drs. J. Conant, A. Compton and H. Urey wrote to General Groves advising on weaponising such uranium products collected from nuclear pile rods and dispersed by various means into enemy territory (dust, smoke or liquid distributed by ground-fired projectile, land vehicle or aerial bomb). The objective of such weapons was to contaminate enemy food and water supplies, making the land uninhabitable, including airports and railroad yards, cause casualties in military and civilian populations, while protecting US troops and civilians with potassium and vitamin D and calcium concentrate. See 'Groves Memo', 30 October 1943, [here](#); also Langley P., Medicine and the Bomb: Deceptions from Trinity to Maralinga, Port Augusta: self-published, July 2012: 7-9.

²³ For example, Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Uranium, U.S. Department of Health and Human Services, 1999, [here](#).

²⁴ Pu 239 is an alpha emitter, has a half life of 240,000 years, mimics iron and goes to the liver, spleen and bone marrow. It causes 10 to 1000 times more chromosome damage than the same amount of gamma or beta radiation. It is pyrophoric (combusts upon contact with oxygen) and changes its volume and density with temperature change. Its heat makes it highly toxic when ingested, glows in the dark (Pu 238), and currently fuels the Curiosity rover on Mars. Caesium 137, a gamma emitter, is the most abundant fission product in nuclear fuel and nuclear waste. Its half-life of 30 yrs, high-energy decay, chemical reactivity and high solubility (Ci), means that Cs 137 will be present for roughly 300 years after Fukushima. It attracts to muscle tissues (prostate/ovary/breast cancer) and causes malignant muscle cancers (rhabdomyosarcomas, heart arrhythmias and cardiac arrests, muscle seizures, loss of consciousness, memory loss). Strontium (Sr89-90) mimics calcium, goes to the bone and teeth, causes bone cancers and leukaemia and is radioactive for 300 years. Along with the above, there are many other radionuclides in the inventory of nuclear reactors: alpha - thorium, radium, neptunium, curium 244, americium 241, californium, polonium 210 (transuranic and actinides); gamma - Cobalt 60, Iridium 92, Barium 137, Iodine 131, Lanthanum 140; Beta - Tritium, Phosphorous, Nickel, Carbon; Alpha and Beta - Strontium 90, Cadmium 113, Europium 155, Krypton 85, Tin 121 (Sn), Samarium 90; noble gases - Xenon and Iodine 131. As the weight or chemical mass of a radionuclide causes most damage to internal structures, when ingested heavy alpha particles are even more destructive than beta and gamma emitters.

²⁵ Natural sources of gamma rays on Earth come from natural radioisotopes, and from interactions with cosmic ray particles. The capacity of radiation to mutate cells and increase mitosis rate means

that radiation is used in cancer therapy (white T cells or red blood cells) and agriculture (new plant strains through mutated seeds; controlled irradiation to kill bacteria in food). This can also create less resistance to cytotoxins (chemical cells) which can increase sickness.

²⁶ See 'Fukushima Prefecture Health Management Survey', [here](#); 'Thyroid cancer found in 18 Fukushima children', NHK, 21 August 2013, [here](#); 'Thyroid cancer found in 12 minors in Fukushima', Kyodo, 5 June 2013, 'Fukushima gov't forced to reveal children's thyroid gland tests,' 22 April 2013, [here](#).

²⁷ This amount was estimated from Aoyama Michio's IAEA statement on Caesium and strontium only releases, '44.9 Tq Contamination Released to Sea and Air in Last 2 years at Fuku Daiichi', 24 September 2013, [here](#).

²⁸ Fukushima is registering 24.9 children per 100,000 compared to 11.3 children per 100,000 in Chernobyl in the same time period. Kinoshita Kôta's calculation of 24.9 children per 100,000 people is higher than Dr. Bandazhevsky's calculation from the Gomel region 5 years after the accident in 1991, where the frequency of thyroid cancer in children was 11.3 children per 100,000 people. Including all actual and suspected cases, the rate of children in Fukushima is more than two times higher than the rate in areas near Chernobyl in less than half the time. Kinoshita Kôta, 'Radiation protection project', Kinoshita Kôta blog, [here](#).

²⁹ 'TEPCO finds new radioactive water leak at Fukushima', Arirang News, 3 October 2013, 00:40-1:00, [here](#).

³⁰ For a survey from 20 September – 3 October 2013, see Katsumi Takahiro, 'Fall Japan 2013 Japan National Residents Nosebleed Survey v1.0', [here](#). See also, Takenouchi Mari, 'Health damage shown among a family from Fukushima city', 24 September 2013, [here](#).

³¹ Similar to the way in which the dismissal of the relation of internal radiation to the death from oesophagus cancer and cerebral haemorrhage of 58 year old Yoshida Masao, who had remained to control the meltdowns at the Fukushima NPP, the LDP Policy Bureau Chief Sanae Takaichi sought to justify the nuclear power plant restarts by declaring that 'it is not that there has been a death from the nuclear accident, including at Fukushima 1 Nuclear Power Plant. We have no choice but utilize nuclear power plants as long as we secure maximum safety'. Sanae went on to claim that 'the stable supply of power is indispensable for maintaining the competitiveness of industries, and that a nuclear power plant costs enormous amount of money if we think about the cost of decommissioning, but while it is operating the cost is relatively cheap'. Editorial, "'There are no deaths from the nuclear accident", LDP Policy Bureau Chief', Asahi Shimbun, [here](#).

³² The health risk from regular tritium emissions (40,000 Bq/l) from nuclear power plants has been a source of contention between nuclear protection bodies. In 1990 in Canada concern was such that the ICRP sought to lower the safety standard for tritium to 7000 Bq/litre and then to lower it by 100 Bq/litre every five years until 20 Bq /litre.

³³ 'S. Korean minister calls Japan 'immoral' for covering-up radiation leak', Yonhap, 30 September 2013, [here](#).

³⁴ John Pilger, 'From Iraq, a tragic reminder to prosecute the war criminals,' 27 May 2013, [here](#). The

US military also used white phosphorus (wP) against Iraqi 'insurgents' during the assault on Fallujah in April and November 2004. WP disperses into a gaseous cloud from the exploded warhead, and burns upon contact with oxygen, water or the skin. The Pentagon claimed wP was a conventional not a chemical weapon and that civilians were not targeted. Maurizio Torrealta, 'Fallujah: The Hidden Massacre', RAI TV, 2005; George Monbiot, 'The US Used Chemical Weapons in Iraq-And Then Lied About It', The Guardian, 15 November 2005.

³⁵ An estimated 14 per cent of Iraq's population are orphans, and one million families are without fathers.

³⁶ See Braverstock K., 'Science, Politics and Ethics in the Low Dose Debate', *Medicine, Conflict and Survival*, vol 21 (2), 2005: 88-100.

³⁷ See [here](#).

³⁸ See Mozghan Savabieasfahani, '[Rise of Cancers and Birth Defects in Iraq: World Health Organization Refuses to Release Data](#),' Global Research, 31 July 2013. Savabieasfahani states that Iraqi doctors are convinced that the epidemic is self-evident, despite the difficulties in absolute proof of cancer etiology. He cites British oncologist Karol Sikora, chief of the cancer programme of WHO in the British Medical Journal (Owen Dyer, 'WHO suppressed evidence on effects of depleted uranium, expert says', 9 November 2006) who points out that 'requested radiotherapy equipment, chemotherapy drugs and analgesics are consistently blocked by United States and British advisers [to the Iraq Sanctions Committee]', and that mentioning Iraq at the WHO was discouraged due to its political nature. See also [Denis Halliday](#), 'WHO Refuses to Publish Report on Cancers and Birth Defects in Iraq Caused by Depleted Uranium Ammunition', Global Research, 13 September, 2013; Rob Edwards, 'WHO 'Suppressed' Scientific Study Into Depleted Uranium Cancer Fears in Iraq,' [The Sunday Herald](#), 24 February 2004.

³⁹ Busby C., Hamdan M., Ariabi E., 'Cancer, Infant Mortality and Birth Sex-Ratio in Fallujah, Iraq 2005-2009', [International Journal of Environmental Research and Public Health](#). See also, Patrick Cockburn, 'Toxic legacy of US assault on Fallujah 'worse than Hiroshima': The shocking rates of infant mortality and cancer in Iraqi city raise new questions about battle', The Independent, 24 July 2010, [here](#).

⁴⁰ Chris Busby, 'Why the WHO report on congenital anomalies in Iraq is a disgrace,' 29 September 2013, [here](#).

⁴¹ There are reports which suggest the chemical toxicity of DU (U^{238}) munitions were being associated with post-exertional malaise. See [US Army Environmental Policy Institute](#), June 1995. Also Bertell R., 'Depleted Uranium: All the questions about DU and Gulf War Syndrome are not yet answered', *International Journal of Health Services*, vol 36, No 3, 2006: 503-520, McDiarmid MA. et al., *Journal of Toxicology and Environmental Health, Part A*, 67:277-296, 2004. There remains contention over whether it is the alpha-particles or the chemical toxicity of uranium which effects genetic material. See Royal Society, *Health Hazards of Depleted Uranium Munitions: Part II*, London: Royal Society, March 2002; Hindin R., Brugge D., Panikkar B., 'Teratogenicity of Depleted Uranium Aerosols: A Review from an Epidemiological Perspective,' *Environmental Health*, 2005, 26(4): 17. Albina L., Belles M., Gomez M., Sanchez D.J., Domingo J. L., 'Influence of Maternal Stress on Uranium-Induced Developmental Toxicity in Rats,' *Experimental Biology and Medicine*, 2003, 228 (9):1072-1077; Arfsten D.P., Still K.R., Ritchie G.D., 'A Review of the Effects of Uranium and Depleted

Uranium Exposure on Reproduction and Fetal Development,' *Toxicology and Industrial Health*, 2001, 17: 180-191.

⁴² From documents released by the RERF in December 2011, Honda Koya of the Ota Hospital in Nagasaki found that the ABCC had done a survey linking black rain exposure to purpura and epilation. 13,000 people were exposed to black rain. Direct exposure after detonation within 1km was 4,500 mSv, and 2km 100 mSv, but indirect exposure of 10-35 mSv through rain and ground shine extended beyond the 2km radius and was suppressed. See 'Black Rain: Fruitless data on the A-bomb survivors', NHK, 1 September 2012, [here](#).

⁴³ Hanford was a plutonium fabrication facility next to Rocky Flats, owned by the US AEC in Arvada, Colorado, and was operated initially by Dow Chemical. The metal would be shipped to Rocky Flats to be made into useful shapes for the reactors - the 'pits' - and then shipped to the Pantex Plant for final assembly into bombs. By 1984, many families had been driven from Hanford due to sickness and cancers. Tom Bailey was a leader of a lobby group seeking compensation, which was finally recognised in the Radiation Exposure Compensation Act (1990). There is now major concern for the remaining plutonium waste buried beneath the Hanford site (10 metric tonnes, 67 tanks, 710,000 m³) contaminating the groundwater.

⁴⁴ Graeub R., *The Petkau Effect - The Devastating Effect of Nuclear Radiation on Human Health and the Environment*, New York: Four Walls Eight Windows, 1994; Burlakova E. B., Naidich V., *The Effects of Low Dose Radiation: New Aspects of Radiobiological Research prompted by the Chernobyl nuclear disaster*, Utrecht and Boston: VSP, 2004.

⁴⁵ See Sternglass E., *Secret Fallout: Low level radiation from Hiroshima to Three-Mile Island*, New York: McGraw Hill 1981.

⁴⁶ Hesse-Honegger C., *Heteroptera*, New York: Scalo Publishers, 2002.

⁴⁷ These figures were re-confirmed at the Chernobyl Forum 2005, attended by delegates from Belarus, Russia, Ukraine, the IAEA, World Bank Group, WHO and UNSCEAR. See [here](#).

⁴⁸ Hesse-Honegger C., Wallimann P., 'Malformation of True Bug (Heteroptera): a Phenotype Field Study of the Possible Influence of Artificial Low-Level Radioactivity', *Chemistry & Biodiversity*, 2008, Vol. 5, Issue 4, pp. 499-539. See also Tom Raum, Associated Press, 'U.N.: Worst effects of Chernobyl disaster may yet occur', *Record Journal*, 26 April 2000; Rebecca Harms, 'The Chernobyl Legacy', 9 June 2006, #645-646, [here](#).

⁴⁹ Møller A., Mousseau T. et al., 'Abundance of birds in Fukushima as judged from Chernobyl,' *Environmental Pollution*, Vol 164, May 2012: 36-39, [here](#); 'Cataracts in the eyes of birds in Chernobyl and Fukushima', *The Economist*, 7 September 2013, [here](#).

⁵⁰ 25,000 Bq/Kg were measured in macaques. See Nippon Veterinary and Life Science University (NVLU) quoted in 'Scientists in groundbreaking study on effects of radiation in Fukushima', *Asahi Shimbun*, 10 April 2012, [here](#).

⁵¹ 'Surviving at the Ranch of Hope: Irradiated Cows from Namie, Evidence of the Nuclear Reactor Accident', *Asahi Shimbun*, 6 September 2013, [here](#) in 'Ranch of Hope - Fukushima' Official Blog,

[here](#); also 'The man living within 20km of the nuclear reactor: Alone in the Zone', Vice, 10 March 2013, [here](#).

⁵² '3100 Bq/kg of Radioactive Caesium from Wild Mice in Kawauchi-mura', EX-SKF, 13 May 2012, [here](#); NHK, 14 May 2012, [here](#). The Forestry and Forest Products Research Institute also measured worms (19,500 Bq/kg Cs137), leaves (319,000 Bq/kg Cs137) and soil (5cm - 20,900 Bq/kg Cs137). See 'High radioactive Caesium levels detected in worms 20 km from nuke plant', Mainichi Daily News, 6 February 2012, [here](#); 'High Caesium found in earthworms', Japan Times Online, 8 February 2012, [here](#).

⁵³ 'Scientists detect highest Caesium levels in a year in Fukushima,' Asahi Shimbun, 4 July 2013, [here](#).

⁵⁴ Reiji Yoshida, 'Tepco raises estimate to 400 tons a day', Japan Times, 27 September 2013, [here](#).

⁵⁵ Between 3-5 July 2013, Fukushima Diary reported 4,300,000 Bq/m³ of all β at 6m from the sea (an 1.4 x increase in 3 days) and 900,000,000 Bq/m³ of all β in the groundwater, the worst reading in groundwater ever published by TEPCO. The exact readings of Strontium-90 were not announced. See [here](#).

⁵⁶ 'How a Scientist Was Censored by the Japanese Government After the Fukushima Accident', Fukushima Voice, 27 September 2013, [here](#); Kanda J., 'Continuing 137Cs release to the sea from the Fukushima Dai-ichi Nuclear Power Plant through 2012', Biogeosciences Discussions, 10: 3577-3595, 2013, [here](#); Geoff Brumfel, 'Oceans still suffering from Fukushima fallout: Continuing leaks and contaminated sediment keep radiation levels high', Nature, 14 November 2012, [here](#).

⁵⁷ Aoyama M., 'Fukushima derived radionuclides in the ocean', [here](#), Negishi Takuro, Fujiwara Shinichi, 'Contaminated water flowing into ocean despite Abe's claim', Asahi Shimbun, 20 September 2013, [here](#).

⁵⁸ While tritiated water may be cleared from the human body in about 10 days (Garland), organically bound tritium (tritium bound in animal or plant tissue) can stay in the body for 10 years or more and regular exposure can lead to chronic exposure. Tritium from tritiated water can become incorporated into DNA, the molecular basis of heredity for living organisms. Most studies indicate that tritium in living creatures can produce typical radiogenic effects including cancer, genetic effects, developmental abnormalities and reproductive effects (Straume; Rytomaa; Torok; Dobson). Studies have shown that there is no evidence of a threshold for damage from 3H exposure, and that low doses of tritium can even cause more cell death (Dobson), mutations (Ito) and chromosome damage (Hori) than higher tritium doses. Tritium can cause damage two or more times greater per dose than either x-rays or gamma rays (Straume; Dobson). There is no technology that has been developed to remove it from water. See Folkers C., 'Tritium: Health Consequences', NIRS, 2006, [here](#).

⁵⁹ Mycle Schneider, Antony Froggatt et al., The World Nuclear Industry Status Report 2013, 30 July 2013, [here](#).

⁶⁰ 'Sun, sand, surf and radiation in shadow of Fukushima', The Daily Tribune, 1 September 2013, [here](#).

⁶¹ The NOAA was quoted by the Emergency and Disaster Information Service – Biological Hazard in multi-countries as reporting over 200 diseased or dead seals found in Canada (Tuktoyuktak), Russia (Kaktovik, Chukotka), Alaska (Barrow, Arctic National Wildlife Refuge). http://hisz.rsoe.hu/alertmap/site/?pageid=event_desc&edis_id=BH-20111013-32661-MLC. This was also reported by major news agencies including MSNBC and Reuters. See 'Independent fisheries scientist Alexandra Morton reported the damage to sock eye salmon. See Lake Babine sockeye fishery at risk of unprecedented closure', The Globe and Mail, 12 August 2013, [here](#).

⁶² Carrie Arnold, 'Massive Starfish Die-Off Baffles Scientists,' National Geographic, 9 September 2013, [here](#).

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