GREENPEACE

Fukushima Daiichi 2011-2021

The decontamination myth and a decade of human rights violations

March 2021

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Executive summary

As a result of a catastrophic triple reactor meltdown at the Fukushima Daiichi nuclear plant on 11 March 2011, several tens of thousands of square kilometres in Fukushima Prefecture and wider Japan were contaminated with significant amounts of radioactive caesium and other radionuclides.[1] The first Greenpeace radiation expert team arrived in Fukushima on 26 March 2011, and Greenpeace experts have since conducted 32 investigations into the radiological consequences of the disaster, the most recent in November 2020.

This report, the latest in a series, chronicles some of our principal findings over recent years, and shows how the government of Japan, largely under prime minister Shinzo Abe, has attempted to deceive the Japanese people by misrepresenting the effectiveness of the decontamination programme as well as the overall radiological risks in Fukushima Prefecture. As the latest Greenpeace surveys demonstrate, the contamination remains and is widespread, and is still a very real threat to long term human health and the environment.

The contaminated areas comprise rice fields and other farmland, as well as a large amount of forest. Many people who lived in these areas were employed as farmers or in forestry. Residents gathered wood, mushrooms, wild fruits and vegetables from the mountain forests, and children were free to play outdoors in the woodlands and streams. Since the disaster, tens of thousands of people have been displaced from their ancestral lands. The harm extends far beyond the immediate threat to health – as well as destroying livelihoods, it has destroyed an entire way of life.

Because of the government's actions, many thousands of evacuees have been forced to make an impossible choice: to return to their radioactively contaminated homes or to abandon their homes and land and seek to establish a new life elsewhere without adequate compensation. This amounts to economic coercion and may force individuals and families to return against their will due to a lack of financial resources and viable alternatives. Given that these people lost their livelihoods, communities, and property as a result of a nuclear disaster they had no part in creating, this is grossly unjust.

Key findings

The failure of decontamination

The Japanese government claims that, with the exception of the 'difficult-to-return' zones, decontamination has largely been completed within the Special Decontamination Area (SDA), which includes the municipalities of Namie and Iitate. Yet Greenpeace has consistently found that most of the SDA, where the government has taken direct charge of decontamination, remains contaminated with radioactive caesium. In fact, despite an enormous decontamination programme, analysis of the government's own data shows that in the SDA an overall average of 15% has been decontaminated. In the case of Namie for example, of the 22,314 hectares that make up the municipality, only 2,140 hectares have been decontaminated - just 10% of the total. One major reason for this is that much of Fukushima prefecture is mountainous forest that cannot be decontaminated.

The Japanese government's long-term decontamination target level is 0.23 microsieverts per hour (μSv/h), the level they estimate would lead to an annual dose of 1 millisievert per year (mSv/y). This is the recommended maximum level for public exposure to radiation other than from medical or natural background exposure. Confronted with radiation levels that would result in annual exposure above this level, in April 2012 the government changed the recommended maximum to 20 mSv per year, the same as the yearly average allowed for Japanese nuclear plant workers under normal circumstances. At no time since has the government given a timeframe for when 'long-term' targets of 0.23 μSv/h are to be reached.

In its radiation surveys over the last decade, Greenpeace has consistently found readings well above the Japanese government's decontamination

target levels. The following data are a selection from the most recent surveys conducted in November 2020.

- At a home in Iitate (Mr Anzai's house) every measurement taken in five of the 11 zones surrounding the property still exceeded the government target of 0.23 μSv/h, with an average radiation level across all zones of 0.5 μSv/h.
- At a former school and kindergarten in the town of Namie, all of the 822 points measured in an adjacent forested area remained above the 0.23 μSv/h target and 88% measured above 1 μSv/h. In the area directly outside the school, 93% of all data points measured remain above the 0.23 μSv/h target. Nevertheless, this location has been open to the public since March 2017.
- In 70% of the points measured in Zone 1 along the Takase riverbank, radiation levels would give an annual dose of 3-5 mSv/year based on the Japanese government calculation method.
- At a home in the Namie 'difficult-to-return' exclusion zone (Ms Kanno's house), which was previously subject to extensive decontamination efforts, dose rates for 98% of the points measured exceed the annual maximum exposure level of 1 mSv per year. For 70% of the points measured, dose rates could lead to an exposure of 3-5 mSv/y based on the government calculation method.

The strontium-90 threat

Radioactive releases from the Fukushima Daiichi disaster and the contamination measured in 2020 are dominated by radio caesiums. However, other isotopes were released by the accident. This includes radioactive strontium-90 (Sr-90). Strontium 90 is a bone seeking radionuclide which if ingested concentrates in bones and bone marrow, increasing the risks of contracting cancer. Greenpeace sampling and analysis of cedar needles collected from forests in areas of Fukushima Prefecture confirmed the presence of Strontium 90. Rather than conducting the large-scale and expensive Sr-90 laboratory analysis needed for accurate measurement, the Japanese government has used calculations based on an anticipated constant ratio between radioactive caesium and strontium. Research published in 2015 warned that this is likely to result in error, and potentially underestimate the strontium risks. The Japanese government continues to largely ignore the potential hazards from strontium 90 and other radionuclides in Fukushima Prefecture.

The greatest threat from strontium-90 comes from the enormous amount at the Fukushima Daiichi site, and in particular the amount in the melted reactor fuel cores in reactor units 1-3. There are uniquely hazardous risks from current plans to decommission the Fukushima Daiichi reactors where this strontium and other radionuclides exist. A smaller but significant amount is also present in the 1.23 million tons of contaminated tank water stored at the site, and which the government is preparing to announce plans to discharge into the Pacific Ocean.[2]

Human rights violations

Evacuation orders have been lifted in areas where radiation still remains above safe limits, potentially exposing the population to increased cancer risk. This is a particular hazard for children and women. In 2020, further plans for the lifting of restrictions have emerged, including the opening up an area of Iitate that is currently part of the 'difficult-to-return' exclusion zone.

Up until 2018, 13 million man hours of work had been applied in decontamination of the SDA, the majority by subcontractors. As documented by Greenpeace,[3] some workers are at risk from exposure to radiation above safety limits, and coerced into accepting hazardous working conditions because of economic hardship. They have also received inadequate training and protection.

During the past decade, the violations have been challenged by multiple United Nations human rights bodies, as well as UN Human Rights Special

Rapporteurs, including Baskut Tuncak.[4] In his report to the UN General Assembly in 2018, Mr Tuncak stated that, "It is disappointing to see Japan appear to all but ignore the 2017 recommendation of the UN human rights monitoring mechanism (UPR) to return back to what it considered an acceptable dose of radiation before the nuclear disaster."[5] In his report, he urged the Japanese government to halt the ongoing relocation of evacuees, including children and women of reproductive age, to areas where radiation levels remain higher than that considered safe or healthy before the 2011 nuclear disaster. He also criticised the Japanese government's decision to raise by 20 times the level of radiation exposure it considered acceptable, stating that it, "was deeply troubling, highlighting in particular the potentially grave impact of excessive radiation on the health and wellbeing of children."[6]

Greenpeace recommendations to the Japanese Government and Fukushima Prefecture

- Suspend the current return policy, which ignores science-based analysis, including potential lifetime exposure risks to the population.
- Immediately clarify its long-term decontamination target of 0.23 μSv/h, equal to 1 mSv/y. Set a date for when 0.23 μSv/h is to be attained and halt any plans to revise the target level to a higher limit.
- Urgently assess the public health risks posed by radioactive hotspots, including the presence of caesium-rich micro particles.
- Abandon plans to lift evacuation orders in the six municipalities of Futaba, Okuma, Namie, Tomioka, Iitate and Katsurao, including the Namie districts of Tsushima, Murohara, Suenomori and Obori.
- In the interests of worker protection, suspend current decontamination programmes in the difficult-to-return zones.
- Establish a fully transparent process to consider and reflect residents' opinions on the evacuation policy and create a council of citizens that includes evacuees.
- Provide full compensation and financial support to evacuees and allow citizens to decide whether to return or relocate on the basis of scientific evidence and free from duress and financial coercion.
- Respond in full to the offer of dialogue and guidance from UN Special Rapporteurs, and accept outstanding requests for Special Rapporteurs to visit Japan.

Geiger counter displaying radiation levels of 7.66 micro Sievert per hour, Iitate, Fukushima prefecture. (March 27, 2011)
© Christian Åslund / Greenpeace

1 The reality of contamination in Fukushima

As a consequence of the triple reactor meltdowns at the Fukushima Daiichi nuclear plant in March 2011, several tens of thousands of square kilometres in Fukushima Prefecture and wider Japan were contaminated with significant amounts of radioactive caesium and other radionuclides.[7] The geography of Fukushima Prefecture ranges from coastal flood plain, including rice fields and other farmland, to mountainous forested upland, which comprises more than 70% of the land. The nuclear accident led the Japanese government to order evacuation of 11 municipalities, or districts, in the prefecture. On 26 August 2011, the government published its "Basic Policy on Decontamination" document, which was associated with the "Act on Special Measures Concerning Radioactive Material Contamination."[8] The stated aim of the decontamination programme was the reduction of radiation levels, which would then allow the lifting of evacuation orders affecting tens of thousands of citizens. On 29 August 2011, Greenpeace Japan submitted its recommendations to the Japanese government.[9] We contended that the decontamination plan did not provide sufficient protection for pregnant women and children, or the necessary support for all evacuees. Nor was the plan sufficiently robust to ensure that vulnerable sections of the population were protected at all points in their daily lives. Little has been done by the Japanese government over the intervening years to improve and protect the lives of the tens of thousands of evacuees who continue to be displaced from their homes.

The first Greenpeace radiation expert team arrived in Fukushima Prefecture on 26 March 2011. Over the last ten years, Greenpeace has conducted 32

investigations into the radiological consequences of the disaster, with radiation surveys ranging from days to several weeks. The latest survey, the results of which are detailed below along with earlier results, took place over two days in November 2020. The Covid-19 pandemic meant that the survey team was much smaller than usual, and that time in the field was limited.

In the early days of the March 2011 surveys, our priority was to understand the risks to the local population, and we therefore focused on radiation levels in areas of Fukushima Prefecture that were outside the 20km evacuation zone established by the Japanese government. Due to the radioactive fallout pattern, our particular concern was with the area north-west of the Fukushima Daiichi plant. Within the first hours of our radiation survey, the Greenpeace team found very high radioactivity levels (around 10 microsieverts (μSv) per hour at 1m height) in Iitate district, which was 40km from the damaged reactors. The next day, 27 March, Greenpeace officially called for its evacuation.[10] The International Atomic Energy Agency (IAEA) confirmed high levels of radiation a few days later.[11] The response at the time from the Japanese nuclear regulator, NISA, was that "the high radioactivity levels detected by the NGO (Greenpeace) around Iitate could not be considered reliable." However, following submission of the evidence from our survey to both the mayor of Iitate and the Japanese government, extension of the evacuation zone was proposed by the government on 11 April, and ordered on 22 April.[12] The villages of Iitate and Katsurao, the town of Namie and parts of the city of Minamisoma and the town of Kawamata were subject to the order.

2

The decontamination myth

Radioactive decontamination work in Iitate, Fukushima prefecture.
(July 15, 2015)
© Jeremy Sutton-Hibbert / Greenpeace

- Up to March 2019, the decontamination programme had cost 28 billion US dollars, employed 30 million workers and generated 17 million tons of nuclear waste.
- The Japanese government claims that decontamination has been completed in many areas. Yet analysis of its own data shows that approximately 15% of the land surface area of the municipalities that make up the Special Decontamination Area (SDA) have been decontaminated.
- The vast majority of the Fukushima SDA remains contaminated with radiocaesium.
- Mountainous, forested areas are acting as a long-term reservoir for radiocaesium and as a large source for future recontamination of the environment beyond the forest.

In 2012, the Japanese government launched a decontamination programme in Fukushima Prefecture (and elsewhere in Japan) that was unprecedented in its scale. Areas where the additional exposure dose per year exceeded 1 mSv/y were designated the Intensive Contamination Survey Area (ICSA). In these areas, municipalities take the initiative in decontamination work, and they have been subject to enormous decontamination efforts, in particular from 2012 to 2017. Areas where the additional exposure dose per year exceeded 20 mSv were designated Special Decontamination Areas (SDA), where the national government directly conducts decontamination work. They are located across 11 municipalities. Seven of these – Namie, Iitate, Tomioka, Okuma, Futaba, Katsurao and Naraha, lie entirely within the SDA.

The government established a long-term decontamination target level of 0.23 microsieverts per hour (0.23 μSv/h), on the basis that exposure at this level would give an annual dose of 1 millisieverts every year (1 mSv/y). The level was set on the assumption that a person in the region would spend an average of eight hours outdoors and 16 hours indoors each day throughout the year. However, this is an agricultural area where many inhabitants spend significantly more time outside, particularly in spring, summer and autumn.

Up to March 2019, the programme had cost 28 billion dollars, employed the equivalent of 30 million decontamination workers and generated 17 million tons of nuclear waste.[13] The government set out a target area for decontamination in each municipality. This was expressed as a percentage of the overall area. When it achieved its target, it reported 'complete' decontamination of the municipality in question. These reports were issued in the regular updates from the Ministry of Environment. In its July 2015 report, the Ministry stated that decontamination had been completed in 100% of the forested areas of Tamura, Kawauchi, Naraha and Okuma.[14] In its May 2016 report, it stated that in Iitate, 86% of forest had been decontaminated, and that it aimed to complete decontamination by March 2017.[15]

However, these percentages refer to the specific targeted land for decontamination, not the overall land in the municipality that is forest or farmland.

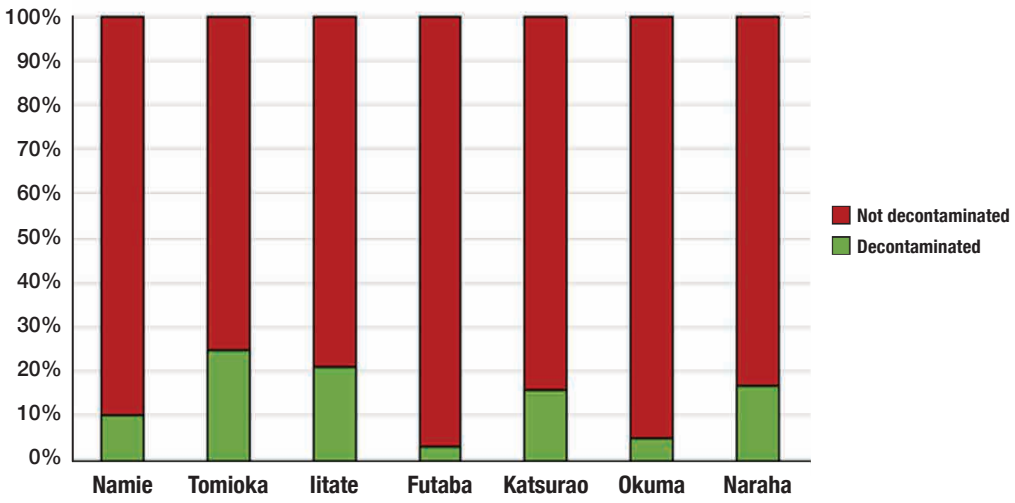
By March 2017, most of the planned decontamination programme had been completed inside the SDAs of Fukushima. Prior to the lifting of evacuation orders in Namie and Iitate, the government declared that decontamination of the district was finished and that it was safe for residents to return. The Ministry of Environment report states: "Whole area decontamination on the Act on Special Measures was completed on March 19, 2018 except in Difficult-to-Return Zones."[16] Japanese government documents give the very clear message that decontamination is comprehensive. This extract from 2018 highlights the approach: "Of the whole area decontamination stipulated in the decontamination implementation plans, regarding the decontamination under the direct jurisdiction of the national government in the SDAs, whole area decontamination was completed in Tamura City, Naraha Town, Kawauchi Village, and Okuma Town by March 2014, in Katsurao Village and Kawamata Town by December 2015, in Futaba Town by March 2016, in Iitate Village by December 2016, in Tomioka Town by January 2017, and in Namie Town and Minamisoma City by the end of March 2017, so it was completed in all 11 municipalities by the end of March 2017."

The reality is very different. Using the Ministry's own data for decontamination, it is possible to calculate how much of the seven municipalities that lie entirely inside the SDA have been decontaminated and the amount of their area that has not been decontaminated.[17]

Table 1 - Seven districts wholly inside the Fukushima Prefecture Special Decontamination Area - decontaminated and not contaminated as of September 2017[18]

Districts	Total area - (hectares)	Decontaminated – as of 30/09/2017 (hectares)	Not Decontaminated (hectares)	Percentage Decontaminated	Percentage Not Decontaminated	Evacuation Order Lifted
Namie	22,314	2,140	20,174	10	90	March 31 2017[19]
Tomioka	6,839	1,710	5,129	25	75	April 1 2017[20]
Iitate	23,013	4,830	18,183	21	79	March 31 2017[21]
Futaba	5,142	133	5,009	3	97	Partial lifting 3 March 2020
Katsurao	8,437	1,355	7,082	16	84	June 12 2016[22]
Okuma	7,871	401	7,470	5	95	Partial lifting 5 March 2020
Naraha	10,364	1,740	8,624	17	83	September 5 2015
Total	83,980	12,309	71,671	15	85	

Chart 1 – Percentage of land in SDA municipalities decontaminated and not decontaminated



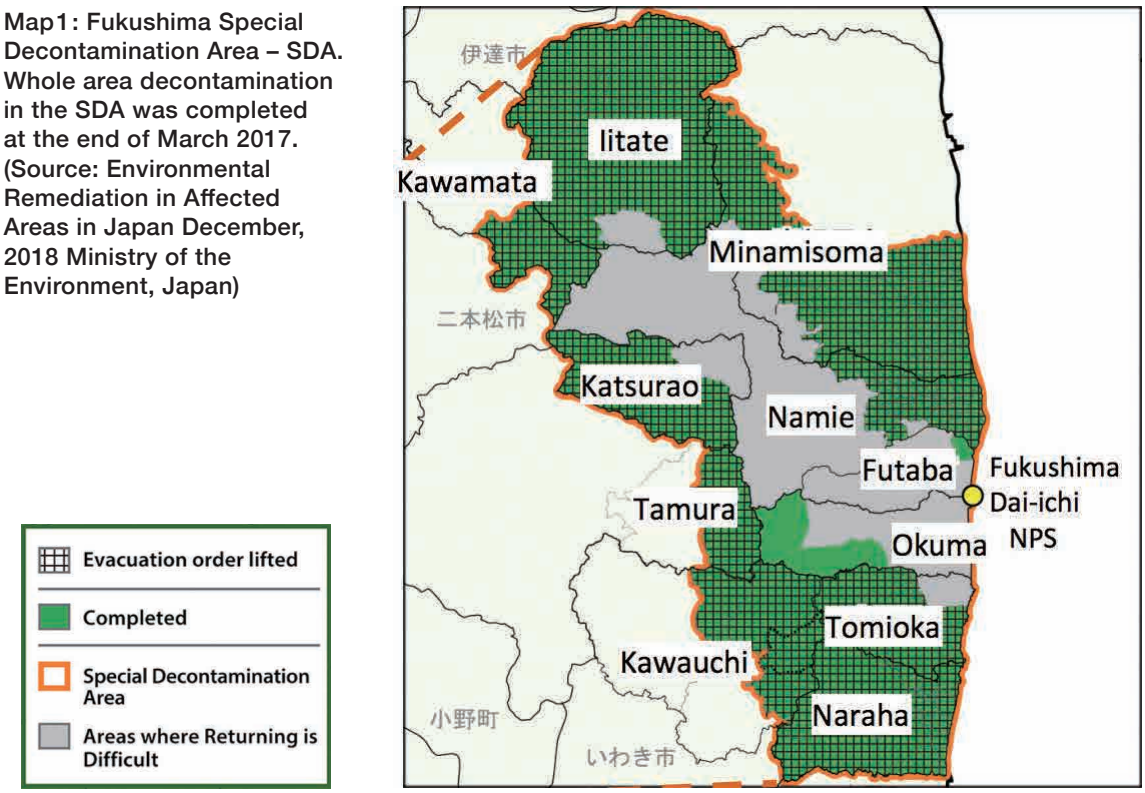
As Table 1 and Chart 1 show, the data contradicts the Japanese government's claim that the districts in the SDA have been decontaminated. It's clear that the vast majority have not. Out of a total area of 83,980 hectares (840km²), only 12,309 hectares (120km²) have been decontaminated. This equates to only 15% of the total area. In Namie, with a population of over 21,000 in 2011, only 10% of the district had been decontaminated by September 2017 – six months after the evacuation order had been lifted for the most densely populated area. At 21%, Iitate has the second highest percentage of decontaminated land. The above table does not include the land area at each house that has been decontaminated as the government does not provide any data on the land surface in hectares that this covers. Instead, it provides the total number of houses, which in the case of the seven municipalities within the SDA amounts to 16,937 as of September 2017. It's not possible to say with absolute certainty what this amounts to in terms of hectares but it is not significant in terms of the total land area of the SDA. In February 2021 Greenpeace requested details on the total hectarage of land for houses within the SDA but was informed by the Ministry of Environment that they do not have such data.

However, in the districts where Greenpeace

conducted survey work (Namie and Iitate), radiation remains at a level unsafe for human habitation. Our data shows that even where decontamination has been conducted, radiation levels remain above those seen pre-2011, and in many cases they are above the government's long-term target of 0.23 μSv/hour.

Forested areas – a source of recontamination

The fact that 85% of the contaminated surface area of the seven Fukushima districts inside the SDA has not been subject to decontamination is directly related to the radiological hazards posed by the mountainous forested areas. These remain a long-term source of contamination, including recontamination. As we stated in our 2016 report, Radiation Reloaded,[23] the radio-ecology, or behaviour of radioactivity, in the mountainous forested environment of Fukushima is highly complex. There is clear evidence that radioactivity on the forest floor remains high, but also that it is entering the soil, with most retained in the topsoil layer to a depth of 5cm. Radioactivity deposited on the forest in the days after the accident washed down to the forest floor as well as into small streams, with a portion washing downstream into rivers and lakes.[24] Over the longer term, radiocaesium in the surface organic layers on the forest floor has moved into the mineral soil, while some of the radiocaesium in organic and mineral soil layers is absorbed by plant roots and transferred into trunks, stems, and leaves above ground. The forests of Iitate, as elsewhere in Fukushima, are acting as a long-term reservoir for radiocaesium and as a large source for future recontamination of the environment beyond the forest. This contradicts the Japanese government's claims for its decontamination programme. As we have demonstrated, the Japanese government's claims regarding the completion of decontamination are misleading and very far from the truth.



Map1: Fukushima Special Decontamination Area – SDA. Whole area decontamination in the SDA was completed at the end of March 2017. (Source: Environmental Remediation in Affected Areas in Japan December, 2018 Ministry of the Environment, Japan)

3 Greenpeace surveys

Greenpeace survey team at Ms Kanno's house in Tsushima, Namie, Fukushima prefecture. (November 22, 2020) © Greenpeace

Over the past decade, Greenpeace radiation surveys have been conducted both inside the SDA difficult-to-return exclusion zones, as well as areas within the ICSA and SDA where evacuation orders have been lifted. Our objective has been to answer the following questions:

- **What have been the effects of decontamination on overall radiation levels in Fukushima?**
- **What are the radiation levels around people's homes, both in the ICSA and SDA areas?**
- **How does radiocaesium behave in the environment from one year to the next?**
- **Is there evidence of recontamination and what are the causes?**
- **How do radiation levels relate to public exposure and safety?**
- **What is the relationship between radiation, decontamination and human rights, including the rights of women, children and workers?**

Radiation survey methodology

As a result of the radioactive releases from the Fukushima Daiichi accident, radioactive caesium (Cs-137 and Cs-134) contributes almost all (98%) of the cumulative exposure. During the Fukushima nuclear disaster, equal amounts of Cs-137 and of Cs-134 were released. Due to the shorter half-life of Cs-134 (2 years) compared with Cs-137 (30 years), the predominant radionuclide present during recent years in Fukushima is Cs-137. Thus by 2013, as a result of the 2-year half-life, the amount of Cs-134 measured would be 50% of that measured in 2011. And consequently, the decline in overall caesium levels was relatively steep in the initial years. Without external factors, such as weathering and other natural systems, as well as human disturbance, the 30-year half-life of Cs-137 means that the Cs-137 levels in the environment should remain relatively constant with a slow decline over the decades.

The Greenpeace radiation team has used different methods for survey work over the years.

Systematic measurements were taken using the following methodology:

- Ambient dose rates were measured at one metre (m) height with a highly-efficient and calibrated NaI scintillator (Georadis RT30: 2000 cps/μSv.h-1 (Cs-137)) with one measurement each second.
- Measurements were taken by walking in a systematic way, where possible in a grid pattern, without searching for hotspots.
- Measurements were taken around individual houses, with the permission of the owners. The area around each house was divided into zones, generally between 5-10, with fewer zones when measuring along rivers or other property. The zones often comprise for example, fields, paths, and forested areas. Each zone was measured separately, with a minimum of 100 measurement points per zone and a median range of 200-300 points per zone. The total radiation measurement points for each house and land area typically ranged between 3,000 and 5,000 points.
- In line with scientific standards, average, minimum, and maximum measurements were taken for each zone. The average for all the zones of one house and land area was then calculated as a weighted average, with the same weight for each zone. This allows for comparison between different years, as the number of measurement points for each year varies. The maximum refers to a maximum measured single point within that zone.

In our report, when referring to potential annual human exposure, expressed in milisieverts per year (mSv/y), the estimated dose based on the Japanese government calculation is presented, which assumes that citizens spend an average of 8 hours per day outside and takes account of shielding from radiation while inside a wooden house. This is considered a likely underestimate due to many citizens in rural areas spending more than 8 hours per dayoutside. As in all previous reports on house surveys in Fukushima, a Greenpeace calculation of annual human dose rates has been included, based on radiation measurements taken at 1 meter, and represent an adult's exposure over one full year (a total of 8,760 hours) at that specific location.

4

Areas where evacuation orders have been lifted – Iitate and Namie

On 31 March 2017, the Japanese government lifted the evacuation orders for areas in Iitate Village and Namie Town, which lie north and north-west of the Fukushima Daiichi nuclear plant. This did not include the most contaminated areas in these districts, which are designated difficult-to-return areas.

Greenpeace conducted its first radiation surveys in the municipalities of Namie and Iitate in March 2011, and subsequent surveys in these areas and others during 2012-2020. Returning to Iitate in 2015, we began a series of systematic house surveys, revisiting the locations each year subsequently. In September 2017, Greenpeace extended its survey work to the central area of Namie Town, where the majority of the population formerly lived. Both in Iitate and in the area of Namie (where the evacuation order was lifted), radiation levels over the years remained significantly higher than the government's current long-term target level of 0.23 μSv/h.

This means that, in some cases, radiation exposure for people returning to Iitate and Namie will be well in excess of the recommended annual maximum of 1mSv. The Japanese government maintains that exposure up to 20 mSv/y is acceptable in the areas where evacuation orders have been lifted. This is despite clear scientific evidence of increased cancer risks from low dose radiation exposure in the 1-5 mSv/y range.[25]

Contaminated Streets in Namie Town (June 1, 2014)
© Robert Knoth / Greenpeace

5
Iitate district

Toru Anzai in his home town, Iitate, Fukushima prefecture. (November 21, 2020)
© Greenpeace

The administrative district of Iitate, also referred to as Iitate village, is located in the Hamadori region of Fukushima Prefecture and lies between 28km and 47km from the Fukushima Daiichi nuclear power plant.[26] Iitate was particularly affected by radioactive releases from the disaster on the nights of 15 and 16 March 2011 due to weather patterns that carried radioactivity north-west from the nuclear power plant.[27] According to the International Atomic Energy Agency (IAEA) Summary Fukushima Report, very high levels of radioactive caesium were deposited north-west of the reactor site, with densities between 1,000 kBq (kilobequerels) per m² and 10,000 kBq/m². The IAEA reports an average deposition density for caesium-137 throughout Fukushima Prefecture of 100 kBq/m².[28] These numbers far exceed the IAEA's benchmark of 40kBq/m² for contaminated land. Radioactive fallout from the Fukushima nuclear plant, particularly iodine-131 and 133 (I-131 and I-133) and caesium-134 and 137 (Cs-134 and Cs-137) were deposited on the forests, farmland and homes of Iitate. Of most concern as of today and into the future is radiocaesium, particularly Cs-137, which has a half-life of 30 years. This means that it will remain a hazard for around ten half-lives – or 300 years.[29] In addition to radiocaesium, other radionuclides of concern to public health were deposited here. Sample testing of black dust collected from roadsides and soil samples throughout Fukushima prefecture, including in Iitate, showed transuranic contaminants (radioactive elements with atomic numbers greater than that of uranium[30]) sharing the same profile as the fuel core.[31]

Population impact

Out of a population of 6,509 on 11 March 2011, over 1,000 residents were still living in Iitate two months after the evacuation order in June 2011 and despite high radiation levels. Citizens in Iitate were as a result and they were the most exposed to radiation of any population in Japan.[32] Along with other areas of Fukushima prefecture, Iitate was designated for radioactive decontamination in 2012.[33]

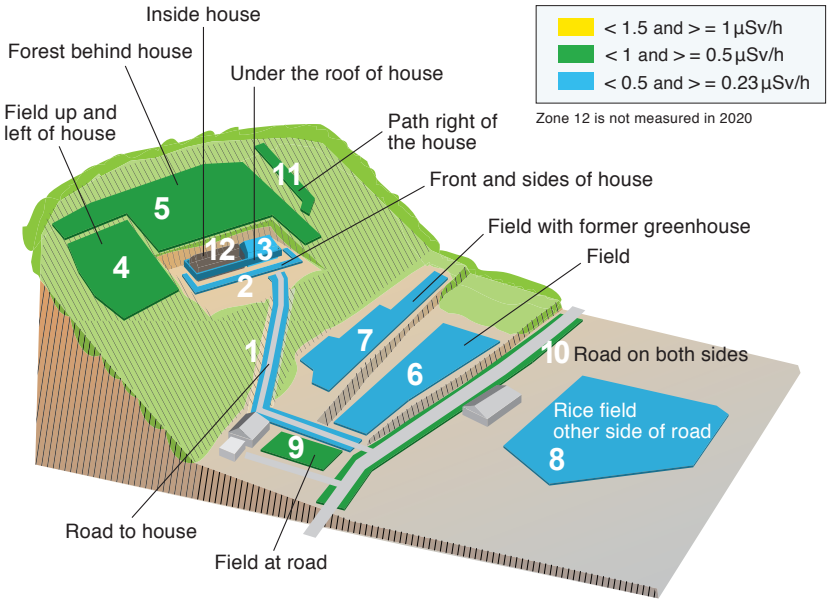
On 31 March 2017, the evacuation order for most of Iitate was lifted and by 1 December 2020, 1,255 had returned – 19% of the population in March 2011.[34] Thousands of citizens are still displaced from their former homes.[35] The government of Shinzo Abe, elected in December 2012, was particularly determined to coerce the people of the district. It is well outside the 20km radius of the Fukushima Daiichi plant, and the radioactive contamination present in Iitate is a constant reminder to the people of Japan that the impacts of a severe nuclear accident cannot be limited to a small area around reactor sites.

Investigations at the home of Mr Toru Anzai

Since 2011, Greenpeace has conducted 10 radiation surveys in Iitate district, and from July 2015 we have focused particularly on investigations at the homes of citizens, one of which is the home of Toru Anzai.

It is located in the south-east of Iitate, 35 km from the nuclear power plant. Mr Anzai was evacuated from his home on 24 June 2011, and his house and the surrounding area were subjected to extensive decontamination by the authorities during 2014 and 2015. This involved scraping away a layer of more than 5cm of topsoil, which was then removed from the site and stored as radioactive waste. In some cases, the surface was covered with uncontaminated soil. The main structure of Mr Anzai's house was demolished in 2018. The survey results from the house between 2015 and 2020 are shown in Table 2 and Chart 2.

Diagram1: Schematic of Mr. Anzai's house in Iitate, showing the designated Zones for the Greenpeace radiation survey team.



When the Greenpeace team first accurately mapped the radiation levels in the area of Mr Anzai's house in October 2015, official decontamination work was still in progress. The 2016 survey found a significant decrease in radiation levels, which we concluded was a combined effect of further decontamination, decay and erosion.

In October 2019, we found a 29% decline from 2018 in the overall average radiation level for all zones measured (0.7 μSv/h to 0.5 μSv/h) and this remained stable at 0.5 μSv/h in 2020. However, the average measurement of 11 zones still exceeded the government target of 0.23 μSv/h.

Table 2 - Mr Anzai's house, Iitate: dose rates in all zones 2015 – 2020
(Measurements taken walking on- and off-road, height: 1m)

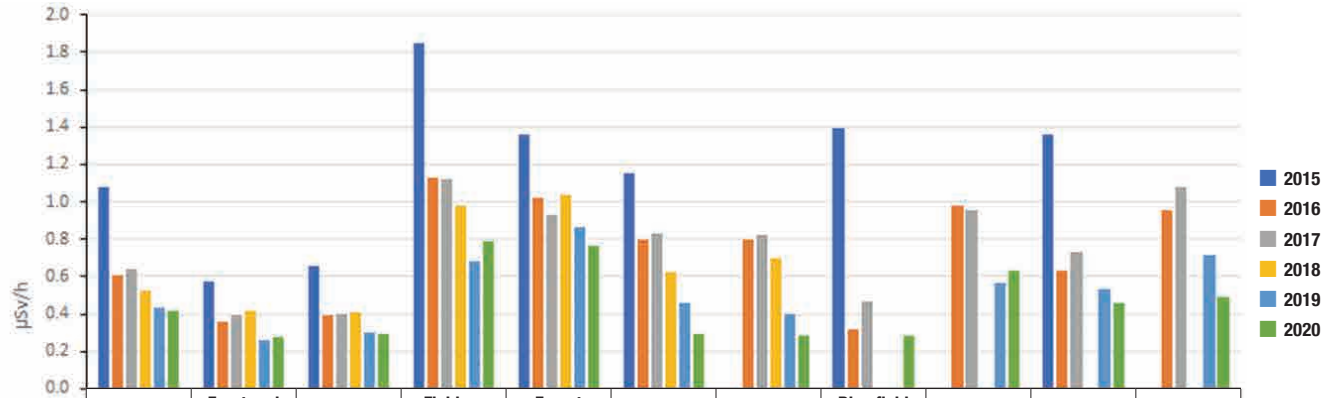
Zone name		Max (μSv/h)						Average (μSv/h)						Average % of previous year					
		2020	2019	2018	2017	2016	2015	2020	2019	2018	2017	2016	2015	2020	2019	2018	2017	2016	2015
Zone-01	Path to house	0.7	0.6	1.0	0.9	0.8	1.4	0.4	0.4	0.5	0.6	0.6	1.1	96%	83%	82%	105%	56%	n/a
Zone-02	Front and sides of house	0.6	0.5	0.9	0.8	0.7	1.3	0.3	0.3	0.4	0.4	0.4	0.6	108%	62%	107%	108%	63%	n/a
Zone-03	Under roof of house	0.5	0.5	0.9	0.6	0.7	1.2	0.3	0.3	0.4	0.4	0.4	0.7	98%	73%	103%	101%	60%	n/a
Zone-04	Field up and left of house	1.2	1.0	1.3	1.4	1.5	2.3	0.8	0.7	1.0	1.1	1.1	1.9	115%	70%	87%	99%	61%	n/a
Zone-05	Forest behind house	1.4	1.3	1.7	1.6	1.5	2.2	0.8	0.9	1.0	0.9	1.0	1.4	88%	84%	111%	92%	75%	n/a
Zone-06	Field low	0.6	0.7	1.1	1.1	1.1	2.0	0.3	0.5	0.6	0.8	0.8	1.2	64%	73%	75%	105%	69%	n/a
Zone-07	Field high	0.7	0.7	1.4	1.4	1.6	n/a	0.3	0.4	0.7	0.8	0.8	n/a	70%	57%	85%	103%	n/a	n/a
Zone-08	Rice field other side of road	0.8	n/a	n/a	1.2	0.6	1.7	0.3	n/a	n/a	0.5	0.3	1.4	n/a	n/a	n/a	145%	23%	n/a
Zone-09	Field near road	1.5	1.0	n/a	2.0	1.5	n/a	0.6	0.6	n/a	1.0	1.0	n/a	111%	n/a	n/a	98%	n/a	n/a
Zone-10	Road on both sides	1.1	1.1	n/a	1.4	1.0	2.6	0.5	0.5	n/a	0.7	0.6	1.4	86%	n/a	n/a	116%	47%	n/a
Zone-11	Path right of house	1.1	1.0	n/a	1.6	1.5	n/a	0.5	0.7	n/a	1.1	1.0	n/a	69%	n/a	n/a	113%	n/a	n/a
Zone-12	Inside house	n/a	n/a	n/a	0.7	n/a	0.9	n/a	n/a	n/a	0.3	n/a	0.5	n/a	n/a	n/a	n/a	n/a	n/a
ALL	**Summary***	**1.5**	**1.3**	**1.7**	**2.0**	**1.6**	**2.6**	**0.5**	**0.5**	**0.7**	**0.7**	**0.7**	**1.1**	**91%**	**72%**	**93%**	**108%**	**57%**	**n/a**

Zone name		Number of points						Above 0.23 μSv/h						Above 1 μSv/h					
		2020	2019	2018	2017	2016	2015	2020	2019	2018	2017	2016	2015	2020	2019	2018	2017	2016	2015
Zone-01	Path to house	324	184	447	255	264	481	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%	0%	78%
Zone-02	Front and sides of house	439	241	464	372	301	234	70%	70%	98%	98%	87%	100%	0%	0%	0%	0%	0%	4%
Zone-03	Under roof of house	121	170	630	186	169	573	87%	76%	99%	98%	98%	100%	0%	0%	0%	0%	0%	11%
Zone-04	Field up and left of house	633	405	542	365	283	524	100%	100%	100%	100%	100%	100%	3%	0%	62%	88%	88%	100%
Zone-05	Forest behind house	1256	732	952	644	358	814	100%	100%	100%	100%	100%	100%	23%	21%	65%	48%	53%	71%
Zone-06	Field low	833	285	1018	370	327	1126	65%	100%	100%	100%	100%	100%	0%	0%	1%	8%	2%	73%
Zone-07	Field high	825	515	695	607	578	n/a	61%	93%	100%	100%	100%	n/a	0%	0%	10%	16%	18%	n/a
Zone-08	Rice field other side of road	791	n/a	n/a	510	239	332	72%	n/a	n/a	100%	98%	100%	0%	n/a	n/a	3%	0%	100%
Zone-09	Field near road	454	178	n/a	183	103	n/a	100%	100%	n/a	100%	100%	n/a	1%	0%	n/a	22%	30%	n/a
Zone-10	Road on both sides	339	694	n/a	857	194	592	100%	100%	n/a	100%	100%	100%	1%	0%	n/a	4%	1%	95%
Zone-11	Path right of house	674	247	n/a	339	292	n/a	96%	100%	n/a	100%	100%	n/a	1%	0%	n/a	65%	42%	n/a
Zone-12	Inside house	n/a	n/a	n/a	217	n/a	817	n/a	n/a	n/a	100%	n/a	100%	n/a	n/a	n/a	0%	n/a	0%
ALL	**Summary***	**6689**	**3651**	**4748**	**4905**	**3108**	**5493**	**86%**	**94%**	**100%**	**100%**	**98%**	**100%**	**3%**	**2%**	**20%**	**21%**	**21%**	**59%**

Maximum levels measured also showed a decline between 2018 and 2019 (1.7 μSv/h to 1.3 μSv/h, or 24%). However, in 2020 the maximum level measured increased to 1.5 μSv/h.

After the completion of decontamination in 2015, radiation levels at Mr Anzai's property mostly remained stable in 2016-2018, but with some indications of recontamination. The significant decline in radiation levels measured in 2019 cannot be explained by radioactive decay alone and was perhaps due to the heavy rainfall resulting from Typhoon Hagibis, which struck Japan in October 2019. One of our principal objectives in 2020 was to return to Mr Anzai's land and to investigate further the impact of heavy rainfall on radiocaesium in the forested mountains.

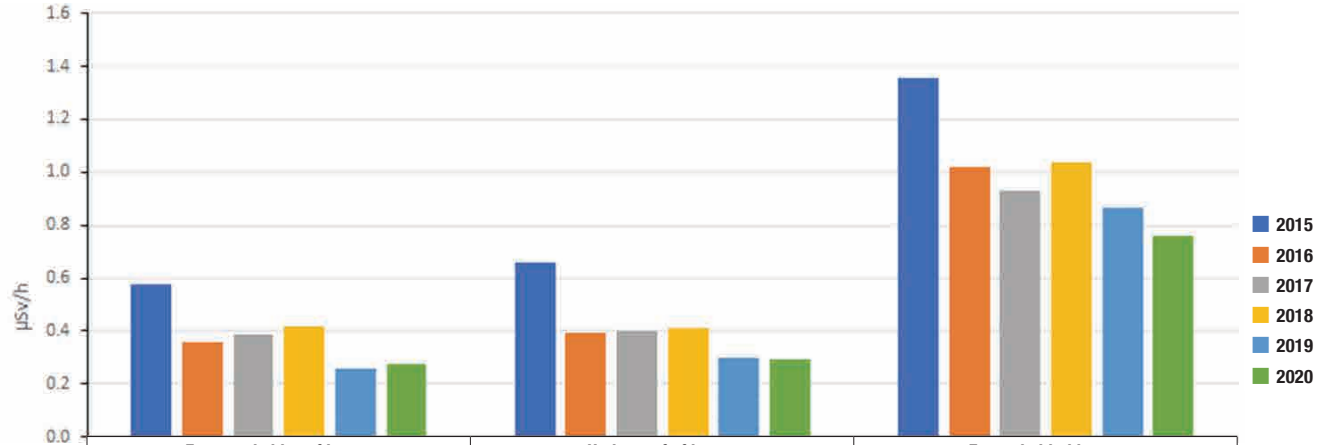
Chart 2 - Mr Anzai's house: Radiation survey, Zones 1-11, 2015-2020



	Path to house Zone-01	Front and sides of house Zone-02	Under roof of house Zone-03	Field up and left of house Zone-04	Forest behind house Zone-05	Field low Zone-06	Field high Zone-07	Rice field other side of road Zone-08	Field near road Zone-09	Road on both sides Zone-10	Path right of house Zone-11
2015	1.1	0.6	0.7	1.9	1.4	1.2		1.4		1.4	
2016	0.6	0.4	0.4	1.1	1.0	0.8	0.8	0.3	1.0	0.6	1.0
2017	0.6	0.4	0.4	1.1	0.9	0.8	0.8	0.5	1.0	0.7	1.1
2018	0.5	0.4	0.4	1.0	1.0	0.6	0.7				
2019	0.4	0.3	0.3	0.7	0.9	0.5	0.4		0.6	0.5	0.7
2020	0.4	0.3	0.3	0.8	0.8	0.3	0.3	0.3	0.6	0.5	0.5

In earlier years, the survey showed that decontamination efforts had been much less effective in the forested area in Zone 5 of Mr Anzai's property. As is standard government practice, an area up to 20 metres from Mr. Anzai's house into the forest has been 'decontaminated'. In November 2020, radiation levels in Zone 5 were still an average of 0.8 µSv/h and a maximum of 1.4 µSv/h. The radiation levels on the steep slopes close to houses are crucial as they have a direct impact on the levels inside the houses. We can also expect that radioactivity from the non-decontaminated forest might recontaminate the already decontaminated area below and closer to houses. Many houses in Iitate also located close to hillside forests where decontamination is not possible, were similarly affected.

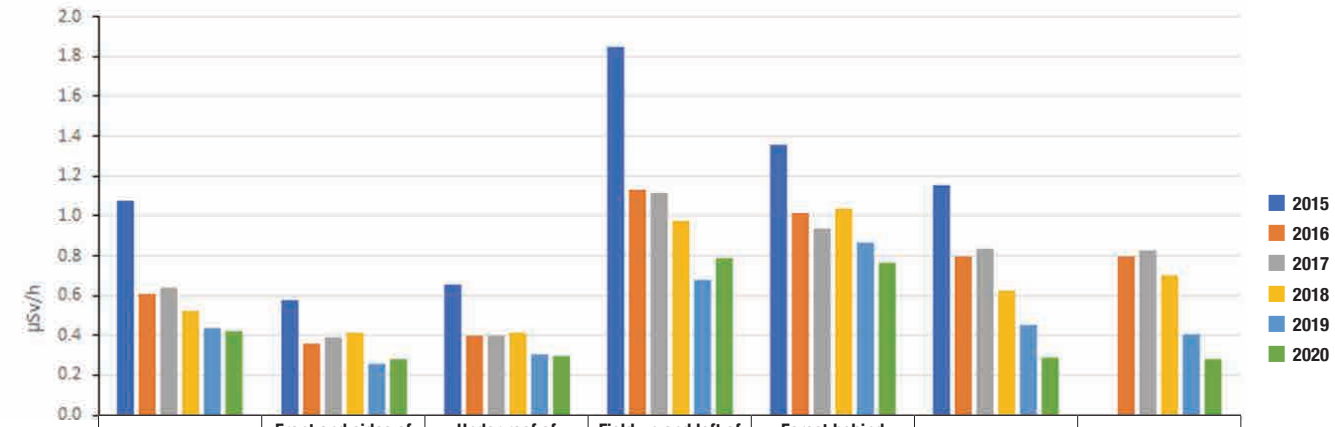
Chart 3 - Mr Anzai's house: Radiation survey, Zones 2, 3 and 5, 2015-2020



	Front and sides of house Zone-02	Under roof of house Zone-03	Forest behind house Zone-05
2015	0.6	0.7	1.4
2016	0.4	0.4	1.0
2017	0.4	0.4	0.9
2018	0.4	0.4	1.0
2019	0.3	0.3	0.9
2020	0.3	0.3	0.8

The data (see Chart 3) from Zones 2 and 3 show that the average radiation levels have remained the same between 2019 and 2020, whereas there has been a decline in the steeply sloping, forested area of Zone 5. It's possible that the radiation levels in these lower zones are maintained through migration from the forested slopes, which continue to leach radiation. Zone 5, where decontamination was more limited, remained the zone with the highest average levels, along with Zone 4, in all previous years.

Chart 4 - Mr Anzai's house: Radiation Survey, Zones 1-7, 2015-2020



	Path to house Zone-01	Front and sides of house Zone-02	Under roof of house Zone-03	Field up and left of house Zone-04	Forest behind house Zone-05	Field low Zone-06	Field high Zone-07
2015	1.1	0.6	0.7	1.9	1.4	1.2	
2016	0.6	0.4	0.4	1.1	1.0	0.8	0.8
2017	0.6	0.4	0.4	1.1	0.9	0.8	0.8
2018	0.5	0.4	0.4	1.0	1.0	0.6	0.7
2019	0.4	0.3	0.3	0.7	0.9	0.5	0.4
2020	0.4	0.3	0.3	0.8	0.8	0.3	0.3

The decline in radiation levels measured between 2018 and 2019 in all zones is likely to be due to weathering effects due to typhoon Hagabis passing shortly before the 2019 survey. In Zone 5, there was a significant reduction of measurement points exceeding 1 µSv/h between 2018 and 2019. In terms of percentages, there was a decline from 65% of all points in 2018 exceeding 1 µSv/h to 21% in 2019. The most noticeable decline in levels between 2018 and 2019 was in Zones 2, 4 and 7.

Radiation levels rose again in 2020 in Zone 4. In November 2020, we measured a 15% increase in average levels in Zone 4 with a decrease of 30% in Zone 7 (Table 2). The most noticeable decline in levels between 2018 and 2019 was in Zones 4 and 7. Radiation levels rose again in 2020 in Zone 4. There is no conclusive evidence that the observations can be explained by weathering effects. The observations highlight the complexity of the radioactive environment in Fukushima.

Table 3 - Mr Anzai's house: Radiation measurements all zones , November 2020
(Measurements taken walking on- and off-road, height: 1m)

Intervals	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
>= 5µSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8µSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2µSv/h	0	0%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5µSv/h	1	0%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1µSv/h	323	5%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5µSv/h	2,467	37%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23µSv/h	2,882	43%	>= 1 mSv/y	>= 2 mSv/y
< 0.23µSv/h	1,016	15%	< 1 mSv/y	< 2 mSv/y
Total number of points	**6,689**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

µSv/h	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
no. points <0.23	1,016	15%	< 1 mSv/y	< 2 mSv/y
no. points >=0.23	5,673	85%	>= 1 mSv/y	>= 2 mSv/y
no. points >=0.5	2,791	42%	>= 3 mSv/y	>= 4 mSv/y
no. points >=1	324	5%	>= 5 mSv/y	>= 8 mSv/y
no. points >=1.5	1	0%	>= 8 mSv/y	>= 13 mSv/y
no. points >=2	0	0%	>= 10 mSv/y	>= 17 mSv/y
no. points >=3.8	0	0%	>= 20 mSv/y	>= 33 mSv/y
no. points >=5	0	0%	>= 26 mSv/y	>= 43 mSv/y
Total number of points	**6,689**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

In 2020, five of the zones at Mr Anzai's home all exceeded the Japanese government's long-term decontamination target of 0.23 µSv/h. Across all measured points (Table 3), 85% of points exceeded the 1 mSv/y dose rate according to Japanese government calculation methods and 2 mSv/y based on sustained exposure over one full year.[36] Decontamination of Mr Anzai's land was completed in 2015, and yet nearly six years later radiation levels remain well in excess of the Japanese government's decontamination targets of 0.23 µSv/h. For 42% of the area at Mr. Anzai's land, dose rates would be in excess of 3 mSv/y based on Japanese government methodology, and 4 mSv/y based on sustained exposure over one full year. As measured in 2020, in 5% of the area around Mr Anzai's property radiation exposure would be in excess of 5 mSv/y based on Japanese government methodology, and 8 mSv/y based on sustained exposure over one full year.

Ten years after being forced from his home, Mr Toru Anzai remains an evacuee from his ancestral land in Iitate. In 85% of the land measured around Mr Anzai's former home, radiation levels continue to exceed the International Commission on Radiological Protection (ICRP) maximum recommended dose rate of 1 mSv a year for the public.[37]

6
Namie town and district

Takase river in Namie, Fukushima prefecture. (October 29, 2019)
© Christian Åslund / Greenpeace

The municipality of Namie lies 5-30 km north-northwest of the nuclear plant. In 2011 it had a population of 21,434.[38] A decontamination programme was run in the district from 2014 up to the lifting of evacuation orders in March 2017. However, in areas surveyed by Greenpeace since 2017, this decontamination has clearly failed to reduce radiation levels to the government's current long-term target of 0.23 μSv/h. An area of Namie is designated a "Difficult to Return" exclusion zone and remains closed to human settlement. As with the other such zones, a limited decontamination programme remains underway as of March 2021.

Namie kindergarten and school

Greenpeace Japan has conducted a radiation survey at a kindergarten and school in the open area of Namie every year since 2017, most recently in November 2020. In particular, we have investigated radiation levels in a small, forested area adjacent to the school. While it's unlikely that these schools will ever open again, they remain accessible to people living in Namie town.

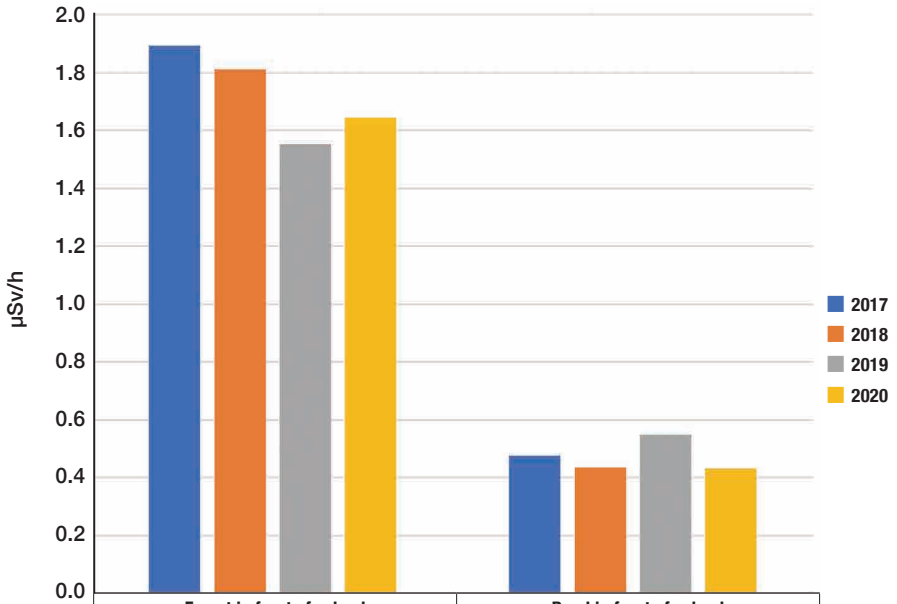
Table 4 - Kindergarten and school in open area of Namie: dose rates in all zones, 2017-2020
(Measurements taken walking on- and off-road, height: 1m)

Zone name		Max (µSv/h)				Average (µSv/h)				Average % of previous year			
		2020	2019	2018	2017	2020	2019	2018	2017	2020	2019	2018	2017
Zone-01	Forest in front of school	2.8	2.3	2.9	3.1	1.6	1.6	1.8	1.9	106%	86%	96%	n/a
Zone-02	Road in front of school	1.0	1.5	0.8	1.1	0.4	0.5	0.4	0.5	79%	126%	91%	n/a
ALL	**Summary***	**2.8**	**2.3**	**2.9**	**3.1**	**1.0**	**1.1**	**1.1**	**1.2**	**92%**	**106%**	**93%**	**n/a**

Zone name		Number of points				Above 0.23 µSv/h				Above 1 µSv/h			
		2020	2019	2018	2017	2020	2019	2018	2017	2020	2019	2018	2017
Zone-01	Forest in front of school	822	2280	1584	822	100%	100%	100%	100%	88%	97%	99%	90%
Zone-02	Road in front of school	858	1468	698	674	93%	98%	98%	100%	0%	5%	0%	1%
ALL	**Summary***	**1680**	**3748**	**2282**	**1496**	**97%**	**99%**	**99%**	**100%**	**44%**	**51%**	**50%**	**45%**

As Table 4 and Chart 5 show, radiation levels have remained relatively stable over the four years. This suggests they are likely to remain fairly constant in the future, with reductions reflecting the radioactive decay of Cs-137.

Chart 5 - Kindergarten and school in open area of Namie: Radiation survey, 2017-2020



	Forest in front of school Zone-01	Road in front of school Zone-02
2017	1.9	0.5
2018	1.8	0.4
2019	1.6	0.5
2020	1.6	0.4

In Zone 1, all of the 822 points measured in 2020 in the forested area remained above the 0.23 µSv/h target set by the Japanese government, and 88% measured above 1 µSv/h. In Zone 2, three years after decontamination was completed and evacuation orders were lifted in 2017, 93% of all data points measured in the area directly outside the kindergarten and school, remain above the 0.23 µSv/h target. There has been fluctuation in radiation levels in both zones, with a decline observed in Zone 1 and an increase in Zone 2 in 2019 (compared to 2017 and 2018). This could be a result of radioactivity being washed down from the forest onto the road by typhoon Hagidis, which took place days before the survey. Given that Zone 2 consists largely of hard road and pavement surface, the decrease in radioactivity on the road in front of the school, measured in 2020, can be explained by

radioactivity being washed off of hard surfaces over the course of time. An increase in radioactivity observed in the forest area in 2020, could be caused by the resuspension of radioactivity from higher up the sloping hillside or through other routes of migration of radioactive materials.[39]

It is clear that both average and maximum radiation levels in both zones remain much too high for an area declared open for human settlement, let alone a place where children are likely to gather.

Table 5 - Forested area adjacent to kindergarten and school, Namie: Radiation, Zone 1, November 2020 (Measurements taken walking on- and off-road, height: 1m)

Intervals	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
>= 5μSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8μSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2μSv/h	238	29%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5μSv/h	271	33%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1μSv/h	217	26%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5μSv/h	94	11%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23μSv/h	2	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23μSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**822**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

μSv/h	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
no. points <0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >=0.23	822	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >=0.5	820	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >=1	726	88%	>= 5 mSv/y	>= 8 mSv/y
no. points >=1.5	509	62%	>= 8 mSv/y	>= 13 mSv/y
no. points >=2	238	29%	>= 10 mSv/y	>= 17 mSv/y
no. points >=3.8	0	0%	>= 20 mSv/y	>= 33 mSv/y
no. points >=5	0	0%	>= 26 mSv/y	>= 43 mSv/y
Total number of points	**822**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

In 33% of the forested area adjacent to the school (Zone 1), the annual dose would be 8-10 mSv according to the government's method of calculation and 13-17 mSv based on sustained exposure over a full year. For 29% of the area, these figures would be 10-20 mSv/y and 17-33 mSv/y respectively. Of the 822 data points for Zone 1, no point measured below a level that would give a dose of 1 mSv/y.

Takase river

The Takase river, which flows through Namie district, divides the publicly open area and the 'difficult-to-return' area that remains an exclusion zone. In an area where the evacuation order was lifted in March 2017, the Greenpeace experts took measurements near the hamlet of Tawatsuda in 2018, 2019 and 2020. As with all the rivers of Fukushima, the Takase river experienced major flooding in October 2019, less than a week before the Greenpeace survey. This led to a large flux of radioactivity moving through the waters of the prefecture. It is worth noting that the Takase river passes through Obori Village, which lies directly upstream from the surveyed area and is one of the most contaminated areas in the Namie exclusion zone.

As Table 6 shows, radiation levels in this area are consistently above the Japanese government's 0.23 µSv/h long-term target. After 2018, it was not possible to accurately measure Zone 2 due to deforestation and reconstruction work being underway. Instead, we measured along a slope by the bank of the river in 2019 and 2020.

Table 6 - Takase river in open area of Namie: dose rates in all zones, 2018-2020
(Measurements taken walking on- and off-road, height: 1m)

Zone name		Max (µSv/h)			Average (µSv/h)			Average % of previous year		
		2020	2019	2018	2020	2019	2018	2020	2019	2018
Zone-01	Path along river	1.5	3.0	1.5	0.6	1.1	0.7	60%	144%	n/a
Zone-02	Forest along river	n/a	n/a	4.8	n/a	n/a	1.9	n/a	n/a	n/a
Zone-03	Bank along river	2.0	1.7	n/a	1.0	1.0	n/a	106%	n/a	n/a
ALL	**Summary***	**2.0**	**3.0**	**4.8**	**0.8**	**1.0**	**1.3**	**83%**	**144%**	**n/a**

Zone name		Number of points			Above 0.23 µSv/h			Above 1 µSv/h		
		2020	2019	2018	2020	2019	2018	2020	2019	2018
Zone-01	Path along river	1803	382	1354	97%	100%	100%	4%	54%	15%
Zone-02	Forest along river	n/a	n/a	2016	n/a	n/a	98%	n/a	n/a	59%
Zone-03	Bank along river	1334	3348	n/a	100%	100%	n/a	53%	47%	n/a
ALL	**Summary***	**3137**	**3730**	**3370**	**98%**	**100%**	**99%**	**29%**	**51%**	**37%**

In Zone 1 of the Takase river survey (the path along the river), average radiation levels were higher in 2019 (1.1 µSv/h) compared to 2020 (0.6 µSv/h) and 2018 (0.7 µSv/h). This could be caused by flooding due to the typhoon. The maximum measurement of 3 µSv/h in 2019 and the return to 1.5 µSv/h in 2020 is further indication of such external influence.

Table 7 - Takase river, Namie: Radiation on path along river, Zone 1, November 2020
(Measurements taken walking on- and off-road, height: 1m)

Intervals	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
>= 5µSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8µSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2µSv/h	0	0%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5µSv/h	0	0%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1µSv/h	78	4%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5µSv/h	1,257	70%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23µSv/h	407	23%	>= 1 mSv/y	>= 2 mSv/y
< 0.23µSv/h	61	3%	< 1 mSv/y	< 2 mSv/y
Total number of points	**1,803**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

µSv/h	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
no. points <0.23	61	3%	< 1 mSv/y	< 2 mSv/y
no. points >=0.23	1,742	97%	>= 1 mSv/y	>= 2 mSv/y
no. points >=0.5	1,335	74%	>= 3 mSv/y	>= 4 mSv/y
no. points >=1	78	4%	>= 5 mSv/y	>= 8 mSv/y
no. points >=1.5	0	0%	>= 8 mSv/y	>= 13 mSv/y
no. points >=2	0	0%	>= 10 mSv/y	>= 17 mSv/y
no. points >=3.8	0	0%	>= 20 mSv/y	>= 33 mSv/y
no. points >=5	0	0%	>= 26 mSv/y	>= 43 mSv/y
Total number of points	**1,803**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

In 70% of the area measured in Zone 1, radiation levels would give an annual dose of 3-5 mSv/year based on Japanese government calculation methods and 4-8 mSv based on full exposure over one year.

Greenpeace survey team, Takase river in Namie, Fukushima prefecture. (November 21, 2020) © Greenpeace

Along the riverbank in Zone 3, where we measured 1,334 data points in 2020, levels averaged 1 µSv/h, the same as in 2019, with a maximum of 2 µSv/h, up from 1.7 µSv/h in 2019. All average measurements exceeded the government's long-term decontamination target and average radiation levels are 20 times higher than the pre-2011 background level of 0.04 µSv/h.

Table 8 – Takase river, Namie: Radiation along river bank, Zone 3, November 2020 (Measurements taken walking on- and off-road, height: 1m)

Intervals	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
>= 5µSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8µSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2µSv/h	0	0%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5µSv/h	45	3%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1µSv/h	664	50%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5µSv/h	625	47%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23µSv/h	0	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23µSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**1,334**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

µSv/h	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
no. points <0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >=0.23	1,334	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >=0.5	1,334	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >=1	709	53%	>= 5 mSv/y	>= 8 mSv/y
no. points >=1.5	45	3%	>= 8 mSv/y	>= 13 mSv/y
no. points >=2	0	0%	>= 10 mSv/y	>= 17 mSv/y
no. points >=3.8	0	0%	>= 20 mSv/y	>= 33 mSv/y
no. points >=5	0	0%	>= 26 mSv/y	>= 43 mSv/y
Total number of points	**1,334**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

The 2020 survey shows that in 50% of the area along the Takase riverbank slope in the publicly accessible area of Namie Town, radiation levels would give an annual radiation dose of 5-8 mSv/year based on government calculation methods and 8-13 mSv based on full exposure over one year.

7 Namie 'difficult-to-return' exclusion zone

The house of Ms Kanno in Tsushima, Namie, Fukushima prefecture. (November 22, 2020)
© Greenpeace

Investigations at the house of Ms Kanno

The home of Ms Kanno is located in Shimo-Tsushima in the district of Namie, 30 km west-north-west of the nuclear plant. It was subjected to significant radioactive contamination resulting from the March 2011 accident and remains inside the Namie 'difficult-to-return' exclusion zone. The house is surrounded on three sides by forest, which has grown extensively since 2011. The Japanese government selected Ms Kanno's house to demonstrate its decontamination techniques and her home was the focus of considerable efforts during December 2011 and February 2012.

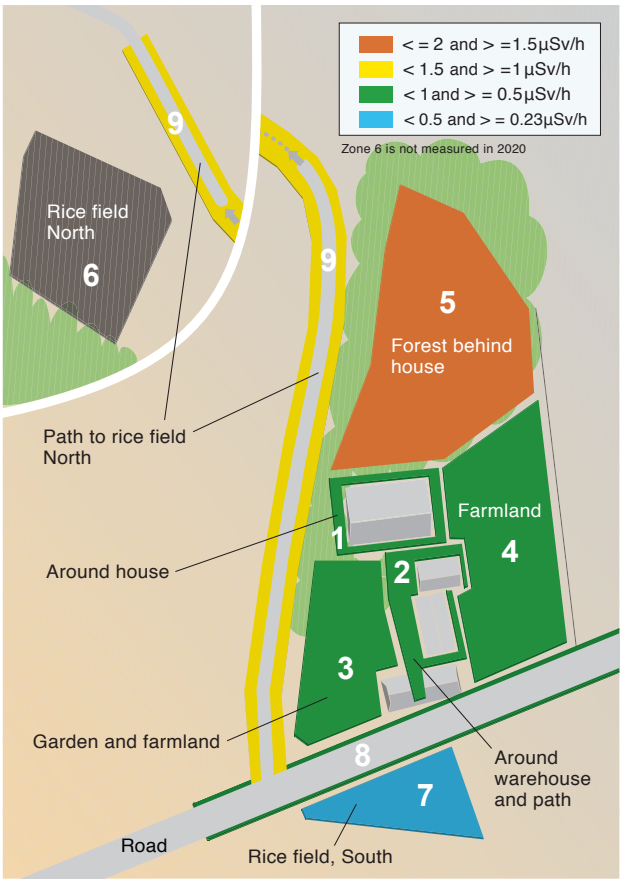


Diagram 2: Schematic of Ms Kanno's house in Shimo-Tsushima, Namie exclusion zone, Fukushima Prefecture, showing the designated Zones for the Greenpeace radiation survey team.

Greenpeace conducted its first radiation survey at the home in September 2017, with follow-up surveys in October 2018, October 2019 and November 2020. In each of the surveys, we focused on the immediate area around the house, as well as on the family's farmland and forest.

Table 9 – Ms Kanno's house: Dose rates in all zones, 2017-2020
(Measurements taken walking on- and off-road, height: 1m)

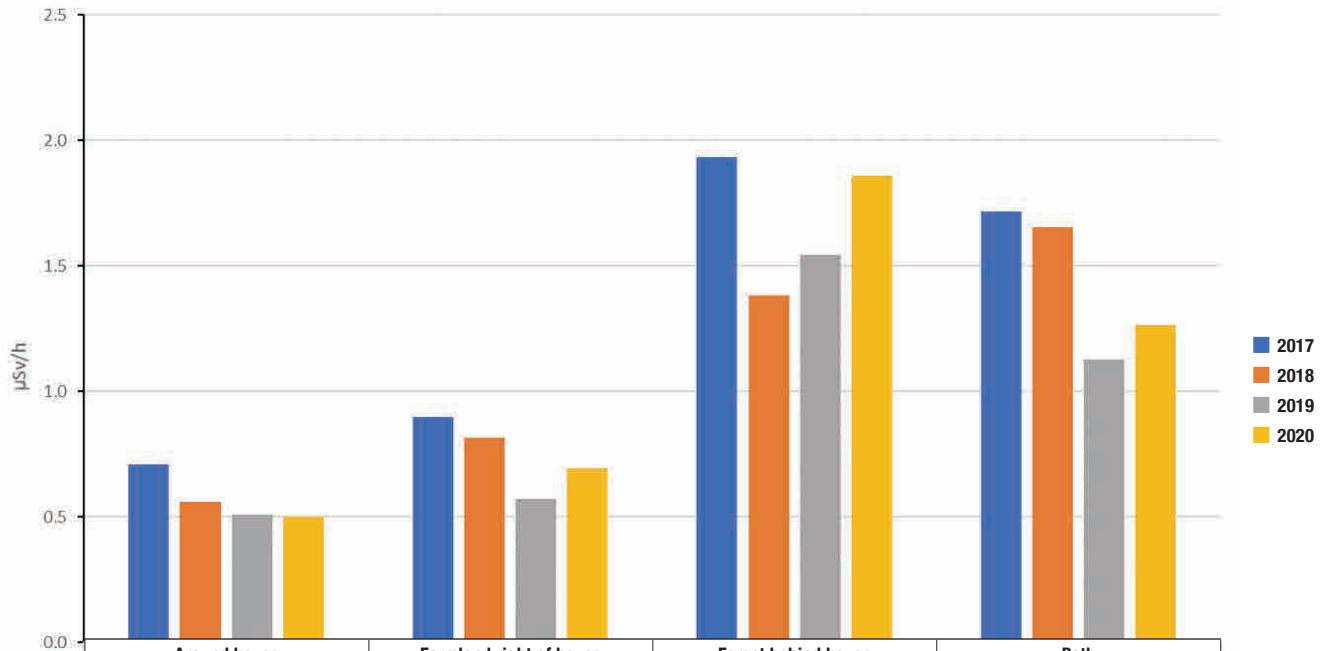
Zone name		Max (µSv/h)				Average (µSv/h)				Average % of previous year			
		2020	2019	2018	2017	2020	2019	2018	2017	2020	2019	2018	2017
Zone-01	Around house	0.9	0.8	0.9	1.3	0.5	0.5	0.6	0.7	99%	91%	79%	n/a
Zone-02	Path to house & around warehouse	1.3	1.1	n/a	2.1	0.7	0.7	n/a	1.1	110%	n/a	n/a	n/a
Zone-03	Garden left of path	1.4	1.5	n/a	1.8	0.7	0.9	n/a	0.8	78%	n/a	n/a	n/a
Zone-04	Farmland right of house	1.0	0.9	1.3	1.2	0.7	0.6	0.8	0.9	121%	70%	91%	n/a
Zone-05	Forest behind house	2.5	2.2	2.4	2.8	1.9	1.5	1.4	1.9	120%	112%	71%	n/a
Zone-06	Rice field behind house	n/a	n/a	n/a	2.4	n/a	n/a	n/a	1.9	n/a	n/a	n/a	n/a
Zone-07	Rice field	0.6	n/a	n/a	1.9	0.3	n/a	n/a	1.5	n/a	n/a	n/a	n/a
Zone-08	Road	2.0	1.3	n/a	1.6	0.6	0.6	n/a	0.7	99%	n/a	n/a	n/a
Zone-09	Path	2.7	2.1	5.9	5.8	1.3	1.1	1.7	1.7	113%	68%	96%	n/a
ALL	**Summary***	**2.7**	**2.2**	**5.9**	**5.8**	**0.8**	**0.8**	**1.1**	**1.3**	**106%**	**85%**	**84%**	**n/a**

Zone name		Number of points				Above 0.23 µSv/h				Above 1 µSv/h			
		2020	2019	2018	2017	2020	2019	2018	2017	2020	2019	2018	2017
Zone-01	Around house	283	248	394	238	100%	100%	100%	100%	0%	0%	0%	9%
Zone-02	Path to house & around warehouse	363	479	n/a	550	100%	100%	n/a	100%	14%	2%	n/a	58%
Zone-03	Garden left of path	665	537	n/a	383	100%	100%	n/a	100%	11%	39%	n/a	13%
Zone-04	Farmland right of house	320	669	597	447	100%	100%	100%	100%	0%	0%	12%	24%
Zone-05	Forest behind house	325	504	803	902	100%	100%	100%	100%	100%	85%	60%	95%
Zone-06	Rice field behind house	n/a	n/a	n/a	761	n/a	n/a	n/a	100%	n/a	n/a	n/a	100%
Zone-07	Rice field	494	n/a	n/a	403	84%	n/a	n/a	100%	0%	n/a	n/a	95%
Zone-08	Road	645	536	n/a	470	99%	100%	n/a	100%	11%	6%	n/a	14%
Zone-09	Path	733	749	996	951	100%	100%	100%	100%	63%	54%	81%	91%
ALL	**Summary***	**3828**	**3722**	**2790**	**5105**	**98%**	**100%**	**100%**	**100%**	**25%**	**27%**	**38%**	**55%**

In 2019, we found that the weighted average recorded was 0.9 µSv/h for the seven zones measured (Table 9). This 15% reduction in the weighted average levels compared to 2018, led Greenpeace to conclude that significant variations cannot be explained by radioactive decay or by further official decontamination. Our 2020 survey shows an increase in radiation levels in four zones measured; in two zones the levels remained constant, and only in zone 3 (garden next to path) a decline is observed compared to 2019.

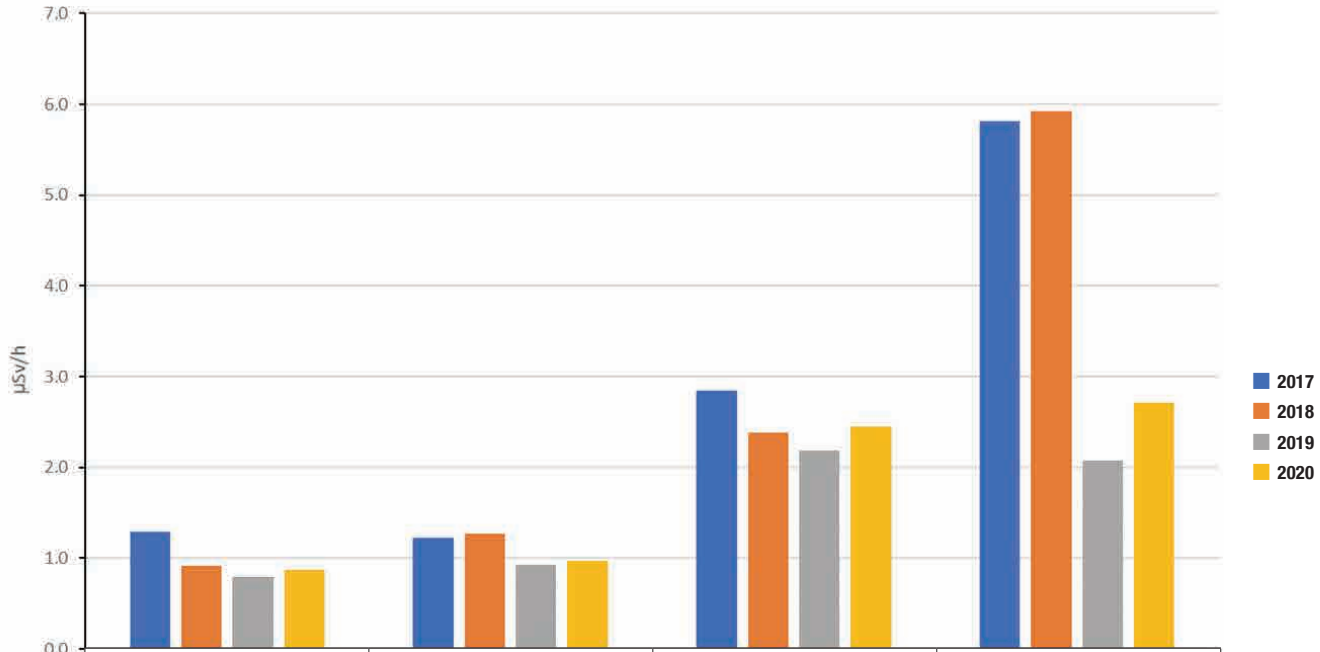
For four zones (Chart 6), we have complete data sets covering 2017-2020. From 2018 to 2019, we measured a reduction of the average levels, compared with a zero reduction between 2017 and 2018. One possible explanation for this may be the small amount of rainfall compared to that which resulted from Typhoon Hagibis in 2019.

Chart 6 - Ms Kanno's house: Average dose rates measured in four zones, November 2020



	Around house Zone-01	Farmland right of house Zone-04	Forest behind house Zone-05	Path Zone-09
2017	0.7	0.9	1.9	1.7
2018	0.6	0.8	1.4	1.7
2019	0.5	0.6	1.5	1.1
2020	0.5	0.7	1.9	1.3

Chart 7 - Ms Kanno's house: Maximum dose rates measured in four zones, November 2020



	Around house Zone-01	Farmland right of house Zone-04	Forest behind house Zone-05	Path Zone-09
2017	1.3	1.2	2.8	5.8
2018	0.9	1.3	2.4	5.9
2019	0.8	0.9	2.2	2.1
2020	0.9	1.0	2.5	2.7

In Zones 1, 4, 5 and 9 (see Charts 6 and 7), there has been an increase in measured radiation between 2019 and 2020. Average levels in Zone 9 increased from 1.1 µSv/h in 2019 to 1.3 µSv/h in 2020, and maximum levels increased from 2.1 µSv/h to 2.7 µSv/h. Zones 1, 4 and 9 saw a dip in 2019, compared to 2018 levels, while Zone 5 (forest behind the house) shows an increase in average levels.

In Zone 5, radiation levels increased, from 1.5 µSv/h to 1.9 µSv/h, between 2019 and 2020. This area lies at the bottom of a gently sloping hillside. In Zone 9, the path leading up the hillside to a former rice field, there was a reduction in radiation levels between 2018 and 2019 (1.7 µSv/h to 1.1 µSv/h). This was followed by a rise to 1.3 µSv/h in 2020.

The observations may indicate migration of caesium contamination following Typhoon Hagibis in October 2019, and possible re-contamination of some of the areas over the course of 2020. Radiation levels seem to decline after heavy rainfall but settle over the following months and, through slow migration, return to prior levels. This underscores the complexity of the behaviour of radiocaesium in the environment.

Table 10 – Radiation in all zones at Ms Kanno house, Namie November 2020 (Measurements taken walking on- and off-road, height: 1m)

Intervals	No. of points	% of points	mSv/y (Japan govt)(*)	mSv/y if 8760h/y (*)
>= 5µSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8µSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2µSv/h	106	3%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5µSv/h	481	13%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1µSv/h	388	10%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5µSv/h	1,716	45%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23µSv/h	1,051	27%	>= 1 mSv/y	>= 2 mSv/y
< 0.23µSv/h	86	2%	< 1 mSv/y	< 2 mSv/y
Total number of points	**3,828**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	
µSv/h	**No. of points**	**% of points**	**mSv/y (Japan govt)(*)**	**mSv/y if 8760h/y (*)**
no. points <0.23	86	2%	< 1 mSv/y	< 2 mSv/y
no. points >=0.23	3,742	98%	>= 1 mSv/y	>= 2 mSv/y
no. points >=0.5	2,691	70%	>= 3 mSv/y	>= 4 mSv/y
no. points >=1	975	25%	>= 5 mSv/y	>= 8 mSv/y
no. points >=1.5	587	15%	>= 8 mSv/y	>= 13 mSv/y
no. points >=2	106	3%	>= 10 mSv/y	>= 17 mSv/y
no. points >=3.8	0	0%	>= 20 mSv/y	>= 33 mSv/y
no. points >=5	0	0%	>= 26 mSv/y	>= 43 mSv/y
Total number of points	**3,828**	**100%**	(*) avg. dose rate of 40nSv/h before March 2011 subtracted	

Annual radiation dose rates for 98% of the areas measured at Ms Kanno's house (Table 10) exceed the International Commission on Radiological Protection (ICRP) recommended annual maximum exposure level of 1 mSv.[40] For 70% of the area measured, dose rates could lead to an exposure of between 3 and 5 mSv/y based on the government calculation method and 4 mSv/y or more based on sustained exposure over one full year. 98% of measuring points exceeded the government's current long-term target level of 0.23 µSv/h.

8 Strontium-90 – an additional threat

Jan Vande Putte, Greenpeace Belgium collecting pine needle samples in Okuma, Fukushima prefecture. (October 16, 2018)
© Shaun Burnie / Greenpeace

Radioactive strontium-90 (Sr-90) is one of the most hazardous radionuclides produced by the fission process in both nuclear weapons explosions and in commercial nuclear reactors. Enormous amounts of Sr-90 remain at the Fukushima Daiichi nuclear plant in both the molten fuel cores and in contaminated water. Preventing further releases into the environment is one of the greatest challenges.

In the environment, Sr-90 behaves in a similar way to calcium, being absorbed by plants, animals and humans through ingestion of contaminated food or water and, to a much smaller extent, through inhalation. Around 70–80% of Sr-90 is excreted, with the rest deposited in bones and bone marrow, and a very small amount (around 1%) in blood and soft tissues.[41] Sr-90 has a half life of 29 years. In the human body, it has a biological half-life (the time required for an amount to reduce to half of its original value) of 18 years.[42] Its presence can cause cancer of the bone, bone marrow and of nearby tissues.[43] Identifying Sr-90 contamination in samples requires significant time and investment in laboratory analysis compared with, for example, radiocaesium. As a result, Sr-90 remains one of the least studied of the radionuclides released from Fukushima Daiichi.

In 2011, the Japanese government's Ministry of Education, Culture, Sports, Science and Technology (MEXT) conducted a radiation monitoring survey at 55 sampling sites around Fukushima Prefecture.[44] Sampling reported by MEXT in 2012 for Sr-90 in soil showed a statistically significant difference to levels measured prior to the accident. The results measured Sr-90 that was a legacy of nuclear weapons testing, but also as a result of releases from the Fukushima Daiichi accident. Rather than conducting large-scale and expensive Sr-90 laboratory analysis, the Japanese authorities have relied on Cs-137 analysis and the assumption of a constant ratio with Sr-90. This has been the basis on which the government has estimated risks from Sr-90 released from Fukushima Daiichi, including the dose delivered to the human population. However, the assumed ratio

may be incorrect and this could have serious implications for long-term health risks. A critically important analysis of the risks from Sr-90 and potential impact on food safety was published in 2015, by Merz et al.[45] One of the main issues they raised related to how Sr-90 behaves in the environment compared with Cs-137. Specifically, they noted how Sr-90 is more readily adsorbed by living matter (i.e. greater bioavailability for plants and animals) compared with cesium 137. Japanese authorities in 2012 had set a regulatory limit based on a constant ratio of Sr-90 to Cs-137. However, the authors concluded that this ratio will change over time and that strontium 90 concentrations in food have the potential to increase. They recommended that Japanese authorities conduct "continuous monitoring of both Cs-137and Sr-90; otherwise the 90Sr content of food will soon be underestimated".[46]

The important work of Merz et al on Sr-90 has not been widely reported in Japan. There is as yet no evidence that Japanese authorities are considering the implications of this issue for population radiation exposure. It should do so urgently, especially given the very large amount of Sr-90 that remains at the Fukushima Daiichi site, including in the molten fuel cores and in the contaminated water and related nuclear wastes.

Greenpeace strontium sampling

In October 2018, the Greenpeace radiation survey team collected samples of needles from Japanese cedar trees (Cryptomeria japonica) from four locations in Fukushima Prefecture – Yanaizu, Okuma, Iitate, and Namie. The samples were then shipped to the independent laboratory ACRO in France for analysis. The results are a strong indicator that Sr-90 was released into the atmosphere from the Fukushima Daiichi reactors 1-3, and that it has been absorbed by plants.

Table 11 – Cedar needles sample results as measures in ACRO laboratory, 2019

SAMPLE IDENIFICATION							
ACRO Sample registration number	181129-GPI-01	181129-GPI-02	181129-GPI-03	181129-GPI-04	181129-GPI-05	181129-GPI-06	181129-GPI-07
Type	Cedar needles	Cedar needles	Cedar needles	Cedar needles	Cedar needles	Cedar needles	Cedar needles
Greenpeace sample registration number	20181014-YNI-1	20181016-OKM-1	20181019-NME-1	20181019-NME-4	20181023-OBR-1	20181024-ITT-2	20181026-OBR-2
SAMPLING							
date	10/14/2018	10/16/2018	10/19/2018	10/19/2018	10/23/2018	10/24/2018	10/26/2018
place	Yanaizu	Okuma	Namie	Namie	Namie	Iitate	Namie
GAMMA COUNTING							
Geometry (ml)	61	61	61	61	61	61	61
Sample mass analysed (g)	27.8	21.4	22.4	21.9	17.4	18.8	20.2
Analysis state	dry	dry	dry	dry	dry	dry	dry
Counting date	12/10/2018	12/12/2018	12/21/2018	03/01/2019	01/07/2019	01/08/2019	12/13/2018
RESULTS							
Reference date	10/14/2018	10/16/2018	19/10/2018	19/10/2018	10/23/2018	10/24/2018	10/26/2018
Unit	Bq/kg dry weight	Bq/kg dry weight	Bq/kg dry weight	Bq/kg dry weight	Bq/kg dry weight	Bq/kg dry weight	Bq/kg dry weight
***ARTIFICIALS RADIONUCLIDES**							
Cs-134 2 years	< 8	455 ± 39	65 ± 5	40.0 ± 3.7	64 ± 6	24.0 ± 2.6	1140 ± 100
Cs-137 30 years	4.9 ± 1.3	5410 ± 460	850 ± 60	506 ± 40	800 ± 60	284 ± 22	13700 ± 1200
BETA COUNTING							
Counting date	03/04/2019	03/04/2019	03/04/2019	03/04/2019	03/04/2019	03/04/2019	03/04/2019
Sr-90 29 years	0.76 ± 0.48	7.6 ± 1.9	21 ± 4	19 ± 4	11 ± 2	6.5 ± 1.4	65 ± 13

*No other artificial gamma-emitting radionuclides were detected during these analyses.

In the case of Yanaizu, which lies over 100km to the west of the nuclear plant, the measured Sr-90 levels were low (0.76 Bq per kg dry weight +/- 0.48). Given background levels of Sr-90 from atmospheric nuclear weapons testing, it is likely that the Sr-90 identified in Yanaizu is from testing rather than the 2011 accident. The fact that no Cs-134 was detected in this sample, is a strong indicator of the origin being nuclear weapons tests. The releases from the Fukushima Daiichi accident in the initial years have a significant Cs-134 presence and are still measurable in 2018. In contrast, the last atmospheric nuclear weapons tests were conducted in the 1960's and therefore Cs-134 (with a half life of 2 years) and released from the tests will no longer exist.

In contrast, cedar needles collected in a forested area in Okuma, less than 10km from the nuclear plant, had strontium levels 10 times higher (7.6 Bq/kg +/-1.9). The concentrations in samples collected in the difficult-to-return exclusion zone of Obori, 10km north-west of the plant, had the highest strontium levels (65 Bq/kg +/-13). The samples from Namie town, which lies due north of the plant, had strontium concentrations that ranged from 11Bq/kg +/- 2 Bq/kg to 19 Bq/kg +/- 4, while samples from Iitate, 35km north-west of the plant, had strontium concentrations of 6.5 Bq/kg +/- 4 Bq/kg.

All of the samples from Iitate, Namie and Okuma had measurable levels of Cs-134 and Greenpeace concludes that there are likely to have originated from Fukushima Daiichi.[47]

The presence of the hazardous radionuclide, Sr-90, in the cedar tree samples is further evidence that, even 10 years after the accident, there is a need for continued investigation. While the levels cannot be considered high, they raise questions about the overall threat to the environment and public health posed by radioactive contamination.

The other major factor is that most of the strontium-90 produced by the reactors remains inside the Fukushima Daiichi plant itself. A small amount of this is held in the contaminated tank water that the Japanese government is expected to discharge to the Pacific Ocean, as detailed in our 2020 report.[48] However, by far the largest amount is within the estimated 600-1,100 tons of molten core fuel. It's estimated that over 500 PBq of strontium 90 remains.[49] Given the hazards it poses, all possible efforts must be made to prevent even a fraction of this strontium-90 entering the environment. The credibility of Tokyo Electric Power Company's (TEPCO) plans for the decommissioning of the Fukushima Daiichi reactors, including the removal of the molten fuel cores, therefore is of critical importance. In addition to the existing widespread contamination of Fukushima Prefecture, partially documented in this report, the even greater potential future threat continues to exist at the nuclear plant and will do for many generations to come.

9

Ten years of evacuation, displacement and human rights violations

- 164,000 citizens became evacuees as a result of the 11 March 2011 nuclear disaster.
- As of 31 January 2021, there were still 36,192 evacuees within and outside Fukushima prefecture. This figure does not reflect the true numbers of citizens who left of their own accord.
- The Japanese government continues to follow a policy that allows people to live in areas where they could be exposed to radiation dose levels of 20 mSv/y, twenty times higher than the recommended maximum levels for public exposure. These high dose limits for citizens including women and children are strongly opposed by Japanese citizens and have been condemned by UN human rights bodies.
- In terms of decontamination workers, 30 million man days have been applied for decontamination up until 2018, and with reports of multiple violations of workers human rights.

Opening day of TEPCO criminal court, Tokyo. (June 2017)
© Shaun Burnie / Greenpeace

"At some point in time, someone will have to say that this region is uninhabitable, but we will make up for it," Liberal Democratic Party (LDP) secretary general, Shigeru Ishiba, 2013.[50] The above quote represents a rare example of honesty from the LDP, but it is not the approach followed by the government of prime minister, Shinzo Abe or his successor, Yoshihide Suga. The Fukushima Daiichi nuclear disaster has brought a decade of human rights violations to the citizens and workers of Fukushima and wider Japan. In its policy, the government has ignored the reality of radioactive contamination in many of the districts evacuated in 2011 and has done everything possible to coerce evacuees to return home. A new plan approved by the Abe cabinet in June 2015 has determined the future of tens of thousands of Japanese citizens ever since.[51] Confronted with radiation levels that would result in annual human exposure above the recommended maximum of 1 mSv per year, the government simply changed the recommended maximum levels to 20 mSv per year. This allowed evacuation orders to be lifted. While it set a long-term target of 1 mSv/y, there has never been a timeframe given for this to be reached. Similarly, the government has never given a timeframe for reaching the long-term decontamination target of 0.23 μSv/h.[52]

Displacement without adequate compensation

Ms Kanno of Namie and Mr Anzai of Iitate, whose homes we have surveyed, are but two of the 164,000 Japanese citizens who became evacuees following the 11 March 2011 nuclear disaster. According to the Fukushima prefectural government, there were still 36,192 evacuees within and outside the prefecture as of 31 January 2021.[53] This figure does not necessarily reflect the number of so-called 'voluntary evacuees' who left their homes in areas not officially designated for evacuation. In December 2011, the then government finally accepted the recommendations made by an advisory panel to give limited financial assistance to residents of 23 municipalities that were outside the compulsory evacuation zones but had high levels of radiation.[54] The amount awarded was a fraction of the cost incurred in moving away from the contaminated areas. In March 2017, the Abe government terminated the housing support, and the official number of evacuees drastically dropped since. As noted at the time in daily newspaper, Asahi Shimbun, "The central government has made a large number of people who voluntarily fled the Fukushima area after the 2011 nuclear disaster disappear by cutting them from official lists of evacuees."[55]

In 2017, the number of self-evacuees listed by Fukushima Prefecture who were in receipt of free housing services was 26,601 in 10,524 households. Of these 13,844 people in 5,230 households were living outside Fukushima Prefecture.[56] Housing support was generally the only public financial support they received.

Because of the actions of the Japanese government, tens of thousands of evacuees have been forced to make an impossible choice: to return to their radioactively contaminated homes or to abandon their homes and land and seek to establish a new life elsewhere without adequate compensation.

This amounts to economic coercion and may force individuals and families to return against their will due to a lack of financial resources and alternatives. These people lost their livelihoods, communities, and property as a result of a nuclear disaster they had no part in creating.

In each of the 11 municipalities with evacuation orders, the return rates of the original population vary. In one of the largest, Namie, as of 31 January 2021, out of the current registered population of 16,681, 1,579 citizens currently live there, equivalent to 9.5% of the population in March 2011.[57] In the case of Iitate, as of 1 December 2020, 1,255 returned equivalent to 19% of ten years before, which was 6,509.[58]

Lack of trust in government data

There are multiple reasons for the failure of the Japanese government to force evacuees to return to Fukushima. A significant one is the lack of trust over government data and assurances that radiation levels are safe. Ten years ago, a survey of evacuees from the district of Futaba, a host community for the Fukushima Daiichi reactors, found that 83% cited radioactivity levels and doubts that these would be reduced as reasons for not returning. And 65.8% said they did not trust safety levels announced by the government.[59]

A 2020 survey conducted by Kwansei Gakuin University gave an insight into the current feelings of Fukushima evacuees.[60] Of the 522 people who responded to questionnaires, 65% said they have no intention of returning. Of these, 46.1% said they still fear contamination of the environment.

In December 2020, the Japanese government announced a financial incentive plan in an attempt to increase the population in the 12 municipalities or districts subject to some form of evacuation order in 2011.[61] Under this new policy up to 2 million yen will be made available to families and 1.2 million yen to individuals. The 12 areas where this new policy applies have a population that is 20% of that in 2011. Those eligible are Japanese citizens who were not residents of the 12 municipalities in 2011.

Many of Japan's demographic issues – an aging population, an overall decline in the rural, and especially agricultural, population and reduced employment opportunities, have been accelerated in Fukushima Prefecture as a result of the March 2011 disaster.[62] The inability of evacuees to return, is largely related to the extended displacement from their homes caused by radioactive contamination and the fact that for many years from 2011 their districts remained closed to habitation.

Human rights violations

The Japanese government's response to the Fukushima nuclear disaster has utterly failed to meet its international commitment to protect the human rights of its own citizens, including women and children. As UN Special Rapporteurs stated in a 2018 communication to then Foreign Minister Taro Kono, "The impact of the decontamination program places a great number of persons, including persons belonging to vulnerable groups, under considerable constraints and could result in violations of their basic human rights...We take this opportunity to recall that those persons evacuated or self-evacuated from their homes by the Fukushima disaster constitute internally displaced persons (IDPs) and to remind your Excellency's Government of its obligations relating to the human rights of IDPs, including those contained in the provisions of the 1998 Guiding Principles on Internal Displacement...".[63] In 2021, the Japanese government still has not responded sincerely.

Furthermore, the government continues to disregard the recommendations made by member states at the United Nations Human Rights Council and dismisses the risks from radiation exposure. It even claims that exposure to 100 mSv poses no cancer risks, as Masayoshi Yoshino, Japanese Reconstruction Minister stated in 2018.[64] These violations are systematic and deliberate.

During the past decade, the violations have been challenged by multiple UN human rights Special Rapporteurs, including Baskut Tuncak.[65] In his report to the UN General Assembly in 2018, Tuncak stated that, "It is disappointing to see Japan appear to all but ignore the 2017 recommendation of the UN human rights monitoring mechanism (UPR) to return back to what it considered an acceptable dose of radiation before the nuclear disaster."[66] In his report, he urged the Japanese government to halt the ongoing relocation of evacuees, including children and women of reproductive age, to areas where radiation levels remain higher than that considered safe or healthy before the 2011 nuclear disaster. He also criticised the Japanese government's decision

Male and female decontamination workers in fields in Okuma. (December 16, 2019)
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to raise by 20 times the level of radiation exposure it considered acceptable, stating that it, "was deeply troubling, highlighting in particular the potentially grave impact of excessive radiation on the health and wellbeing of children."[67]

The Convention on the Rights of the Child (CRC), of which Japan is a signatory, specifies in article 3 that the best interests of the child, including those of future generations, must be a "primary consideration in all actions."[68] This includes the requirement that children are not exposed to toxic chemicals and pollution so their right to the highest standard of health is not compromised. In its report of 1 February 2019, the UN Committee on the CRC made seven important recommendations to the Japanese government under Principle Concerns and Recommendations in relation to the Fukushima nuclear disaster.[69]

These included the following:

- Reaffirm that radiation exposure in evacuation zones is consistent with internationally accepted knowledge on risk factors for children.
- Continue providing financial, housing, medical and other support to evacuees, children in particular, from the non-designated areas.
- Conduct comprehensive and long- term health check-ups for children in areas with radiation doses exceeding 1 mSv/year.[70]

If the Japanese government were to comply with the CRC guidelines and recommendations, and apply them to its Fukushima policy, it would mean adoption of the international recommended maximum exposure of 1 mSv/y, not the 20 mSv/y limit it subsequently adopted. Furthermore, it would result

in the termination of plans to lift evacuation orders, as well as the reversal of earlier orders in Namie and Iitate. The Japanese government has not done this so has failed to meet its international commitments to protect children's human rights.

Workers' rights ignored

The Ministry of Environment reports that 30 million man days of labor have been applied for decontamination in the SDA and ICSA combined up until 2018.[71] At its overall peak in 2016, 500,000 man days of work were applied. In Iitate, decontamination work peaked in October-November 2014, with 180,000 man days of labor in the district – over 2.8 million man days were applied in total to the end of 2017.[72] In Namie, the peak of decontamination took place in early 2016 with just under 100,000 man days, and around 1.7 million man days applied in the area in total. With such a large workforce, the majority of whom are employed by sub-contractors, comes the risk of exploitation on an equally large scale.

As detailed in our 2019 report.[73] abuse of the human rights of nuclear workers was prevalent, with multiple ongoing legal cases against contractors.[74] The issue was raised by United Nations Human Rights Special Rapporteurs in August 2018, when three Rapporteurs issued a statement to the Japanese government expressing that they were, "deeply concerned about possible exploitation by deception regarding the risks of exposure to radiation, possible coercion into accepting hazardous working conditions because of economic hardships, and the adequacy of training and protective measures."[75] As documented by the Greenpeace radiation survey team, workers in Namie have been exposed to high levels of radiation, with further risks as the decontamination programme is extended into areas where radiation levels are even higher. This means many more workers will face an unjustifiable radiation risk, given that the programme will only decontaminate a small fraction of the overall area.[76]

Our assessment at the time, and currently, is that that decontamination plans for Namie, as well as the other areas in the difficult-to-return exclusion zones, cannot be justified from a radiation protection perspective, and there is no possibility that it will be safe for people to return over the coming decades.

In 2018, in a personal testimony to Greenpeace, Minoru Ikeda, a Fukushima nuclear worker and a representative from the Radiation-exposed Workers' Solidarity Network in Tokyo has provided details of the abuse by subcontractors, the role of organised crime, low pay, the recruitment of 'homeless' people, falsification of health certificates and the lack of any effective radiation training. "As a worker, I don't feel like I was treated as a human. One person compared it to slavery," he said.[77]

10 The future of difficult-to-return exclusion zones

Ms Kanno's house in Tsushima, Namie, Fukushima prefecture. (October 22, 2018)
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Difficult-to-return zones, or areas where citizens are not permitted to live, exist in seven districts of Fukushima Prefecture and cover a total of about 340 square kilometres. The government aims to lift evacuation orders in parts of these zones by 2023. These are referred to as "Designated reconstruction and rehabilitation areas" and cover a total of about 30km^3 in six municipalities, excluding Minamisoma City.

Lifting of evacuation orders in Futaba, Okuma and Tomioka

On 17 January 2020, approval was given for the lifting of evacuation orders in small areas of Futaba Town, Okuma Town, and Tomioka Town.[78] Orders were then lifted in these areas in early March 2020, opening up a total of 0.5km^3. The areas are close to the main Joban express route and linked to the plans for the 2020 summer Olympics, which were subsequently postponed. It was the first time that evacuation orders had been lifted in highly contaminated difficult-to-return zones.

Re-designation of highly contaminated areas

The Japanese government's objective is to lift evacuation orders in all of the municipalities in Fukushima. In the difficult-to-return zones, the so-called 'recovery bases', small areas in each of the municipalities, comprise 8.8% of the total area of these zones. When evacuation orders are lifted in the next few years, places such as Tsushima, in Namie, will become islands surrounded by areas of high radiation contamination.

The decontamination programme has proved to be limited in effect and expensive, and in 2020 a new approach emerged.[79] In Iitate, the designation of an area as a difficult-to-return zone will be terminated so there will be no restriction on people entering in

the certain area. However, they will not be able to return to live in their former homes. The policy was presented to Japan's Nuclear Regulation Authority (NRA) on 26 August 2020.[80]

In presenting its policy to the NRA, the government stated that in applying the new approach it would require that:

- a/ the annual radiation exposure doses are confirmed to be no more than 20 mSv
- b/ residents' radiation exposure doses are controlled by using personal dosimeters
- c/ information to curb radiation exposure is provided.[81]

The new approach was reportedly prompted by a request to the government from the Iitate local government in February 2020, specifically for the 'Recovery Park' in the Nagadoro District of Iitate village, which is presently designated a difficult-to-return zone.'[82] On 25 December 2020, at a meeting at the Nuclear Emergency Response Headquarters hosted by prime minister Suga, the decision to end the difficult-to-return zone in Iitate was formally approved.[83] There are several problems with the new policy. Japanese citizens, including children, will now be able to enter these areas, potentially risking their health. As the Citizen's Nuclear Information Center has pointed out, there are several laws in Japan which set the radiation exposure limit for the general public at 1 mSv per year.[84] Even if the natural decay of radioactive nuclides has brought the annual air dose rate to below 20mSv, practically all of the present difficult-to-return zones are above 1mSv per year and therefore restrictions in these zones should not be lifted. It is also a violation of the Act on Special Measures Against Radioactive Material Pollution, which states that decontamination is a national responsibility. This policy shift is not led by an assessment of radiation risks but is a political decision. The other five municipalities, which at this stage do not intend to follow the Iitate model, have recently expressed concern that they will be forced to take the same approach.[85]

11

Conclusion and recommendations

Ten years after the start of the Fukushima Daiichi nuclear disaster the radiation environment in Fukushima Prefecture remains significant and complex. Greenpeace survey work during the last decade has investigated and measured radiation levels in municipalities across the prefecture. As in previous years, the results of our November 2020 survey in the lifted evacuation areas of Iitate and Namie (ie areas determined by the Japanese government to be safe for return) remain too high for normal life to be considered possible without increased health risks to returning citizens. The forests of Fukushima remain long term sources of contamination and in our latest survey we measured variation in levels of radiation in zones around houses in both Iitate and Namie that cannot be explained by radioactive decay of Cs-137. This, Greenpeace concludes, is both strong evidence of the effects of resuspension of Cs-137 due to flooding and a legacy of the major Typhoon Hagibis in October 2019. The need for further investigations into the complex radioactive environment of Fukushima is obvious and remains critical.

One decade after March 2011, we are in the early stages of the impact of this disaster. This is not the official narrative. For the government of Shinzo Abe, in power for most of the last 10 years, and his successor Yoshihide Suga, the communication to the people of Japan and the wider world is that decontamination has been effective, completed and that radiation levels are safe.

This is clearly false.

Based on the Japanese government's own data, 716 square kilometers of the seven municipalities that make up the Special Decontamination Area (SDA) have not had any decontamination efforts applied. By March 2017 when the government declared decontamination completed in the areas scheduled for lifting evacuation orders, only 123 square kilometers, or 15%, of the SDA was actually subject to any decontamination.[86] This has been a deliberate and on-going effort by the Japanese government to deceive the citizens of Iitate, Namie, Naraha, Tomioka, Okuma, Futaba and Katsurao, all of which lie inside the SDA. The reality is that in the fraction of the Fukushima SDA where decontamination has been applied it has reduced radiation levels, but not consistently, and with wide variations. The government has failed to reach its long-term decontamination target of 0.23 μSv/h in many areas open to the public and there are no prospects of attaining it in the coming years.

The human consequences of the nuclear disaster cannot be measured in simple numbers. The consistent and multiple failure of the Japanese government to respect the rights of its citizens, in particular the tens of thousands of evacuees, has been challenged by civil society in Japan and United Nations human rights bodies through almost the entire period since 2011. Human rights Special Rapporteurs have played a crucial role in questioning the government over its failure to protect especially women, children and workers from harmful radiation. The policy of permitting public exposure up to 20 mSv/y, twenty times higher than international norms, continues to be widely condemned. The refusal of the government to meet in full the legally obligated rights of its own citizens, including the rights they would be accorded if designated Internally Displaced Persons remains wholly unacceptable.

The government of Japan is on a mission to erase from public memory the triple reactor meltdown and radioactive contamination of a large part of Japan. However, they have failed to impose their atomic amnesia on the people of Japan. In large part this is

due to the courageous efforts of citizens and their lawyers to hold the government and Tokyo Electric Power Company to account. Together with the work of non-governmental organisations, scientists, as well as UN human rights bodies and Special Rapporteurs, these efforts will ensure that the ongoing nuclear disaster, its effects and consequences will continue to be better understood and explained in the years and decades ahead.

Recommendations to the Japanese Government and Fukushima Prefecture

- **Suspend the current return policy, which ignores science-based analysis, including potential lifetime exposure risks to the population.**
- **Immediately clarify its long-term decontamination target of 0.23 μSv/h, equal to 1 mSv/y. Set a date for when 0.23 μSv/h is to be attained and halt any plans to revise the target level to a higher limit.**
- **Urgently assess the public health risks posed by radioactive hotspots, including the presence of caesium-rich micro particles.**
- **Abandon plans to lift evacuation orders in the six municipalities of Futaba, Okuma, Namie, Tomioka, Iitate and Katsurao, including the Namie districts of Tsushima, Murohara, Suenomori and Obori.**
- **In the interests of worker protection, suspend current decontamination programmes in the difficult-to-return zones.**
- **Establish a fully transparent process to consider and reflect residents' opinions on the evacuation policy and create a council of citizens that includes evacuees.**
- **Provide full compensation and financial support to evacuees and allow citizens to decide whether to return or relocate on the basis of scientific evidence and free from duress and financial coercion.**
- **Respond in full to the offer of dialogue and guidance from UN Special Rapporteurs, including accepting outstanding requests for Special Rapporteurs to visit Japan.**

Endnotes

1. A range of between 24,000-34,000 km square area of mainland Japan received Cs-137 deposition exceeding 10,000 Bq/m2 / 40,000 Bq/m2 see “Fukushima, one year later - Initial analyses of the accident and its consequences” Report IRSN/DG/2012-003 of March 12, 2012; Modelling the global atmospheric transport and deposition of radionuclides from the Fukushima Dai-ichi nuclear accident. T. Christoudias and J. Lelieveld. The Cyprus Institute, Nicosia, Cyprus 2Max Planck Institute of Chemistry, Mainz, Germany Atmos. Chem. Phys., 13, 1425–1438, 2013 https://acp.copernicus.org/articles/13/1425/2013/
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8. The Act entered into force on 1 January 2012, after which full scale decontamination was to begin. “Decontamination Project in Fukushima Prefecture Conducted by Japanese Government” Masaru Moriya, Chief of Fukushima Decontamination Team, Acting Superintended of Fukushima Office for Environmental Restoration, Ministry of the Environment, February 2012, see https://www.oecd-nea.org/rp/meetings/ISTC-STCU/docs/5-feb-fukushima/14%20Moriya(Ministry_of_Environment)_English.pdf
9. Greenpeace Japan, “Detailed Demands to the Japanese Government”, 29 August 2011, see https://bit.ly/307kzzW
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15. Ministry of Environment, “The Current Situation of Off-site Clean-up in Japan”, Kazumi Yoshikawa, Director, 23 May, 2016, see https://conferences.iaea.org/event/89/contributions/11403/
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17. These figures are from September 2017. Decontamination hectares are provided by the Ministry of Environment, and included in the report, Decontamination Projects for Radioactive Contamination Discharged by Tokyo Electric Power Company Fukushima Daiichi Nuclear Power Station Accident (Full Version), chapter 5: Effects, Verification, and Risk Communication of Decontamination 5.1. Status of Implementation of Decontamination Projects, 20 February 2019, see http://josen.env.go.jp/en/policy_document/. The SDA area includes all of Naraha Town, Tomioka Town, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village. Districts that are both inside the SDA and ICSA are Tamura City, Minamisoma City, Kawamata Town and Kawauchi Village municipalities. We have not included these in the above data as we have been unable to see comparable data for hectares within the ICSA that have been decontaminated. The percentages are likely to be similar inside the ICSA part of the above districts. For example, 50% of Tamura is outside the SDA but inside the ICSA. Inside the SDA of Tamura, 359 hectares have been decontaminated, which is 1% of the total area of the district. The government does not provide comparable data for the number of hectares decontaminated in the ICSA in each district.
18. The table does not include the area around houses, which in standard decontamination is several metres from around the home, and therefore does not add significantly to the total area decontaminated.
19. Namie continues to have an area within the ‘difficult-to-return’ highly contaminated exclusion zone.
20. Tomioka continues to have an area within the ‘difficult-to-return’ highly contaminated exclusion zone.
21. Iitate continues to have an area within the ‘difficult-to-return’ highly contaminated exclusion zone.
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27. "Summary of the Fukushima accident's impact on the environment in Japan, one year after the accident", IRSN February 28 2012, see https://www.irsn.fr/en/publications/thematic/fukushima/documents/irsn_fukushima-environment-consequences_28022012.pdf ; One report states that, "In the evening of March 15, just 4 days after the accident, the radiation level measured in front of the town hall of the village showed 44.7μSv/h." as reported in Masuro Sugai"Consequences of Delayed Evacuation in Iitate-Mura Village", Kokugakuin University, July 2014, Conference: XVIII ISA World Congress of Sociology,
see https://www.researchgate.net/publication/268108920_Consequences_of_Delayed_Evacuation_in_Iitate-Mura_Village
28. Fukushima Daiichi Accident, Summary Report by the Director General, Board of Governors May 14 2015, IAEA, 2015,
see https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1710-ReportByTheDG-Web.pdf
29. The total Cs-134 inventory was almost equivalent to Cs-137 at the time of initial deposition (year 0) but becomes less than 10% of the total initial inventory after 5 years due to the fact that Cs-134 has a half-life of 2.1 years. The total Cs-137 and Cs-134 combined inventory will decrease to approximately half of the initial fallout after approximately 10 years, primarily because of the radioactive decay of Cs-134. However, the rate at which the total radiocaesium inventory decreases will slow after 10 years, when Cs-137 remains as the dominant nuclide, see, Shoji Hashimoto, Toshiya Matsuura, Kazuki Nanko, Igor Linkov, George Shaw & Shinji Kaneko,"Predicted spatio-temporal dynamics of radiocaesium deposited onto forests following the Fukushima nuclear accident", 2 September 2013,
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30. Transuranics are radioactive elements with atomic numbers beyond or greater than 92 which is the atomic number for uranium. They are the so called actinide series of elements, there are 26 of them and they include one of the most radio toxic and hazardous of materials, plutonium
31. M. Yamamoto, et al,"Isotopic Pu, Am and Cm signatures in environmental samples contaminated by the Fukushima Dai-ichi Nuclear Power Plant accident", Journal of Environmental Radioactivity. 132 (2014) 31- 46.
32. Tetsuji Imanaka 1, Satoru Endo, Masuro Sugai, Shoji Ozawa, Kiyoshi Shizuma, Masayoshi Yamamoto", Early radiation survey of Iitate village, which was heavily contaminated by the Fukushima Daiichi accident, conducted on 28 and 29 March 2011", June 2012,
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33. The legal policy framework for the decontamination efforts in Iitate and the other districts in the Special Decontamination Areas was the Act on Special Measures Concerning the Handling of Radioactive Pollution ("the Act on Special Measures") enacted in August 2011 and which took full effect from January 2012: the Ministry of the Environment is responsible for off-site remediation and waste management; the Ministry of Agriculture, Forestry and Fishery is involved in countermeasures related to forest and agricultural areas; the Ministry of Health, Labour and Welfare is responsible for radiation protection of remediation workers; the Cabinet Office for the designation and rearrangement of evacuated areas, and, the Nuclear Regulation Authority supports all activities by the coordination of monitoring and the provision of scientific and technical advice.
34. Iitate Village, "About the evacuation situation of villagers as of 1 December 2020",
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36. The Japanese government 0.23 μSv/h long-term target is estimated to give a dose of 1 mSv/y based on citizens spending an average of 8 hours per day outside and taking account of shielding from radiation while inside a house. The methodology used by the Japanese authorities for many people is an underestimation. Residents in this agriculture and forestry- dependent region mostly worked and lived outside prior to the Fukushima nuclear disaster, particularly during the spring, summer, and autumn seasons. Even during the winter period, work is conducted outside, for example in the forest. The maximum figure here is based on if a person was to spend the entire year of 8,760 hours at this location
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