On the Frontline of the Fukushima Nuclear Accident: Workers and Children

Radiation risks and human rights violations

March 2019

GREENPEACE

Contents

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A very special thanks to all house owners in Namie and Iitate, and in particular Fukushima evacuees, Ms. Kanno and Mr. Anzai who were so very generous with their time and much appreciated and necessary guidance during our survey work. Also special thanks to Mr. Minoru Ikeda, former decontamination and nuclear worker and Mr. Nasubi of the Radiation-exposed Workers' Solidarity Network, both of whom provided invaluable insight into the conditions and nuclear hazards in Fukushima. We also would like to express our deep appreciation to Japanese citizens who kindly donated to this project. Their critical support made this survey project possible.

Cover photo : Workers at school playing field, Namie, Fukushima prefecture, October 2018.
Currently displayed image : Workers in Obori, Namie exclusion zone, Fukushima prefecture, October 2018.

Back cover : Workers at school playing field, Namie, Fukushima prefecture, October 2018.

1. Executive summary

Eight years after the start of the Fukushima Daiichi nuclear disaster and two years after the Japanese government lifted evacuation orders in areas of Namie and Iitate, radiation levels remain too high for the safe return of thousands of Japanese citizen evacuees. That is the conclusion of Greenpeace's latest extensive radiation survey in Namie and Iitate, Fukushima prefecture. The survey, conducted during October 2018, focused in particular on the radiation risks to decontamination workers, whose exploitation and human rights violations have rightly become a focus of attention from United Nations human rights experts during the last year. The report also focuses on the failure of the Japanese government to comply with its international obligations to protect the rights of children. Preventing exposure of children to harmful radiation, one of the obligations under the Convention on the Rights of the Child, is particularly critical given their higher vulnerability to health effects from radiation. In the case of workers and children, who are in the frontline of hazards resulting from the Fukushima Daiichi nuclear disaster, the Japanese government continues to ignore international radioprotection recommendations.

Through the support of local citizens, Greenpeace was able to continue its survey work in Iitate and Namie and in the highly contaminated exclusion zone of Namie.

Radiation risks, long-term dose estimates and revision of targets

In the areas of Iitate and Namie where evacuation orders were lifted in March 2017, contamination will remain well above international maximum safety recommendations for public radiation exposure of 1 millisievert per year (mSv/y) for many decades. Greenpeace includes projections on dose rates to mid-21st century, which show that they will still be well in excess of the current government's long-term target levels of 0.23 microsieverts per hour (μSv/h).

It is this target level that the government uses for its calculation to reach an estimated annual exposure level of 1 mSv/y. The government calculation is based on citizens spending an average of 8 hours per day outside and takes into account shielding from radiation while inside a wooden house. Unless otherwise stated in the text, the Greenpeace calculations of annual human dose rates are based on radiation measurements taken at 1 meter, and what an adult's exposure would be over one full year (total of 8,760 hours) at that specific location.

In the case of radiation levels in the highly contaminated exclusion zone of Namie the situation is even more severe. It will be at least many decades for some areas, and well into next century for others, before radiation levels start to even approach government targets of 0.23 μSv/h. The Japanese government continues to disregard scientific evidence of cancer and other health risks from low-dose radiation exposure, including in the range of 1-5 mSv/y.[1] Yet the government has not only opened areas of Namie and Iitate where citizens will be exposed to rates equal to this and higher, but is also moving ahead with plans to open even higher radiation areas in the six municipalities of Futaba, Okuma, Namie, Tomioka, Iitate and Katsurao.

In 2018, the Japanese government began a process to revise its current long-term decontamination target of 0.23 μSv/h, for which it still does not define 'long-term'. In September 2018, the Radiation Council, the principle body advising the government on this issue, warned that "0.23 is a fixed idea of whether it is safe for residents... In the absence of a drop in the dose, 0.23 remains as a major problem."[2] The major problem is that it is not attainable in many areas. It has been suggested that the new target would be in the 1.0 μSv/h range. This is a politically motivated process with the aim of allowing the government to claim success in its decontamination program, which in reality has failed and which excludes the majority of contaminated areas which are forested mountains. Unable to set a date for when radiation exposure would be a maximum of 1 mSv a year in many areas, the government is seeking to shift the goal posts. This is a cynical disregard for public health protection and the human rights of Japanese citizens.

Radiation survey results overview

Exclusion zone in Namie

The results of Greenpeace's 2018 extensive survey around houses, farmland and forest in the Namie exclusion zone reveal radiation levels that far exceed the government's long-term decontamination target of 0.23 μSv/h. The community of Obori, around 20 km west-northwest of the Fukushima Daiichi nuclear plant, is targeted as a reconstruction hub by the Japanese government with a target date for lifting evacuation orders in a small area in March 2023.[3] Yet, in all of the survey work conducted by Greenpeace in October 2018, it was this area that showed the most extensive and consistently high radiation levels. In the community of Obori, we took 4,899 measurements with an average of 4.0 μSv/h and a maximum of 24.3 μSv/h.

In the Obori hamlet, along a road and path where workers were operating on 23 October 2018, radiation hot spots were measured at 12 μSv/h at 1 meter, 19 μSv/h at 0.5 meters, and 64.9 at 0.1 meters. To put these figures into context, at this one location radiation readings at one meter were 300 times higher than the background level of 0.04 μSv/h in the prefecture before the March 2011 Fukushima Daiichi nuclear accident.

As in 2017, the survey also investigated radiation levels at the Tsushima home of Ms. Kanno. The home was selected for a demonstration of the government's decontamination techniques and was subjected to considerable effort during December 2011 and February 2012. The focus of the research was in the immediate area around the house, as well as on the family's farmland and forest.

Overall, for the zones measured at Ms. Kanno's home the weighted average in October 2018 was 1.3 μSv/h, which remains unchanged since September 2017. Maximum levels in October 2018 were 5.9 μSv/h, compared with 5.8 μSv/h in 2017. This trend is consistent with Greenpeace survey results in Iitate from 2015-2016 and the results of survey work at Ms. Kanno's house in 2017. In 53% of the forested zone measured radiation levels would lead to an exposure of between 10-20 mSv over one year based on the Japanese government's methodology and between 17-33 mSv/y based on exposure over one full year. In terms of lifetime exposure (70 years), taking the average for the four zones, dose rates would range from 170 mSv to 283 mSv depending on time spent outside, with these ranges based on 8 hours and 24 of hours per day, respectively.

Lifted evacuation areas - Namie town

Greenpeace returned to a kindergarten and school in Namie town where we had investigated radiation levels in 2017, including in a small forested area adjacent to the school. In our October 2018 survey, the average radiation level in Zone 3, a forested area, was 1.8 μSv/h with a maximum of 2.9 μSv/h. In 28% of this area, the annual dose would be between 10-20 mSv, based on the Japanese government methodology, and between 17-33 mSv, based on full time exposure. 100% of all points measured exceeded the Japanese government's long-term decontamination target of 0.23 μSv/h. In our 2018 survey at this location we also used our radiation-measuring UAV (Unmanned Aerial Vehicle). While decontamination has been carried out at the school property, as well in the fields south of the school property, our aerial survey showed that the forest north of the school property has only been decontaminated up to 20 meters from the road. The aerial measurements reveal very clearly the sharp contrasts between the decontaminated and non-decontaminated zones. At the same time, these zones are in such close proximity that the potential for recontamination from the higher radiation areas will remain long into the future.

Given that this is an area of Namie where there is no restricted access and which formally remains a designated school – even if it is unlikely ever to reopen as such – these levels are deeply worrying. Amongst other reasons for the low population return to Namie are undoubtedly the radiation risks that persist in Namie, which is reflected in the population statistics. As of 31 January 2019 the population of Namie was 4% of its pre-disaster level, at 896, compared with 21,434 in March 2011.[4] It is important to note that this total population also includes new residents who prior to March 2011 did not live in Namie. On the basis of Greenpeace radiation survey investigations, the citizens of Namie are wholly justified in making the difficult decision not to return to their homes.

Lifted evacuation areas - Iitate

The situation in Iitate underlines the complex nature of the radiological condition of the most contaminated areas of Fukushima prefecture. From 2015, Greenpeace has conducted investigations at the home of Mr. Toru Anzai. None of the zones, for which we have complete data sets of radiation levels, have significantly declined during the period from 2016-2018. Explanations for these results include re-contamination through migration of radionuclides from the nearby contaminated forested mountain slopes. The inevitability of re-contamination from the forested mountains, which represent 70% of Iitate, as well as an equal proportion of Namie, is further evidence that the government's limited decontamination program for thousands of homes has been, and will continue to be, ineffective in reducing the risks to citizens of Fukushima if they were to return to their homes.

Radiation survey result overview (Air dose at 1m hight)

	Place name (Weighted average of all zones)	2018				
		Max (μSv/h)	Average (μSv/h)	Number of points	Above 0.23 μSv/h	Above 1 μSv/h
Namie (Area 3 - Exclusion zone)	Obori	24.3	4.0	4,899	100%	100%
	Tsushima	2.8	1.2	1,609	100%	71%
	Ms. Kanno's House	5.9	1.3	2,317	100%	52%
Namie (Lifted evacuation area)	Takase River	4.8	1.9	2,016	98%	59%
	Kindergarten / School	2.9	1.8	1,584	100%	99%
Iitate (Lifted evacuation area)	Mr. Anzai's House	1.7	0.7	4,747	100%	22%

- "Long-term target" = 1 mSv/y (0.23 μSv/h)
  (Japanese Government policy and international limit for public exposure in a non-accidental situation)
- Before the accident : background = 0.04 μSv/h

Workers exposure and exploitation

In 2018, abuse of the human rights of nuclear workers continues, with multiple ongoing legal cases against contractors.[5] The issue was raised by United Nations Human Rights Special Rapporteurs in August 2018 when three Rapporteurs issued a statement to the Japanese government: "We are 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."[6]
As documented by the Greenpeace radiation survey team, workers in Namie are being exposed to high levels of radiation. The decontamination program will continue and be extended during 2019, with the certainty that many more decontamination workers will face an unjustifiable radiation risk for a program that only decontaminates a small fraction of the overall area.[7] These plans for Namie, as well as the other areas in the exclusion zones, cannot be justified from a radioprotection perspective, and there are no prospects over the coming decades that it will be safe for people to return. In personal testimony to Greenpeace, and included in this report, a Fukushima nuclear worker and a representative from the Radiation-exposed Workers' Solidarity Network in Tokyo provides details of the abuse by subcontractors, the role of organized crime, low pay, the recruitment of 'homeless', falsification of health certificates and the lack of any effective radiation training. As told to Greenpeace, "As a worker, I don't feel like I was treated as a human. One person compared it to slavery."[8]

The decontamination program is motivated by the political agenda of Prime Minister Abe's government and corporate interests. The original the Japanese government cost estimate of 2.5 trillion yen for the Fukushima decontamination program was revised in 2016 to 4-5 trillion yen[9] however, independent assessments have estimated that the total cost could reach 30 trillion yen (271 billion dollars).[10] For Japanese contractors, hundreds of subcontractors (and organized crime) this is a source of enormous profit at the taxpayers' expense. All for a program that fails to decontaminate 70% of the most contaminated areas of Fukushima and that violates the rights of workers.

Children's radiation exposure and human rights abuses

The Japanese government found its policies with regards Fukushima children under attack in 2018 at the United Nations General Assembly (UNGA), and again in 2019 at the UN Committee on the Rights of the Child.[11]

UN Human Rights Special Rapporteur Baskut Tuncak, in his report to the UNGA, 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."[12] The Special Rapporteur urged the Japanese government to halt the ongoing relocation of evacuees, who are children and women of reproductive age to areas of Fukushima where radiation levels remain higher than what was considered safe or healthy before the 2011 nuclear disaster. The Special Rapporteur criticized the Japanese government's decision to raise by 20 times what it considered to be an acceptable level of radiation exposure, which "was deeply troubling, highlighting in particular the potentially grave impact of excessive radiation on the health and wellbeing of children."

The Convention of the Rights of the Child (CRC), of which Japan is a signatory, specifies that the best interests of the child, including future generations, must be a "primary consideration" in all actions; with best interest of the child including the requirement of prevention of exposure to toxic chemicals and pollution in order to attain his or her right to the highest standard of health.[13] The UN Committee on the CRC in its report of 1 February 2019 under Principle Concerns and Recommendations made seven important recommendations to the Government of Japan in relation to the Fukushima nuclear disaster.[14] These included recommendations that the government, "(a)Reaffirm that radiation exposure in evacuation zones is consistent with internationally accepted knowledge on risk factors for children; (b) Continue providing financial, housing, medical and other support to evacuees, children in particular, from the non-designated areas (and) (d) Conduct comprehensive and long-term health check-ups for children in areas with radiation doses exceeding 1 mSv/year;"[15] If the Japanese government were to comply with the CRC guidelines and the new recommendations from the CRC Committee and apply it to its Fukushima policy, it would mean adoption of the international recommended maximum of 1 mSv/y (not 20 mSv/y). 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's response to the Fukushima nuclear disaster has utterly failed to meet its international commitments to protect children's human rights.

The risks from radiation are only set to worsen with the impending lifting of evacuation orders in the highest contaminated areas of Namie and Iitate, Katsurao, Futaba and Okuma during the coming years.

Conclusion

In 2019, based on our latest survey, there clearly remains a radiological emergency within the areas of Namie and Iitate which were opened by the government in March 2017. To clarify the use of the word emergency: if these radiation levels were measured in a nuclear facility, immediate action would be required by the authorities to mitigate serious adverse consequences for human health and safety, property and the environment. Risking such exposures for decontamination workers and citizens of Namie and Iitate, including vulnerable populations of women and children, is unjustifiable. Potential exposures to children is of particular concern, as they are both more vulnerable to the impacts of ionizing radiation exposure and are at much greater risk of coming into contact with ground level radiation through play.[16] One year after signaling to United Nations member states that it would accept the

recommendations made at the Human Rights Council Universal Periodic Review (UPR), there is no sign that the Abe government has any intention of changing its Fukushima policies and to instead prioritize the human rights of evacuees, especially those of children and women.

However, so long as the Japanese government remains committed to its failing program in Fukushima, it will continue to come under domestic and international criticism. Eight years after the start of the nuclear disaster, thousands of evacuees are continuing their legal challenges against both TEPCO and the government. These include the judgment of the Tokyo District Court on the criminal prosecution of three TEPCO executives due in early 2019 and the newly initiated lawsuit by citizens of Namie.

The Japanese government is defying United Nations human rights specialists who have challenged the policy of lifting evacuation orders and exposing citizens, in particular women and children, to unsafe radiation levels. At the same time, nuclear workers in Fukushima are continuing to suffer from varied forms of exploitation, including low pay, lack of comprehensive access to medical services, and the abuse of their right to not be exposed to hazardous radiation. The Greenpeace survey results highlight the scale of the ongoing nuclear crisis in the most contaminated areas of Fukushima, and why the United Nations human rights experts are fully justified in expressing their urgent concerns.

Recommendations to the Japanese government

- Suspend its current return policy which ignores Fukushima citizens and which ignores science based analysis, including potential lifetime exposure risks;

- Comply in full with Fukushima recommendations from the United Nations 2017 Universal Periodic Review of Japan, and outstanding United Nations Special Rapporteurs recommendations on all evacuees rights (including those from non designated areas) and workers rights, including to set a maximum radiation exposure to the public of 1 mSv/y;

- Comply in full with its obligations under the Convention of the Rights of the Child, including placing the rights of children at the center of its Fukushima policies and fully implementing the recommendations of the Committee on the Rights of the Child;

- Immediately clarify its long-term decontamination target of 0.23 μSv/h, equal to 1 mSv annual exposure based on the government's calculation, including setting a date for when 0.23 is to be attained, and halt any plans to revise the target level;

- Abandon plans to lift evacuation orders in the six municipalities of Futaba, Okuma, Namie, Tomioka, Iitate and Katsurao; which includes the Namie districts of Tsushima, Murohara, Suenomori and Obori;

- In the interests of worker protection, suspend current decontamination programs in the "Difficult to Return" exclusion zones;

- Establish a fully transparent process to reflect and consider residents' opinions on evacuation policy, including opening a council of citizens including all evacuees;

- Provide full compensation and financial support to evacuees and take measures to reduce radiation exposure based on science and the precautionary principle to protect public health and allow citizens to decide whether to return or relocate, 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 Rapporteur in country visits.

The results of our investigations add further to the urgency for the Abe government to halt its current program of lifting evacuation orders, to comply with its domestic and international human rights obligations and to initiate a comprehensive and publicly accountable review of current policy.

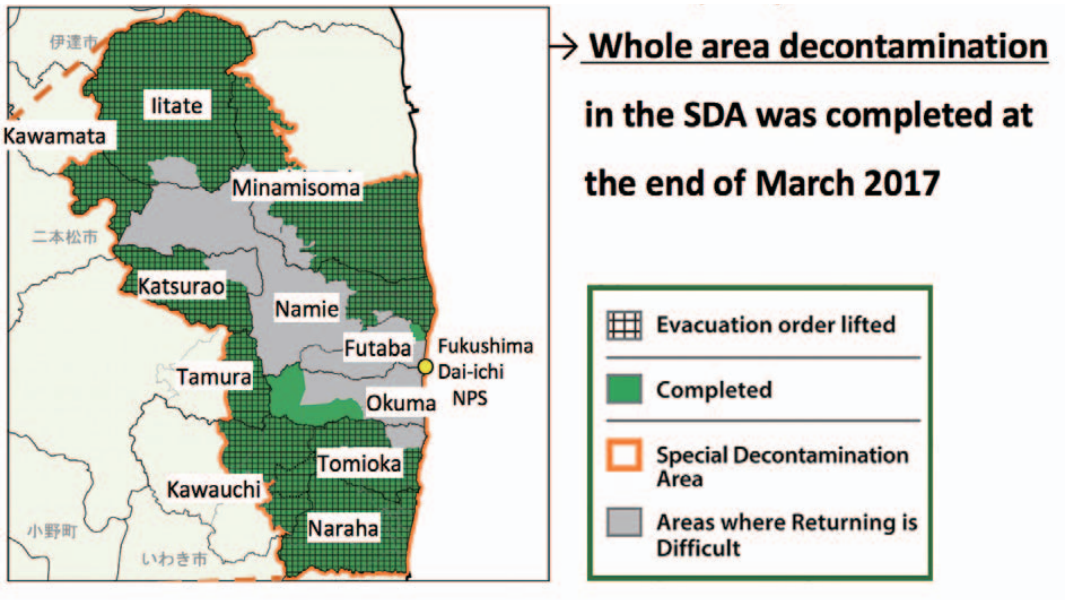
2. Introduction

Eight years after the start of the Fukushima Daiichi nuclear accident, Greenpeace has completed its latest investigation of radiation levels in areas of Fukushima prefecture. Conducted in October 2018, the survey took place in the "Difficult to Return" exclusion zone of Namie, as well as in the lifted evacuation areas of Namie and Iitate. This report has a particular emphasis on the human rights issues and risks faced by those on the frontline of radiation exposure in Fukushima – decontamination workers and children.

The Japanese government Fukushima policies are under mounting domestic and international pressure. Legal actions continue against both TEPCO and the government, brought by thousands of Fukushima citizens, including evacuees, who are demanding full compensation for the damage inflicted on their lives and protection from radiation risks.

As of 2016, 76,951 workers had officially been employed in decontamination work.[17] The 2018 Greenpeace survey included a focus on the specific areas where workers were operating and radiation levels were high. The report includes personal testimony of the systematic exploitation and human rights abuses experienced by workers. As decontamination efforts extend into the highest radiation areas, it is clear that the intervention of United Nations human rights experts on the rights of Fukushima nuclear disaster workers is justified, necessary and urgent. Equally, for Fukushima children, the Japanese government continues to fail to meet its obligations under the United Nations Convention on the Rights of the Child. Greenpeace investigations and analysis have confirmed that the radiation exposure over a lifetime for citizens, including children, returning to the survey areas of Namie and Iitate where evacuation orders have now been lifted, could be high and well beyond the level acceptable from a public health safety perspective.

Greenpeace was only able to conduct the house surveys in both Iitate and in the highly contaminated exclusion area of Namie as a result of the invitation and support of citizen evacuees.



Map1: Fukushima Special Decontamination Area – SDA

(Source: Environmental Remediation in Affected Areas in Japan December, 2018 Ministry of the Environment, Japan)

3. Radiation survey methodology

Radiation protection advisors Ray Lei and Mai Suzuki in zone 5 forest above Mr. Anzai's house, Iitate, Fukushima prefecture, October 2018.
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The Greenpeace radiation team used two different methods for survey work in Namie and Iitate. Radio-cesiums (Cs-137 and Cs-134) contribute to almost all (98%) of the long-term cumulative exposure. During the Fukushima nuclear disaster, equal amounts of Cs-137 and of Cs-134 were released.

1. Scanning

Systematic measurements:

- Ambient dose rate at 1 meter with a high-efficient and calibrated NaI scintillator (Georadis RT30: 2000 cps / µSv.h-1 (Cs-137) with 1 measurement each second.
- High-precision GPS (GNSS Trimble R1) with external antenna and < 1m precision, with 1 set of GPS-coordinates / second.
- Walking in systematic way, without searching for hot spots, where possible in a grid pattern.
- The area around the house is divided into Zones (typically: a field, path, and forests around the house) and each measured separately. We defined around 5-10 Zones around each house, with a minimum of 100 measurement points per Zone, and a median range of 200 - 300 points per Zone. The overall total of measurement points for each house and land area ranged typically between 3,000 - > 5,000 points.
- Statistics are collected for each of these Zones (average, minimum and maximum for each Zone). The average of all the Zones of one house and land area is calculated as a weighted average, with the same weight for each Zone. This also allows a comparison between different years (as the number of measurement points for each year is not identical).

2. Hot spots

In addition, radiation hot spots, which are areas with concentrated radioactivity and other points of interest around the houses, were identified and measured as follows:

- Ambient dose rate at 10 / 50 / 100 cm using a NaI scintillator (Radeye PRD- ER) and GPS position from handheld Garmin Montana 650 were used;
- These points were collected for each of the defined Zones.

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3. Car Scanning

To cover a wider area, we also measured radiation levels from a vehicle, driving at low and constant speed (typically 20 km/h, but when traffic safety did not allow such low speed, max 40 km/h). The Georadis RT30 and GNSS Trimble R1 were mounted outside the car at one meter, with one radiation measurement every second synchronized with GPS data for every second.

4. UAV Scanning

The systematic measurements with the Georadis and precise GNSS (GPS) have proven to be highly accurate and reliable. As mentioned in this report (see section on Iitate - Mr. Anzai) and the 2018 *Reflections in Fukushima* report,[18] the measurements collected since 2015 allow us to compare trends in radiation levels. However, there are some limitations to this approach. As 70% of Fukushima prefecture is mountainous forest there is a physical challenge to accessing on foot, including areas where vegetation is becoming denser each year. Precise replication between one year and the next under such conditions is difficult.

Given the growth of vegetation in evacuated areas such as in the “Difficult to Return” Namie areas, access has been particularly problematic around houses and in the surrounding forests.

In order to surmount these limitations, in 2018 we developed a highly sensitive (Unmanned Aerial Vehicle (UAV) measurement system. The availability of technology that is both light and very sensitive allowed us to demonstrate in October 2018 the feasibility of precise measurements from the air.

From the technology point of view, we deployed the DJI Matrice 200 UAV. More importantly, we used a very light but sensitive CsI(Tl) thallium activated caesium iodide scintillator Kromek (Sigma-50), a LIDAR system to measure the altitude, precise GPS system for locating the measurements and a radio transmission to have real-time readings on the ground. The data is recorded and synchronized on a Raspberry Pi mini-computer mounted under the UAV, with one reading (GPS coordinates, altitude and measurements) for every second.

We tested the use of the UAV monitor at different altitudes and found interesting applications starting from low altitude at 2m up to more than 100m. In section four, you can see an aerial map of the measurements of the surroundings of a school in Namie, measured at 100m.

This new monitoring system is performing extremely well. Even at 100m, which enables virtually all obstacles to be avoided but it is still well below the legal limit of 150m in Japan, the sensitivity of the Kromek Sigma-50 is sufficient with a count rate mostly between 500-4000cps in the areas we measured (including more highly contaminated areas in the “Difficult to Return” area in Namie).

After a successful demonstration of the concept in 2018, Greenpeace will in 2019 further calibrate the UAV monitor. A detailed explanation of the methodology and results will be given once the system is fully operational.

Greenpeace radiation survey UAV in Namie, Fukushima prefecture, October 2018.

4. Radiation survey results

Ms. Kanno at her evacuated home, Shimo-Tsushima, Namie exclusion zone, Fukushima prefecture, October 2018.

Exclusion zone in Namie Town

The “Difficult to Return” exclusion zone in Namie remains in place as of 2019 and is one of six municipalities targeted by the Japanese government for limited decontamination and the lifting of evacuation orders during the period 2020-2023.[19] These areas are designated by the government as “Specified Reconstruction and Revitalization Bases” (SRRB), and decontamination efforts are underway as of 2018.[20] In the case of Namie, the plans cover 661 hectares, equivalent to 3% of the municipality, with a target date for lifting the evacuation order iin the period between 2019 and 2023. Areas surveyed by Greenpeace include the communities of Tsushima and Obori. As in 2017, the survey team were able to conduct their investigations in these areas on the invitation and with the cooperation of Tsushima citizen, Ms. Kanno.

Obori

The community of Obori, around 10 km west-northwest of the Fukushima Daiichi nuclear plant, has been designated as a reconstruction hub by the Japanese government with a target date for lifting evacuation orders in a small area in March 2023.[21] Yet, in all of the survey work conducted by Greenpeace in October 2018, it was this area that showed the most extensive and consistently high radiation levels. In the community of Obori, we took 4,899 measurements with an average of 4.0 µSv/h and a maximum of 24.3 µSv/h. 100% of the points are above 1µSv/h, 88% of the points above 2 µSv/h and 37% above 3.8 µSv/h. At 3.8 µSv/h, a person would receive an annual dose between 20-26 mSv following the methodology of the Japanese government or between 33-43 mSv if exposed 8760 h/year.

If we compare identical sections of the roads in the center of Obori between 2017 and 2018, we see a decrease which cannot be explained by decay and erosion only. This strongly indicates that there has been more intensive decontamination along Route 253 through the center of Obori, with a decrease of the average from 4.3 µSv/h in 2017 to 2.8 µSv/h in October 2018, a decrease of 35%.

Zone name	2018				
	Max (µSv/h)	Average (µSv/h)	Number of points	Above 0.23 µSv/h	Above 1 µSv/h
R253 center Obori (A)	5.4	2.5	1,739	100%	100%
Small roads Center Obori (B)	11.8	3.2	1,793	100%	100%
Sub total to compare 2017 (A+B)	**11.8**	**2.8**	**3,532**	**100%**	**100%**
R253 high contami. Field (C)	24.3	7.0	1,367	100%	100%
ALL Average of all points (NOT WEIGHTED) (A+B+C)	**24.3**	**4.0**	**4,899**	**100%**	**100%**

Zone name	2017				
	Max (µSv/h)	Average (µSv/h)	Number of points	Above 0.23 µSv/h	Above 1 µSv/h
Roads cener Obori, incl. R253	11.6	4.3	2,640	100%	100%

Table1: Radiation measurement data in Obori

Workers in Obori

While Greenpeace was conducting its survey work in Obori, workers were active in small areas of the main Obori settlement. Greenpeace observed the workers as they spent their time clearing areas of grasses and plants along small roads. Greenpeace surveyed the exact location where the workers were operating, and collected data that showed very high average radiation levels, together with even higher concentrations at ground level, including hot spots.

- >= 5μSv/h
- < 5 and >= 3.8μSv/h
- < 3.8 and >= 2μSv/h
- < 2 and >= 1.5μSv/h
- < 1.5 and >= 1μSv/h
- < 1 and >= 0.5μSv/h
- < 0.5 and >= 0.23μSv/h
- < 0.23μSv/h

Image1: Radiation measurement data route in Obori (walking on- and off-road), October 2018

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 μSv/h	17	4%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 μSv/h	64	14%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 μSv/h	368	81%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 μSv/h	7	2%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 μSv/h	0	0%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 μSv/h	0	0%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 μSv/h	0	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 μSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**456**	100%		

Total number of points	**456**
Max. of all points (μSv/h)	7
Min. of all points (μSv/h)	1.9
Average of all points (μSv/h)	3.1

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	456	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	456	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	456	100%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	456	100%	>= 8 mSv/y	>= 13 mSv/y
no. points >= 2	449	98%	>= 10 mSv/y	>= 17 mSv/y
no. points >= 3.8	81	18%	>= 20 mSv/y	>= 33 mSv/y
no. points >= 5	17	4%	>= 26 mSv/y	>= 43 mSv/y

(*) av. Doserate of 40nSv/h before March 2011 substracted

Table 2: Radiation measurement data in Obori Zone 01 (walking on- and off-road) 456 points (height 1 m), October 26, 2018

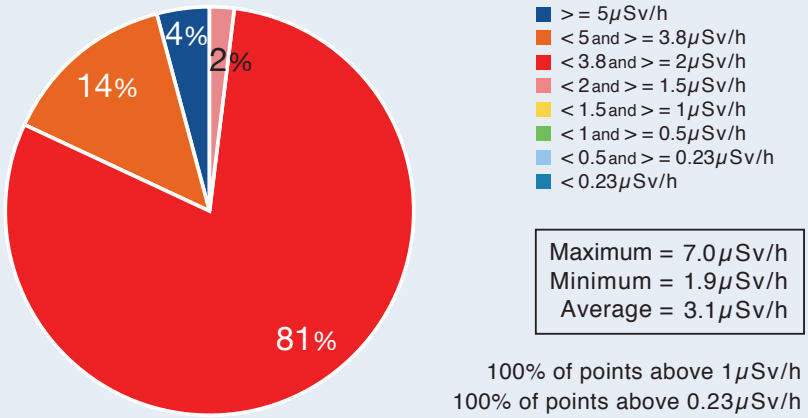


Chart 1 : Breakdown of dose rates in Zone 01 (walking on- and off-road)
456 points (height of 1m), October 26, 2018

In part of what we designated as Zone 1 in Obori (Image 1, Table 2 and Chart 1), for 98% of the road and paths where workers were operating, the dose rate was above 2 µSv/h. The average across all measuring points was 3.1 µSv/h, with maximum measurements of 7 µSv/h at 1 meter. For 81% the annual exposure would be between 10-20 mSv based on the government model, and between 17-33 mSv based on 8760 hours.

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 µSv/h	1,158	85%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 µSv/h	166	12%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 µSv/h	43	3%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 µSv/h	0	0%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 µSv/h	0	0%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 µSv/h	0	0%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 µSv/h	0	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 µSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**1,367**	100%		

Total number of points	**1,367**
Max. of all points (µSv/h)	24.3
Min. of all points (µSv/h)	3.1
Average of all points (µSv/h)	7

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	1,367	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	1,367	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	1,367	100%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	1,367	100%	>= 8 mSv/y	>= 13 mSv/y
no. points >= 2	1,367	100%	>= 10 mSv/y	>= 17 mSv/y
no. points >= 3.8	1,324	97%	>= 20 mSv/y	>= 33 mSv/y
no. points >= 5	1,158	85%	>= 26 mSv/y	>= 43 mSv/y

(*) av. Doserate of 40nSv/h before March 2011 substracted

Table 3 : Radiation measurement data in Obori Zone 02 (walking on- and off-road)
1367 points (height 1 m), October 26, 2018

To put these figures in perspective, a worker exposed to 3.1 μSv/h, which is the average of this part for Zone 1, would receive the equivalent of 270 chest X-rays a year (one every 32 hours) based on the Japanese government methodology, and 447 X-rays a year based on full time exposure. The dose figure for a chest X-ray in Japan is 60 μSv as reported by the Ministry of Economy, Trade and Industry, METI. It should be noted that the workers are not in this one location through an entire year, but move to other areas upon completion of their work.

In Zone 2 in Obori (Table 3), which was on a road along the Takase River, the radiation levels were significantly higher than Zone 1. Average levels for 1,367 measuring points was 7 μSv/h, with a maximum of 24.3 μSv/h. For 85% of this area, annual dose rates would be 26 mSv or above based on the Japanese government methodology, and 43 mSv or above, based on 8760 hours over one year. The equivalent number of chest X-rays would be greater than 436 and 724, a chest X-ray every 20 and 12 hours, respectively.

Hot spots in Obori

In addition to systematic scanning of the radiation levels in Obori, the radiation survey team also took measurements of hot spots. Clearly, hot spots are not representative of the average radiation levels in the surveyed zones. However, these hot spots highlight that, in addition to the generally elevated levels of radiation throughout the area, there are multiple places where levels are many times higher (at one meter) than the government's long-term decontamination target of 0.23 μSv/h, and even more so than the background levels prior to the Fukushima Daiichi nuclear disaster in 2011, which were 0.04 μSv/h.

2018/10/23
Namie

Dose rate (μSv/h)
at 1m: 12
at 0.5m: 19
at 0.1m: 64.9

Image2: Hot spots in Obori along road and path (walking), October 2018

In the Obori hamlet, along a road and path where workers were operating on 23 October 2018, radiation hot spots were measured at 12 μSv/h at 1 meter, 19 μSv/h at 0.5 meters, and 64.9 μSv/h at 0.1 meters. (See Image 2) To put these figures into context, at this one location radiation readings were 300 times higher at one meter than the background levels of 0.04 μSv/h in the prefecture before March 2011.

Decontamination workers, often operating at ground level, are being subjected to levels of radiation that if they were in a nuclear facility would be considered an emergency situation requiring immediate controlled action.[22] Our experience of observing the workers is that they are almost completely unaware of the actual radiological conditions they are working under. In other areas of Obori, where decontamination work is expected at some point in the future, radiation levels were even higher.

2018/10/23
Namie

Dose rate (μSv/h)
at 1m: 29
at 0.5m: 45
at 0.1m: 125

Image3: Hot spots measurement along Takase River (walking on-road), October 2018

Along the Takase River, which flows through both Obori and Namie then on to the Pacific Ocean, the survey team consistently measured very high hot spots, including levels of 29 μSv/h at 1 meter, 45 μSv/h at 0.5 meters, and 125 μSv/h at 0.1 meters near the small hamlet of Tateishi in Obori (Image 3). These radiation readings were 725 times higher at one meter than background levels of 0.04 μSv/h in the prefecture before the March 2011 Fukushima Daiichi nuclear accident.

Tsushima

In the small community of Tsushima, 30 km from the Fukushima Daiichi plant, (Table 4) Greenpeace surveyed the road measuring average radiation readings of 1.2 μSv/h and a maximum level of 2.8 μSv/h. These are effectively the same values as in 2017. Tsushima, along with other areas in Namie, specifically Murohara, Suenomori and Obori, have been targeted by the government as 'reconstruction hubs' with the aim of lifting the evacuation order for an area of 660 hectares in total by 2023.[23] Greenpeace observed workers conducting decontamination work in Tsushima in October 2018, and although the radiation levels are lower when compared with Obori, they are significant and pose a direct risk to workers' health.

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 μSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 μSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 μSv/h	56	3%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 μSv/h	295	18%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 μSv/h	793	49%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 μSv/h	457	28%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 μSv/h	8	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 μSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**1,609**	100%		

Total number of points	**1,609**
Max. of all points (μSv/h)	2.8
Min. of all points (μSv/h)	0.4
Average of all points (μSv/h)	1.2

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	1,609	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	1,601	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	1,144	71%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	351	22%	>= 8 mSv/y	>= 13 mSv/y
no. points >= 2	56	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

(*) av. Doserate of 40nSv/h before March 2011 substracted

Table 4 : Breakdown of doserate in Zone 01 road from gate to gate (walking on- and off-road) 1609 points (height 1 m), October 25, 2018.

Ms. Kanno's house in Tsushima

The home of Ms. Kanno is located in Shimo-Tsushima in the district of Namie, 30 km west-northwest of the Fukushima Daiichi nuclear plant. It was subjected to significant radiation contamination resulting from the March 2011 nuclear accident. The government selected the house for demonstrating its decontamination techniques and it was subjected to considerable effort during December 2011 and February 2012. Greenpeace conducted its first radiation survey in September 2017, with a follow-up survey in October 2018. The focus of the research was on the immediate area around the house, as well as on the family's farmland and forest.

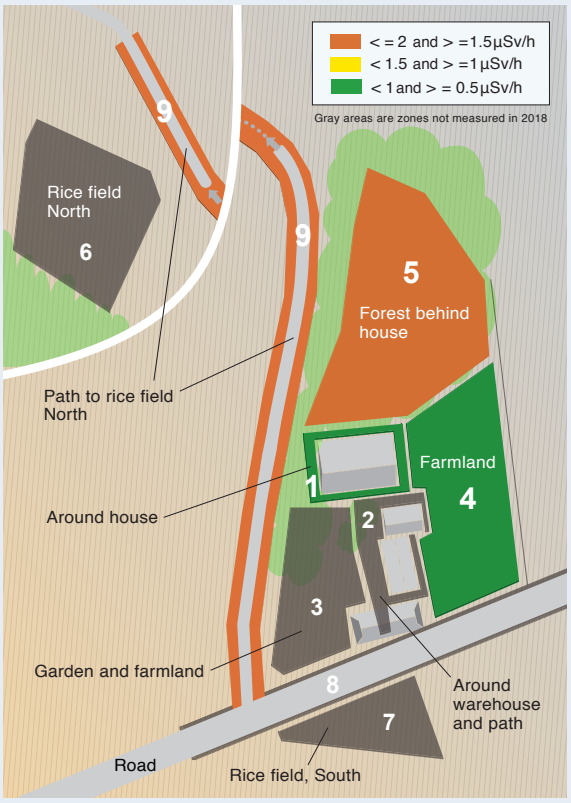


Diagram1: Schematic of Ms. Kanno's house in Shimo-Tsushima, Namie exclusion zone, Fukushima prefecture, showing the designated Zones for the Greenpeace radiation survey team.

Zone name		Max (µSv/h)		Average (µSv/h)		Number of points		Above 0.23 µSv/h		Above 1 µSv/h	
		2018	2017	2018	2017	2018	2017	2018	2017	2018	2017
Zone 1	Around house	0.9	1.3	0.6	0.7	394	238	100%	100%	0%	9%
Zone 2	Around warehouse and path	n/a	2.1	n/a	1.1	n/a	550	n/a	100%	n/a	58%
Zone 3	Garden and farmland	n/a	1.8	n/a	0.8	n/a	383	n/a	100%	n/a	13%
Zone 4	Farmland	1.3	1.2	0.8	0.9	597	447	100%	100%	12%	24%
Zone 5	Forest behind house	2.4	2.8	2	1.9	330	902	100%	100%	100%	95%
Zone 6	Rice field, North	n/a	2.4	n/a	1.9	n/a	761	n/a	100%	n/a	100%
Zone 7	Rice field, South	n/a	1.9	n/a	1.5	n/a	403	n/a	100%	n/a	95%
Zone 8	Road	n/a	1.6	n/a	0.7	n/a	470	n/a	100%	n/a	14%
Zone 9	Path to rice field North	5.9	5.8	1.6	1.7	996	951	100%	100%	81%	91%
ALL	**Weighted average of all zones**	**5.9**	**5.8**	**1.3**	**1.3**	**2,317**	**5,105**	**100%**	**100%**	**52%**	**67%**

Table 5: Breakdown of doserate in all Zones at Ms. Kanno house (walking on- and off-road) 2317 points (height 1 m), October 27, 2018.

Overall, the weighted average recorded in October 2018 was 1.3 µSv/h for the four Zones measured at Ms. Kanno's home (Table 5), which remains unchanged since September 2017. Maximum levels in October 2018 were 5.9 µSv/h, compared with 5.8 µSv/h in 2017. This trend is consistent with Greenpeace survey results in Iitate from 2015-2018 and the results of survey work at Ms. Kanno's house in 2017.

The results demonstrate the complex and persistent nature of radionuclide contamination in the most highly contaminated areas of Fukushima prefecture.

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 μSv/h	3	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 μSv/h	4	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 μSv/h	470	20%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 μSv/h	463	20%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 μSv/h	265	11%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 μSv/h	953	41%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 μSv/h	159	7%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 μSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**2,317**	100%		

Total number of points	**2,317**
Max. of all points (μSv/h)	5.9
Min. of all points (μSv/h)	0.3
Average of all points (μSv/h)	1.3

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	2,317	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	2,158	93%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	1,205	52%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	940	41%	>= 8 mSv/y	>= 13 mSv/y
no. points >= 2	477	21%	>= 10 mSv/y	>= 17 mSv/y
no. points >= 3.8	7	0%	>= 20 mSv/y	>= 33 mSv/y
no. points >= 5	3	0%	>= 26 mSv/y	>= 43 mSv/y

(*) av. Doserate of 40nSv/h before March 2011 substracted

Table 6: Radiation in all Zones at Ms. Kanno's house (walking on- and off-road) 2317 points (height 1 m), October 27, 2018.

Annual dose rates for 31% of the areas at Ms. Kanno's house (Table 6) could lead to an exposure between 5-10 mSv/y based on the Japanese government' methodology and between 8-17 mSv/y based on sustained exposure over one full year. For 20% of the measuring points in the area for annual exposure would be between 10-20 mSv based on the Japanese government' methodology and between 17-33 mSv based on sustained exposure over one full year.[24] The International Commission on Radiological Protection (ICRP) recommendation for the public sets the maximum additional recommended dose at 1 mSv/y.[25] 100% of the measuring points exceeded the government's current long-term radiation target level of 0.23 μSv/h. In Zone 1, which is in the immediate vicinity of the house (within 5-10 meters) and where workers had conducted decontamination, radiation levels were on average 0.6 μSv/h, compared to 0.7 μSv/h in 2017; in Zone 9, the path along to the rice field had an average of 1.6 μSv/h and a maximum level of 5.9 μSv/h compared to 1.7 μSv/h and 5.8 μSv/h respectively in 2017.

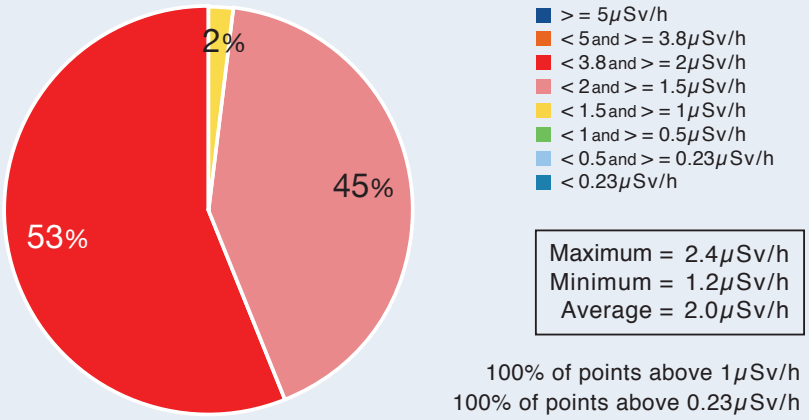


Chart 2: Radiation in Zone 05: forest behind house (walking on) 330 points (height of 1 m), 27 October 2018

The house itself is surrounded on three sides by forest which has grown extensively since 2011. The survey results in Zone 5 (Chart 2), an accessible forest area just behind the house, reveal the limited impact of decontamination. The average measured 2 μSv/h with peak levels of 2.4 μSv/h, compared with 1.9 μSv/h and 2.8 μSv/h in 2017 respectively.

In 53% of the forested area radiation levels in Zone 5 would lead to an exposure of between 10-20 mSv over one year based on the Japanese government methodology and 17-33 mSv based on permanent exposure over one full year.

In terms of lifetime exposure (70 years), taking the average for the four zones, dose rates would range from 170 mSv to 283 mSv depending on time spent outside, with these ranges based on 8 hours and 24 of hours per day, respectively.

Additional data from Ms. Kanno house survey is contained in Appendix.

Ms. Kanno and Greenpeace radiation survey team arriving at her house in Shimo-Tsushima, Namie exclusion zone, Fukushima prefecture, October 2018.

Lifted evacuation order area in Namie Town and Iitate Village

On 31 March 2017 the Japanese government lifted the evacuation orders for areas in Namie Town and Iitate Village, which lie north and northwest of the Fukushima Daiichi nuclear plant, and are not in the "Difficult to Return" Zone. In March 2011, the populations of Iitate and Namie Districts were 6,509 and 21,434 respectively.[26] As of 31 January 2019, the population of Namie was 896, and the population of Iitate was 1003 as of 1 February 2019.[27] Greenpeace conducted radiation surveys in Namie and Iitate in 2011, as well as from 2015 to the present in Iitate. In September 2017, Greenpeace extended its survey to the central area of Namie town where the majority of the population formerly lived. As with the results of our surveys in Iitate conducted in 2015, 2016 and 2017, we found that radiation levels in the area of Namie Town where the evacuation order has been lifted are significantly higher than the government's current long-term target level of 0.23μSv/h.

- Namie Town

Namie Town lies 10 km north-northwest of the Fukushima Daiichi nuclear plant, and has clearly undergone extensive decontamination between 2014 and March 2017. However, in areas surveyed by Greenpeace this decontamination has clearly failed to reduce radiation levels to the government's current long-term target of 0.23 μSv/h.

The Takase River, which flows through Namie Town, acts as a crossing point between the publicly open area and "Difficult to Return" Zone of Namie. In October 2018, Greenpeace extended its survey in this area following our initial investigations in 2017.

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 μSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 μSv/h	94	5%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 μSv/h	942	47%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 μSv/h	54	3%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 μSv/h	108	5%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 μSv/h	344	17%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 μSv/h	431	21%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 μSv/h	43	2%	< 1 mSv/y	< 2 mSv/y
Total number of points	**2,016**	100%		

Total number of points	**2,016**
Max. of all points (μSv/h)	4.8
Min. of all points (μSv/h)	0.2
Average of all points (μSv/h)	1.9

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	43	2%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	1,973	98%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	1,542	76%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	1,198	59%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	1,090	54%	>= 8 mSv/y	>= 13 mSv/y
no. points >= 2	1,036	51%	>= 10 mSv/y	>= 17 mSv/y
no. points >= 3.8	94	5%	>= 20 mSv/y	>= 33 mSv/y
no. points >= 5	0	0%	>= 26 mSv/y	>= 43 mSv/y

(*) av. Doserate of 40nSv/h before March 2011 substracted

Table 7 : Radiation in Zone 02; forest along river (walking on-and off-road) 2016 points (height of 1m), October 19, 2018

At the Takase River, near the hamlet of Tawatsuda, in Zone 2, (Table 7 and Chart 3) the average levels were 1.9 μSv/h with a maximum of 4.8 μSv/h. These are respectively 8 and 20 times higher than the government's long-term 0.23 μSv/h decontamination target, and are between 48 and 120 times higher than the pre-2011 Fukushima Daiichi nuclear disaster levels. In 2017, our more limited survey found an average in this area of 1.4 μSv/h and a maximum of 2.7 μSv/h. In 47% of the area surveyed in October 2018 radiation levels would give an annual radiation dose of between 10-20 mSv based on the Japanese government methodology and between 17-33 mSv based on full exposure. In 5% of the area the annual exposure would be between 20-26 mSv based on the Japanese government methodology and between 33-43 mSv based on full exposure.

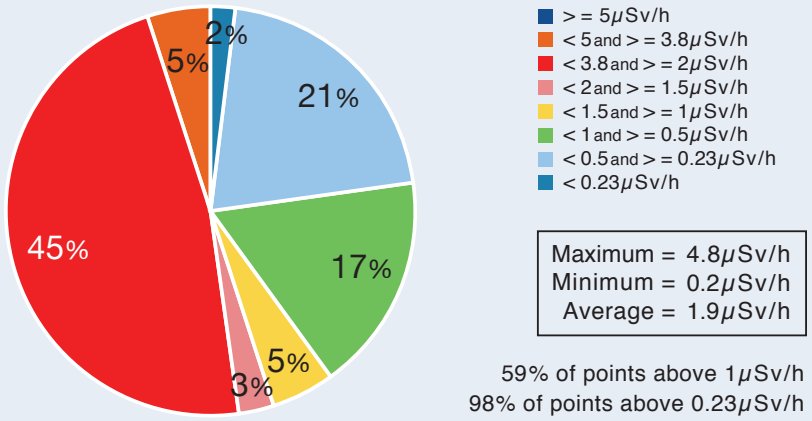


Chart 3 : Radiation in Zone 02; forest along river (walking on-and off-road)
2016 points (height of 1 m), October 19, 2018

- Namie kindergarten and school

Greenpeace returned to a kindergarten and school in Namie surveyed in 2017 where we had investigated radiation levels, including in a small forested area adjacent to the school, where in 2017 the average radiation level was 2 µSv/h with a maximum of 3.1 µSv/h (see Image 4). As measured in 2017, in 82% of the areas annual dose would be between 8-10mSv based on the Japanese government methodology and 13-17mSv based on full exposure. Hot spots in the forest reached up to 5 µSv/h.

Given that this is an area of Namie where there is no restricted access these levels are deeply concerning and in October 2018, we consequently extended our survey in this area around the kindergarten and school.

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 µSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 µSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 µSv/h	438	28%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 µSv/h	863	54%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 µSv/h	271	17%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 µSv/h	12	1%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 µSv/h	0	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 µSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**1,584**	100%		

Total number of points	**1,584**
Max. of all points (µSv/h)	2.9
Min. of all points (µSv/h)	0.8
Average of all points (µSv/h)	1.8

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	1,584	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	1,584	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	1,572	99%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	1,301	82%	>= 8 mSv/y	>= 13 mSv/y
no. points >= 2	438	28%	>= 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

(*) av. Doserate of 40 nSv/h before March 2011 substracted

Table 8 : Radiation in Zone 03; forest in front of school (walking on- and off-road)
1584 points (height of 1 m), October 19, 2018

In our October 2018 survey (Table 8 and Chart 4), the average radiation level in Zone 3, a forested area, was 1.8 μSv/h with a maximum of 2.9 μSv/h. In 28% of this area, the annual dose would be between 10-20 mSv based on the Japanese government methodology and between 17-33 mSv based on sustained exposure over a full year. 100% of all points measured exceeded the Japanese government's long-term decontamination target of 0.23 μSv/h.

Obori, Namie, in Fukushima Prefecture, October 2018.

In our survey work in this area, we used our radiation-measuring UAV. The UAV measurements of the school area and surroundings is particularly interesting. Decontamination has taken place at the school property, as well in the fields south of the school property. However, as our aerial survey showed (see Image 4), the forest north of the school property has only been decontaminated 20 meters from the road. The aerial measurements reveal very clearly the sharp contrasts between the decontaminated and non-decontaminated zones. It also visualizes clearly the general problem encountered in decontaminated areas whereby the relatively small areas that have been decontaminated are surrounded by large areas that are not decontaminated. This has been further described in this and the last year's report.

As mentioned in Section 3 on the methodology of the measurements, the purpose of the 2018 UAV measurements was to demonstrate how the concept works, and the further calibration of the drone system will take place in 2019. But as a rough indication, the readings in counts per second from at a 100 meters altitude above the ground level are a factor 2 higher above the forest area North of the school property compared to the decontaminated schoolyard.

The interpretation of these figures require a proper understanding of the UAV measurements physics. For the small decontaminated schoolyard measured at a 100 meters altitude, the higher contaminated areas around the schoolyard will also contribute to the reading above the schoolyard, so there is an averaging effect between smaller areas. For larger homogeneous areas, the measurements at 100m will reflect more accurately the actual contamination levels as measured at a standard 1 meter altitude. It is worth noting that the standard aerial surveys conducted by Japanese authorities are conducted at a target level between 150-300m, with results in an even greater averaging of on the ground radiation levels.

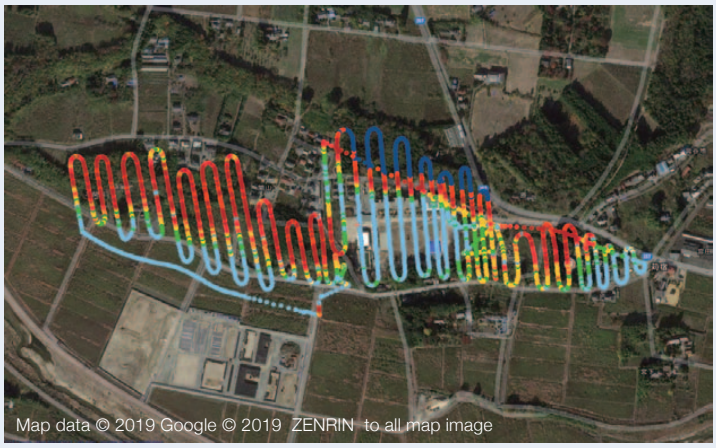


Image4: UAV Aerial survey at 100 meters of kindergarten and school, Namie Town, October 2018.

The colors on this image reflect the range of counts per second (CPS) and therefore the variation in radiation levels, with light blue over schoolyard lower than the red and dark blue above the forests.

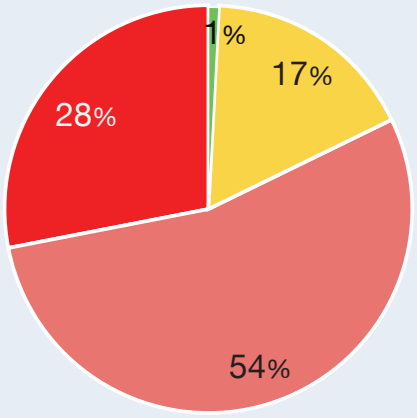


Chart 4: Radiation in Zone 03; forest in front of school (walking on- and off-road)
1584 points (height of 1 m), October 19, 2018

To put these figures in perspective, a child exposed to 1.8 μSv/h, which is the average for Zone 3, the forest in front of the school entrance, would receive the equivalent of 9 mSv/y, equivalent to 156 chest X-rays a year based on the Japanese government methodology, and 15.4 mSv/y, equivalent to 257 chest X-rays a year, based on full time exposure.

2018/10/19
Namie

Dose rate (μSv/h)
at 1m: 3.3
at 0.5m: 4.23
at 0.1m: 5.08

Image5: Hot spots kindergarten and school in Namie town

- Hot spots in Namie Town

Many hot spots were identified adjacent to the kindergarten and school. The highest of these was 3.3 μSv/h at one meter, 4.23 μSv/h at 0.5 meters, and 5.08 μSv/h at 0.1 meters (Image 5). This is 14 times higher than the Japanese government's long-term decontamination target. If such levels were to be found in a nuclear facility, it would require emergency control measures to be deployed – and yet this is not a nuclear facility but opposite a kindergarten and school.

- Mr. Anzai's house in Iitate Village

Since 2015, Greenpeace has been conducting radiation surveys at the house of Mr. Toru Anzai which is located in the south-east of Iitate Village, 35 km from the Fukushima Daiichi nuclear power plant. Mr. Anzai evacuated from his home on 24 June 2011. The house and the surrounding area were subjected to extensive decontamination by the authorities during the period 2014-2015. This involved scraping away a layer of more than 5 cm of topsoil, which was then removed from the site and stored as radioactive waste. In some cases, the surface was covered over with uncontaminated soil. The survey results from Mr. Anzai's house in 2015 - 2018 are shown in Table 9.

Belongings of Mr Anzai after demolition of his house in 2018, Iitate, Fukushima prefecture, October 2018.

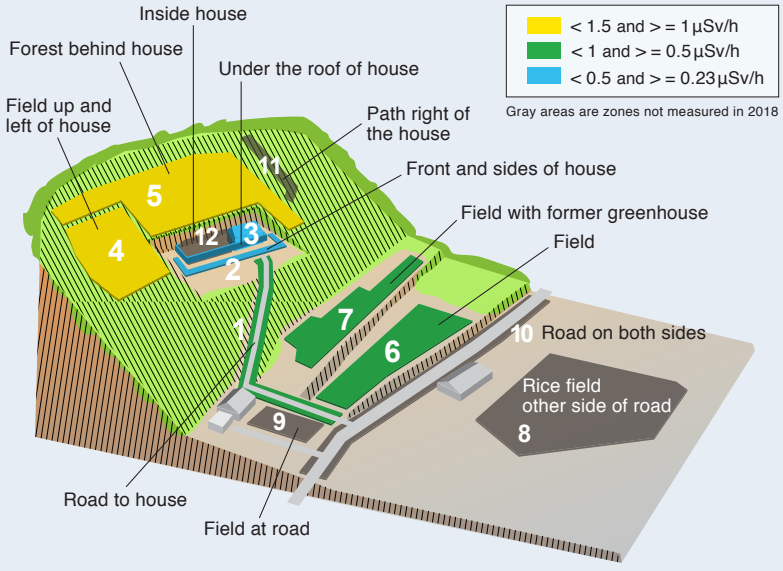


Diagram 2: Schematic of Mr. Anzai's house in Iitate, showing the designated Zones for the Greenpeace radiation survey team.

Readings were taken at a total of 4,747 measurement points in October 2018. When conducting the survey in October 2015, decontamination work was still in progress, which led us to conclude in 2016 that the measured decrease was a combined effect of further decontamination, decay and erosion.

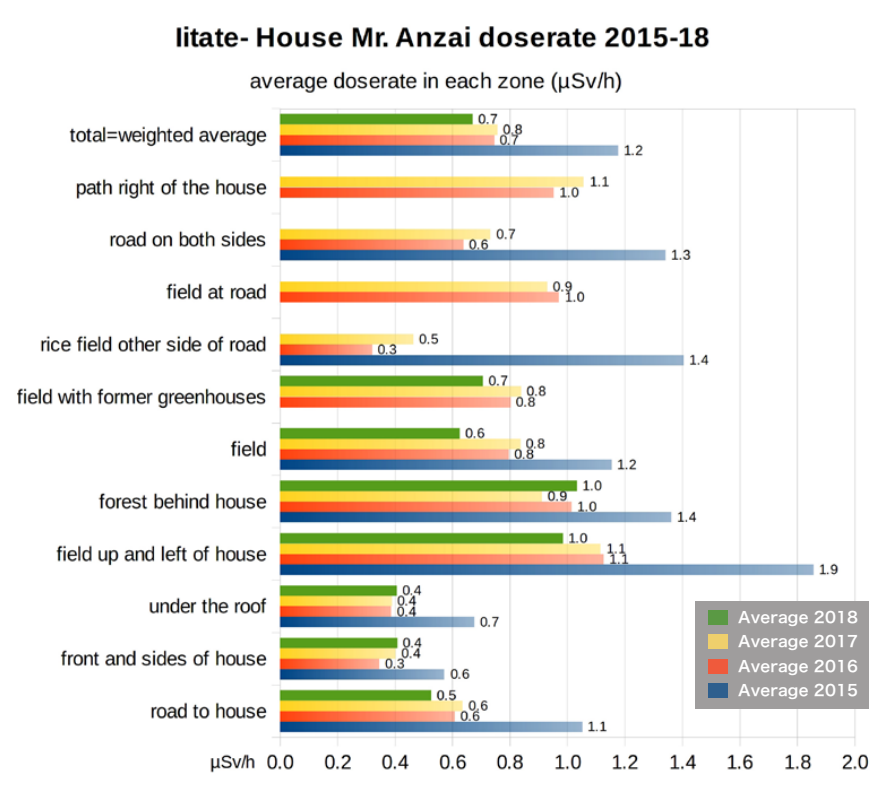


Chart 5: Average dose rates and comparison from 2015 to 2018 at Mr. Anzai's house

Table 9 : Radiation survey data, Mr. Anzai's house - 2015-2018

Zone name		Max (µSv/h)				Average (µSv/h)				Average % of previous year				Number of points				Above 0.23 µSv/h				Above 1 µSv/h			
		2018	2017	2016	2015	2018	2017	2016	2015	2018	2017	2016	2015	2018	2017	2016	2015	2018	2017	2016	2015	2018	2017	2016	2015
Zone 1	Road to house	1.0	0.9	0.8	1.4	0.5	0.6	0.6	1.1	83%	105%	58%	n/a	447	255	264	481	100%	100%	100%	100%	0%	0%	0%	78%
Zone 2	Front and sides of house	0.9	0.8	0.7	1.3	0.4	0.4	0.3	0.6	102%	116%	60%	n/a	464	372	301	234	98%	98%	87%	100%	0%	0%	0%	4%
Zone 3	Under the roof of house	0.9	0.6	0.7	1.2	0.4	0.4	0.4	0.7	105%	101%	57%	n/a	629	186	169	573	99%	98%	98%	100%	0%	0%	0%	11%
Zone 4	Field up and left of house	1.3	1.4	1.5	2.3	1.0	1.1	1.1	1.9	88%	99%	61%	n/a	542	365	283	524	100%	100%	100%	100%	62%	88%	88%	100%
Zone 5	Forest behind house	1.7	1.6	1.5	2.2	1.0	0.9	1.0	1.4	113%	90%	75%	n/a	952	644	358	814	100%	100%	100%	100%	65%	48%	53%	71%
Zone 6	Field	1.1	1.1	1.1	2.0	0.6	0.8	0.8	1.2	75%	105%	69%	n/a	1,018	370	327	1,126	100%	100%	100%	100%	1%	8%	2%	73%
Zone 7	Field with former greenhouses	1.4	1.4	1.6	n/a	0.7	0.8	0.8	n/a	84%	105%	n/a	n/a	695	607	578	n/a	100%	100%	100%	n/a	10%	16%	18%	n/a
Zone 8	Rice field other side of road	n/a	1.2	0.6	1.7	n/a	0.5	0.3	1.4	n/a	145%	23%	n/a	n/a	510	239	332	n/a	100%	98%	100%	n/a	3%	0%	100%
Zone 9	Field at road	n/a	2.0	1.5	n/a	n/a	0.9	1.0	n/a	n/a	96%	n/a	n/a	n/a	183	103	n/a	n/a	100%	100%	n/a	n/a	22%	30%	n/a
Zone 10	Road on both sides	n/a	1.4	1.0	2.6	n/a	0.7	0.6	1.3	n/a	115%	48%	n/a	n/a	857	194	592	n/a	100%	100%	100%	n/a	4%	1%	95%
Zone 11	Path right of the house	n/a	1.6	1.5	n/a	n/a	1.1	1.0	n/a	n/a	111%	n/a	n/a	n/a	339	245	n/a	n/a	100%	100%	n/a	n/a	65%	50%	n/a
Zone 12	Inside house	n/a	0.7	n/a	0.9	n/a	0.3	n/a	0.5	n/a	n/a	n/a	n/a	n/a	215	n/a	817	n/a	100%	n/a	100%	n/a	0%	n/a	0%
ALL	**Weighted average of all zones**	**1.7**	**2.0**	**1.6**	**2.6**	**0.7**	**0.8**	**0.7**	**1.1**	**89%**	**101%**	**68%**	**n/a**	**4,747**	**4,903**	**3,061**	**5,493**	**100%**	**100%**	**98%**	**100%**	**22%**	**22%**	**23%**	**58%**

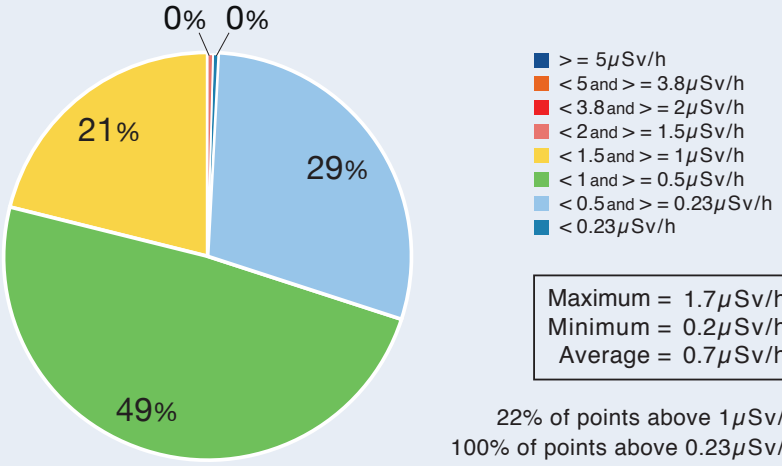


Chart 6: Radiation in all Zones (walking on- and off-road)
4747 points (height of 1 m), October 24, 2018

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 μSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 μSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 μSv/h	0	0%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 μSv/h	19	0%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 μSv/h	1,013	21%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 μSv/h	2,331	49%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 μSv/h	1,370	29%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 μSv/h	14	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**4,747**	100%		

Total number of points	**4,747**
Max. of all points (μSv/h)	1.7
Min. of all points (μSv/h)	0.2
Average of all points (μSv/h)	0.7

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	14	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	4,733	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	3,363	71%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	1,032	22%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	19	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

(*) av. Doserate of 40 nSv/h before March 2011 substracted

Table 10: Radiation in all Zones (walking on- and off-road)
4747 points (height of 1 m), October 24, 2018

In October 2018, 100% of all measurements in five of the seven Zones exceeded the government target of 0.23 μSv/h, with 22% in excess of 1 μSv/h (Chart 6 and Table 10). For all the Zones outside Mr. Anzai's house, the weighted average from October 2018 was 0.7 μSv/h, which compares with 0.8 μSv/h in 2017, and 0.7 μSv/h in November 2016. In 2015, decontamination was still ongoing and the levels recorded in 2016 and 2017, after decontamination had been completed, have mostly remained stable.

Intervals	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
>= 5 μSv/h	0	0%	>= 26 mSv/y	>= 43 mSv/y
< 5 and >= 3.8 μSv/h	0	0%	>= 20 mSv/y	>= 33 mSv/y
< 3.8 and >= 2 μSv/h	0	0%	>= 10 mSv/y	>= 17 mSv/y
< 2 and >= 1.5 μSv/h	19	2%	>= 8 mSv/y	>= 13 mSv/y
< 1.5 and >= 1 μSv/h	598	63%	>= 5 mSv/y	>= 8 mSv/y
< 1 and >= 0.5 μSv/h	335	35%	>= 3 mSv/y	>= 4 mSv/y
< 0.5 and >= 0.23 μSv/h	0	0%	>= 1 mSv/y	>= 2 mSv/y
< 0.23 μSv/h	0	0%	< 1 mSv/y	< 2 mSv/y
Total number of points	**952**	100%		

Total number of points	**952**
Max. of all points (μSv/h)	1.7
Min. of all points (μSv/h)	0.5
Average of all points (μSv/h)	1

uSv/h	Number of points	% of points	mSv/y (Japan govt.)(*)	mSv/y if 8,760h/y (*)
no. points < 0.23	0	0%	< 1 mSv/y	< 2 mSv/y
no. points >= 0.23	952	100%	>= 1 mSv/y	>= 2 mSv/y
no. points >= 0.5	952	100%	>= 3 mSv/y	>= 4 mSv/y
no. points >= 1	617	65%	>= 5 mSv/y	>= 8 mSv/y
no. points >= 1.5	19	2%	>= 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

(*) av. Doserate of 40 nSv/h before March 2011 substracted

Table 11: Radiation in forest behind house (walking off-road) 952 points (height of 1 m), October 24, 2018

The decontamination was much less effective in Zone 5. This problem is similar to many houses in Iitate which are also located in close proximity to hillside forests and where it is not possible to decontaminate. As is standard practice throughout the contaminated regions, an area up to 20 meters from Mr. Anzai's house into the forest has been 'decontaminated'. In Zone 5, including a non-decontaminated area, we measured a decrease from an average of 1.4 μSv/h in 2015 to 1.0 μSv/h in 2016, and 0.9 μSv/h in September 2017. In 2018 we measured the levels in Zone 5 at an average of 1.0 μSv/h. The maximum measurement was 1.7 μSv/h, compared with 1.6 μSv/h in 2017. The radiation levels on steep slopes close to houses are crucial as they have a direct impact on the radiation levels inside houses. We also expect that radioactivity from the non-decontaminated forest might re-contaminate the already decontaminated area below and closer to houses. In the case of Mr. Anzai, his house was demolished in 2018, and there are currently no plans to rebuild at this location.

The survey data from 2015-2018 in Table 9 underlines the complex nature of the radiological condition in one of the most contaminated areas of Iitate Village. In none of the seven Zones at Mr. Anzai's home, for which we have complete data sets, did radiation levels significantly decline during the period from 2016-2018. Explanations for these results include re-contamination through migration of radionuclides from the nearby contaminated forested mountain slopes, and possibly some variation in the precise survey track due to the topography and rough terrain in these areas. The inevitability of re-contamination from the forested mountains, which represent 70% of Iitate, as well as an equal proportion of Namie, is further evidence that the government's limited decontamination program for thousands of homes has been, and will continue to be, ineffective in reducing the risks to citizens of Fukushima if they were to return to their homes.

Additional data from the surveys in Namie and Iitate are contained in the Appendixes.

Conclusion

The conclusions of our radiation survey work in both the “Difficult to Return” exclusion areas of Namie and the areas of Iitate and Namie in which evacuation orders have been lifted reveal complex radiologically contaminated areas of Fukushima prefecture that are not safe for human settlement given radiation exposure levels in excess of the international recommended maximum. For the most contaminated areas of Namie, inside the exclusion zone, and including Obori and Tsushima, decontamination efforts now underway will have only a limited effect in reducing overall contamination, while leaving most of the areas heavily contaminated. The fact that workers are being exposed to high radiation levels for a flawed program, and where projections of eventual population return are at a lower rate, highlights that the current government policy is without justification. For the opened area of Iitate, areas measured by the survey team show radiation levels did not significantly decline during the 2016-2018 period. This is to be expected given the 30 year half life of cesium-137, the predominant radionuclide as of 2018, as well as risks of re-contamination from nearby contaminated forested mountain slopes.

The conclusion of our survey work in the opened area of Namie is that despite major decontamination efforts, the radiation levels were consistently higher than the government’s long-term target of 0.23 μSv/h. Elevated radiation levels along roads and next to forests are clearly not safe from a radiation exposure perspective. Particularly concerning are the levels of radiation around the kindergarten and school, as well as along the Takase River. Amongst other reasons for the low population return to Namie are undoubtedly the persistent radiation risks. As of January, the population of Namie was 896, or 4% of what it was in 2011. On the basis of Greenpeace’s radiation survey investigations, the citizens of Namie are wholly justified in making the difficult decision not to return to their homes.

Hot spot radiation reading of 108 microSieverts at 0.1 meters, Obori, Namie exclusion zone, Fukushima prefecture, October 2018.

5. Human rights and Fukushima nuclear workers

Worker collecting grasses, Obori, Namie exclusion zone, Fukushima prefecture, October 2018.

"TEPCO is God. The main contractors are kings, and we are slaves."

Tanaka, homeless Fukushima worker, Sendai, August 2015.[28]

In 2018, abuse of nuclear workers human rights continues, with multiple ongoing cases against contractors.[29] The issue was raised by United Nations Human Rights Special Rapporteurs in August 2018 when three Rapporteurs issued a statement to the Japanese government: "We are 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."[30]

Sporadic reports of exploitation of Fukushima nuclear workers have emerged over the last 8 years.[31] Shocking as it is, it is a continuation of the Japanese nuclear industry's decades long practice of targeting destitute and untrained workers to conduct hazardous maintenance and cleanup work at nuclear plants across Japan.[32] Japan's poverty rate, which remains higher than the OECD average, has provided a large pool of labor for recruitment in Fukushima.[33] When Japan's parliament approved a bill to fund decontamination work in August 2011, the law did not apply existing rules regulating the construction industry. As a result, contractors working on decontamination were not required to disclose information on management or undergo any screening. Anyone could become a nuclear contractor, resulting in hundreds of companies[34] without experience bidding for contracts and then brokers were used to recruit the actual workers. In 2013, it was reported that 733 companies had secured contracts for decontamination work.[35] This standard approach to business in Japan has had negative consequences, including opportunities for abuse and violation of workers rights. Many companies that were subcontracted were not even registered officially with the Ministry of Reconstruction.

According to Mr. Nasubi, an official with the Radiation-exposed Workers' Solidarity Network in Tokyo, and interviewed by Greenpeace in October 2018, while the number of homeless people recruited to conduct radiation work is not necessarily high, the recruitment mirrors the construction industry in Japan where homeless people working as casual day laborers are found on many building sites. There have been examples where rough sleepers in Osaka have been rounded up en masse and sent to Fukushima, "I suspect that homeless people find themselves working at Fukushima Daiichi in the same way."[36]

As Mr. Nasubi explained to Greenpeace in October 2018, "homelessness" isn't just limited to people who have no residence, but includes people living in extreme poverty who have lost touch with family and friends, with "a lot of people in that position finding themselves working at Fukushima Daiichi or doing decontamination jobs."[37] Among the people who seek help from the association, there have been several who have quit their job only to be kicked out of their accommodation and left with nowhere to stay. The laborers tasked with carrying out this huge ambitious project, Japan's nuclear 'gypsies', include both the homeless and those who can be said to be just one notch above homelessness – jobless people. These two classes are nearly identical.[38] The original Japanese government cost estimate of 2.5 trillion yen for the Fukushima decontamination program, was revised in 2016 to 4-5 trillion yen;[39] however, independent assessments have estimated that the total cost could reach 30 trillion yen.[40] For Japanese contractors, hundreds of subcontractors (and organized crime), this is a source of enormous profit at taxpayers' expense. However, for those at most risk from radiation exposure, the thousands of desperate nuclear workers, low pay is the norm.

Homeless person in Tokyo, October 2018.

Low pay exploitation

The pay for decontamination work is generally in the range of 17,000 yen (US$154) per day. Of that, 7,000 yen (US$63) is the daily rate, and 10,000 yen (US$90) is a dangerous work allowance, making 17,000 yen (US$154) in total. In 2013, it was disclosed that a 55-year-old homeless man reported being paid the equivalent of US$10 for a full month of work. The worker's pay slip showed deductions for food, accommodation and laundry equivalent to about US$1,500 were docked from his monthly pay, leaving him with US$10 at the end of the month.[41] As reported to Greenpeace in October 2018, "there have also been decontamination workers who were only paid 5,000 yen (US$45) a day for their work."[42] The most common complaint from Fukushima nuclear workers, as told to the Radiation-exposed Workers' Solidarity Network, is that wages have not been paid. "Non-payment of the dangerous work allowance is particularly common. A lot of people come to us regarding this, and where our investigations find a clear case of non-payment, we take up industrial disputes with the employers and contractors to recover the unpaid wages. However, although wages and employment are the issues that most often bring workers to us initially, when we listen to their complaints we also come across accidents being covered up, faked health check certificates, and other illegal practices."[43] In the case of faked health certificates, workers had been presented with faked health check certificates even though they had not had a health check, and told to sign their names."[44] In August 2018, in response to the United Nations Special Rapporteurs, the Japanese government claimed that in terms of recruitment "employers are obliged to implement the special training to all workers, regardless of their nationality, race and housing situation, according to Article 19 of the Ordinance on Prevention of Ionizing Radiation Hazards (and) contractors require sub-contractors to check identification of potential employees properly. Sub-contractors never hire people whose identities are unknown like homeless persons."[45] The reality is very different. Although workers are asked to provide a residence certificate when applying for nuclear work in Fukushima, "if the agency wants to fake it, in practice they can get away with anything they want. There have been cases of decontamination workers being given faked health certificates, and people have managed to work at Fukushima Daiichi under false names. These companies can always find a way around so even though the government insists that identity checks are a requirement that is simply wishful thinking."[46]

Fukushima nuclear worker personal testimony

"As a worker, I don't feel like I was treated as a human. One person compared it to slavery."[47]

Mr. Minoru Ikeda was recruited from his home city of Tokyo and is a former decontamination worker. He has worked both in Namie and at the Fukushima Daiichi plant.

"The attitude of the contractors was that there are always plenty more people who need the job and the money. Because there are so many layers of subcontractors, the company itself can't say anything directly to TEPCO or whoever is on top, so as workers, we were in even less of a position to take our concerns higher up. We just had to do whatever we were told. I had half a day of briefing before I started. Because it only lasted a few hours, there was very little detail. Mostly it dealt with the work itself, rather than radiation. They did touch briefly on the danger of radiation, but there were no specific details on the amount of radiation or how we should deal with it. Even if they felt anxious, some of the people from Fukushima wanted to do something to help their local area.

On the other hand, many of the youngsters in particular didn't seem to think much about the radiation because there wasn't any other work to do and they needed the money. When we started work, we were provided with surgical masks helmet and gloves, just normal rubber gloves. Other than that, we wore our own clothes. We left our accommodation, went to the meeting point, and put on our masks and helmets. We had to provide our own shoes, too. Everything we wore was our own clothes. Most of our work in Namie was along the embankments at the side of a river. We cut down weeds on the banks and by the water at the bottom of the slope. This involved cutting back the weeds, bagging them up, and taking them to a collection point nearby.

Once we'd finished, we would throw away the masks and gloves at the site, but other than that we would travel to and from our accommodation wearing our dirty clothes."

"We had basic radiation meters. When we set off from the accommodation, at the meeting area where we waited, we were all given a code number. There would be a box of radiation meters and I would pick one, switch it on myself, and set off to work. When I came back after work I would go to the same place, tell the attendant how many microsieverts it was showing for that day, and switch off the radiation meter and give it back. In practice,

sometimes people would forget to switch their meter on and so they would show zero microsieverts. Because they were just simple radiation meters, sometimes the numbers would go crazy. When things like that happened, supposing the meter was showing zero, the staff on duty would write the same radiation levels as one of the other people who had been working in the same area, or just write “5 μSv/h” or “10 μSv/h” or use the same value as the next person. They didn’t take it very seriously.

I would set out to the work site from Namie high school. The Ministry of Environment had installed a radiation monitoring post in front of the school that would tell us what the radiation levels were that day, but the work site was two or three kilometers away, so we had no idea what the radiation levels were where we were actually working. If I checked using my personal radiation meter it would be about 25 or 26 μSv/h. Even if the level was around three or four microsieverts at Namie High School, where we were working it could be around 25 μSv/h. I remember that even though we were only a couple of kilometers away, the readings were very different. Although we were supposed to finish at 5 pm we would carry on until half-past or almost six o’clock. We weren’t paid for this overtime. And although we were supposed to have weekends off, they made us work on Saturdays or Sundays, violating our contract. They paid us according to the contract.

The reality is that even if the radiation levels have gone down slightly, contamination still remains across Fukushima prefecture. Because of the decontamination work we have done, the government says people can return, and some people are now going back there. But the decontamination is not complete. I’d voluntarily measure a spot that was 25 μSv/h to start with, and find it was about 20 μSv/h a month after we cut the grass. Well, the radiation levels would go down a bit, but I suspected that as the seasons changed they would creep back up again. I didn’t think there was much point to what we were doing. For that reason, I wish Abe wouldn’t try to tell the rest of the world that the accident is over and life in Fukushima has gone back to how it was before. Workers like me will still be working on decommissioning the Fukushima Daiichi plant for decades, maybe even in 100 years time. More and more people will be exposed to radiation, both residents and workers. They really don’t care about us workers. As someone who has been there at the scene, I want to let the world know what is happening. I want to call on the Japanese government to respect the health of workers and stop sending people to do these dangerous jobs, and also to provide proper compensation for the workers.”

United Nations on Fukushima workers rights

The issue of the violation of Fukushima nuclear workers rights, including hazardous radiation exposure, was taken up by the United Nations in June 2018, when three Human Rights Special Rapporteurs challenged the Japanese government to explain their policies[48] The Special Rapporteurs informed the government that "we wish to express our serious concern regarding the overall situation of workers employed in the framework of the decontamination program in the Fukushima Prefecture of Japan, including violations to their right to health and serious safety risks conditioned by radiation exposure in the context of decontamination works. Deep concern is also expressed about the alleged violation of labor rights, in particular the right to just and favorable remuneration, the right to a safe and healthy working environment and the right to just and favorable conditions of work."[49] The Special Rapporteurs, "in view of the urgency of the matter", called on the Japanese Foreign Minister, Taro Kono, to explain evidence of conditions "faced by workers employed in the ongoing decontamination and resettlement program in the Fukushima Prefecture of Japan, more particularly, the existing and potential risks to which they are exposed, inconsistencies in the monitoring and implementation of guidelines aimed at protecting their security and required working conditions, reported consistent violations of their labor rights and their right to physical and mental health, including unsatisfactory levels of health and security safeguards in place."[50]

The Special Rapporteurs cited multiple human rights conventions, as well as the Japanese Constitution, that requires the highest worker protection,[51] which if applied as intended and in full, would effectively terminate the decontamination program currently underway in Fukushima prefecture.

The Japanese government misreporting reality

The response of the Japanese government in August 2018 was simply to repeat earlier misleading claims that nuclear workers in Fukushima were being protected under the law. The Foreign Ministry stated that it "is conducting reliable management of radiation levels for Fukushima workers, however, and had already informed the office of the United Nations High Commissioner for Human Rights of this, along with data...The fact that this statement was issued despite this, is extremely regrettable, and this was conveyed to the OHCHR in Geneva."[52] Demonstrating a complacency and a disregard for the rights and safety of nuclear workers, an unnamed Foreign Ministry official further stated that "we properly handled problematic cases in the past and do not regard it as a situation which requires any urgent response."[53] According to the Japanese government in their 2018 submission to the United Nations, "employers are required to (i) monitor external exposure doses at working sites, (ii) provide special education to the workers, and (iii) offer necessary radiation prevention measures under the Ordinance on Prevention of Ionizing Radiation Hazards. Based on the Ordinance, the Fukushima Labor Bureau established general measures for the decontamination work and supervises contractors and makes visits to construction sites."[54] However, there is clear evidence that in all these areas the current program is failing. As explained to Greenpeace in October 2018, "They have no idea what is going on. We're expendable, like pawns in a game of chess and they have the attitude that there are always plenty more people out there to replace us. The Japanese government has no idea who is working for the subcontractors. They might say they do, but for example there is no record of me even having been in Namie. If the government says they are keeping track of that, it's a lie... In the case of decontamination, the government employees at the Office for Fukushima Recovery occasionally make site inspections. But although they visit the site, they always give advance warning. They never carry out spot checks so they don't see the true picture. The same thing happens at Fukushima Daiichi. So the government line is simply wishful thinking. In reality, they don't know what is happening on the ground."[55]

Dangerous reality for workers

As Mr. Nasubi of the Radiation-exposed Workers' Solidarity Network explained to Greenpeace, "A decontamination worker who had called the Ministry of Environment to report improper practices on site came to speak to us. After he spoke to the Ministry of Environment, the Ministry contacted the chief contractor about the complaint and told them to do something about it. The chief

contractor then got in touch with the subcontractor to pass on the complaint. From the details of the complaint it's not too hard to work out where it came from and you end up with a game of "hunt the snitch." The worker who raised the complaint can end up getting fired. In some instances, everyone working for the subcontractor in question can get the sack. The companies do this in order to set an example. So in reality, it is very unusual for the workers to make their voices heard."[56]

Radiation exposure

On the issue of radiation exposure, the United Nations Special Rapporteurs in June 2018 challenged the government, stating that, "information received indicates that the diligent application of these guidelines may have been hampered because of the nature of the recruitment of workers, as well as the uncertainty surrounding the number of official workers and those recruited by subcontractors. Evidence suggests that radiation exposure of workers involved in decontamination exercise could be producing serious underlying effects on their health."[57]
The Japanese government's response was that, "According to the Ordinance on Prevention of Ionizing Radiation Hazards, all employers including the subcontractors have to fulfill the obligation to carry out medical examinations, etc. for the personnel engaged in decontamination and related work. The ordinance applies to all these workers, irrespective of the nature of recruitment of the laborers or the environment in which they are placed."[58] Again the evidence shows the Japanese government's claims to be false. As explained to Greenpeace in October 2018, "workers who received less than 50 mSv have no follow-up whatsoever. In order to build up data, workers are told to take health checkups on their own or to go for a health check at the next company they work for and pass the results on to the government. So in other words, the country is not prepared to monitor the health of each worker and take responsibility for health problems that appear later."[59] The government's response relies upon the rigorous application of regulations that they claim protects workers rights, whereas, the reality on the ground is that violations are commonplace. The Japanese government statement to the United Nations that "subcontractors never hire people whose identities are unknown such as homeless persons"[60] does not reflect the actual situation in Fukushima.
As told to Greenpeace in October 2018, "We're currently working on a court case for a worker who developed leukemia after working at Fukushima Daiichi. He says that the reality was completely different to how the Japanese government makes out, that there was no proper safety monitoring. I suspect the Japanese government will say that they had given instructions, but they never checked to see that the rules were being followed in practice. TEPCO and the main contractors tell the government that the rules are being followed but the government simply accepts that without actually carrying out any checks."[61] The challenge of effectively overseeing the complex web of subcontractors is further exacerbated by the involvement of organized crime in Fukushima radiation work. As explained to Greenpeace in 2018 by Mr. Nasubi of the Radiation-exposed Workers' Solidarity Network. "There was a case where a company operating at Fukushima Daiichi was docking workers' wages and that money was going directly to the yakuza. There were arrests when the case came to light. I suspect that is just the tip of the iceberg and that it is far from an isolated case. The main contractors are being subjected to lectures about eliminating organized criminal gangs. I'm sure they would never admit it in public, but from our dealings with general construction laborers I'm sure the yakuza has significant involvement in recruitment (in Fukushima)."[62]

Conclusion

Despite the UN Special Rapporteurs offering their services to the Japanese government on how to address the ongoing issue of workers exposed to toxic radiation in Fukushima, and their rights, there is near total silence from the government.

More than six years after the initial intervention by the UN Human Rights Special Rapporteurs, there is little evidence that the conditions of workers have significantly improved. Fukushima nuclear workers are still denied their basic rights, which include "the right to remove themselves from conditions they believe are unsafe, and the right to information regarding occupational health and safety."[63] With the misguided and ineffective decontamination program moving into the higher radiation areas, and therefore exposing workers to even greater risk of exposure, the complacency of the Japanese government and their disregard for the rights of workers in Fukushima is unacceptable and a violation of their multiple obligations under international human rights conventions.

Nuclear decontamination workers at temporary nuclear waste storage site, Namie, Fukushima prefecture, October 2018.

6. Human rights and Fukushima children

Children at school, Iitate, Fukushima prefecture, October 2018.

"The timing of exposure is a critical factor in whether exposure to toxic chemicals may result in adverse impacts on the right to life or health. Children are not little adults. They have far greater sensitivity than adults at both high and low levels of exposure."

Special Rapporteur UN Human Rights Council, September 2017.[64]

In April 2018, 14 public elementary and junior high schools in five municipalities in Fukushima prefecture reopened their doors for the first time in seven years, but only 3% of the total school population of 4000 between 21 schools prior to the 2011 Fukushima nuclear disaster attended.[65] Schools reopened in Namie, Tomioka, Iitate, the Yamakiya district of Kawamata, and Katsurao. The "Difficult to Return" zones with the highest level of radiation, including in Namie, Iitate and Katsurao, remain closed to human settlement. As reported in the Japanese media, younger residents apparently are reluctant to return due to lingering concerns about radiation and also because many have made a fresh start in the areas where they moved after the disaster.[66] The results of the Greenpeace 2018 radiation survey confirm that these concerns are justified.

United Nations Convention on the Rights of the Child

Over the past years the Japanese government has been accused of consistently violating the human rights of Fukushima citizens, including families with children, with its policy of lifting evacuation orders and the coercion to return to contaminated areas.[67] As Greenpeace documented in 2017, Japan is party to multiple international human rights agreements that explicitly acknowledge the right to health, including those that protect the specific rights of children, including the Convention on the Rights of the Child (CRC) and its two Optional Protocols.[68] Under the CRC, Japan is obligated to take the best interest of the child as a guiding principle, and guarantee children's right to life, survival, and development, as well as their right to health.[69] The CRC stresses, "the child's right to participation, including the right to be heard, to express their views freely in all matters affecting the child (Article 12.CRC) and to have access to appropriate information."[70] The CRC includes Article 3 (para 1), which specifies that the best interests of the child, including future generations, must be a "primary consideration" in all actions; including the requirement of preventing exposure to toxic chemicals and pollution in attaining their right to the highest standard of health,[71] which in the case of children means preventing radiation exposure above the international recommended maximum of 1 mSv/y.

Special Rapporteur at the United Nations General Assembly

In 2018, the Japanese government once again found its policies with regards Fukushima children under attack, this time at the United Nations General Assembly (UNGA).[72] UN Human Rights Special Rapporteur Baskut Tuncak, in his report to the UNGA, 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,"[73] and urged the Japanese government to halt the ongoing relocation of evacuees who are children and women of reproductive age to areas of Fukushima where radiation levels remain higher than what was considered safe or healthy before the nuclear disaster seven years ago. The Special Rapporteur criticized the Japanese government's decision to raise by 20 times what it considered to be an acceptable level of radiation exposure, which "was deeply troubling, highlighting in particular the potentially grave impact of excessive radiation

on the health and wellbeing of children." In March 2018, at the United Nations Human Rights Council Universal Periodic Review (UPR) of Japan, the recommendation to lower acceptable levels of exposure to 1 mSv/y was proposed by the government of Germany, and the government of Japan 'agreed to follow up' on this.[74] However, in the view of the UN Special Rapporteurs, the recommendation is not being implemented. The UN Special Rapporteur stated that Japan has a duty to prevent and minimize childhood exposure to radiation, referring to a 2017 report on childhood exposure to toxic material.[75] As noted by the UN Special Rapporteur, Japan, as party to the CRC, has a clear obligation to respect, protect and fulfill the right of the child to life, to development and to the highest attainable standard of health, taking their best interests into account. If Japan were to meet its obligations under the Convention on the Rights of the Child, its current decontamination program and policy of lifting evacuation orders would in effect be terminated. At the UN in New York, the Human Rights Special Rapporteur called on Japan to provide full details as to how its policy decisions in relation to the Fukushima Daiichi nuclear accident, including the lifting of evacuation orders and the setting of radiation limits at 20 mSv/y, are not in contravention of the guiding principles of the Convention, including the best interests of the child.

Japanese civil society has been highly critical of Japanese government policies in Fukushima since 2011, including as they relate to children. Human Rights Now in its 2017 submission to the Committee on the Rights of the Child stated that "the government has failed to establish free, periodic, and comprehensive health checks for affected persons, except for biennial ultrasound examinations for children under the age of 18 at the time of the accident who live or used to live in Fukushima prefecture."[76] In its submission to the UN Committee on the Rights of the Child in October 2018, the Japanese organization "3.11 Fund for Children with Thyroid Cancer", criticized the current health survey system used by Fukushima prefecture, which "has not been constructed to accurately assess the thyroid cancer incidence of children who resided in the prefecture at the time of the nuclear accident. It does not track all children who were in the prefecture during the accident, losing track of those who do not fit the official designation of evacuee who have cut ties with the prefecture. Even if they have moved away from Fukushima prefecture, it is necessary to accurately identify those children who have been diagnosed with cancer. Additionally, as stated above, thyroid examinations should also be conducted in contaminated areas outside of Fukushima prefecture."[77]

Radiation exposure risks to children

Greenpeace investigations and analysis have confirmed that the radiation exposure over a lifetime for citizens, including children, that return to the survey areas of Namie and Iitate where evacuation orders have now been lifted, could be high and well beyond the level acceptable from a public health safety perspective.[78] These would range between 39 mSv and 183 mSv over 70 years, over and above the expected lifetime exposure due to natural sources. For the "Difficult to Return" areas of Fukushima, including Namie and Iitate,

Lifetime dose (70 years)			
Dose rate (μSv/h)	24h outside (mSv)	12h outside (mSv)	8h outside (mSv)
0.1	22	15	13
0.2	44	31	26
0.3	65	46	39
0.4	87	61	52
0.5	109	76	65
0.6	131	92	78
0.7	153	107	92
0.8	174	122	105
0.9	196	137	118
1.0	218	153	131
1.1	240	168	144
1.2	262	183	157
1.3	283	198	170
1.4	305	214	183
1.5	327	229	196
1.6	349	244	209
1.7	371	259	222
1.8	392	275	235
1.9	414	290	249
2.0	436	305	262
2.1	458	320	275
2.2	480	336	288
2.3	501	351	301
2.4	523	366	314
2.5	545	382	327
2.6	567	397	340
2.7	589	412	353
2.8	610	427	366
2.9	632	443	379
3.0	654	458	392

Table 12: Lifetime exposure (70 years) corresponding to different dose rates and durations of stay outside.

where radiation levels are even higher, the lifetime exposure dose rates would be even higher.

Epidemiological studies monitoring the health effects of long-term exposure to low-ionizing radiation conclude that there is no low-threshold limit for excess radiation risk to non-solid cancers such as leukemia.[79] The additive radiation risk for solid cancers continues to increase throughout life with a linear dose-response relationship, which is the international basis for radioprotection standards set by the International Commission for Radiological Protection (ICRP).[80] Children, as well as women and young people, are known to be more vulnerable to the impacts of radiation and would be exposed to radiation over many decades should they return to these contaminated areas.

As UNSCEAR itself declares, "the commonly held notion that children might be two to three times more sensitive to radiation than adults is true for some health effects but certainly not for all."[81] In general, children are more sensitive to radiation and are more likely to develop the short-term and some of the long-term effects of radiation exposure. The American Academy of Pediatrics reported in 2018 that several tissues (e.g., thyroid, bone marrow, breast, and brain) are more sensitive to radiation in children than in adults, and children are at higher risk of radiation-related cancers of these tissues. Other tissues do not appear to be more sensitive in children than in adults (e.g. lung and bladder).[82] As they concluded, children are likely to experience higher external and internal radiation exposure levels than adults because children are shorter and have smaller body diameters and organ sizes. Children also have a longer time to live and, thus, more time in which to develop adverse outcomes. In addition, children may ingest radioactive material from picking up contaminated items and putting hands in their mouths when crawling, ingesting soil, or consuming milk from cows feeding on contaminated pastures or feed. The 20 mSv/y permissible dose set by the Japanese government is the same maximum allowable annual dose recommended by the ICRP for adult nuclear workers – which is now being applied to men, women, children, and infants alike.[83] It is shocking to consider that nuclear plant workers world-wide, working in hazardous and controlled environments, under regulation, have more protection from radiation than would children and other citizens of Iitate, Namie and other areas of Fukushima if they were to return to their homes.

UN Committee on the Rights of the Child

On 16-17 January 2019, the United Nations Committee on the Rights of the Child held its eightieth session where it considered the government of Japan's compliance with the Convention of the Rights of the Child.[84]

The Committee had requested the government of Japan to provide information on its compliance with the Convention on the Rights of the Child, including on children and their medical support in relation to the Fukushima Daiichi accident.[85] Greenpeace in its most recent submission to the CRC had urged the CRC during its dialogue with the government of Japan to raise the issue of radiation exposure to children, including lifetime exposure. We also called on the CRC to request that the Japanese government apply in full all the relevant principles of the Convention on the Rights of the Child in regard to its policies related to the Fukushima Daiichi nuclear disaster. At the January 2019 session, Committee members raised multiple issues to the Japanese delegation in relation to the Fukushima nuclear disaster and children's rights. These included children's rights to information and the consequences of the accident and questions over long-term health monitoring, and the measures taken to take account of thyroid cancer rates in Fukushima children. They noted that the Ministry of Foreign Affairs is responsible for the implementation of the Convention on the Rights of the Child.

In response to the Committee members, the Japanese delegation was neither convincing nor comprehensive. The Japanese Ministry of Education stated that they issued in August 2011 a notice reducing the radiation dose at school buildings and school yards in Fukushima prefecture which required "the radiation exposure dose criteria for students at school at 1 mSv/y or less."[86] In terms of the radiation air dose rate, after October 2011, the Ministry set a target of 1 μSv/h. The problem with this response is that while radiation exposure may have been reduced at schools now operating in Fukushima prefecture, for example in Iitate and Namie, as shown by the Greenpeace radiation surveys, the overall environment where these schools are located have radiation levels far in excess of 1 mSv/y.

The Committee in its report of 1 February 2019 under Principle Concerns and Recommendations made seven important recommendations to the government of Japan in relation to the Fukushima nuclear disaster.[87] These included, "(a) Reaffirm that radiation exposure in evacuation zones is consistent with internationally accepted knowledge on risk factors for children; (b) Continue providing financial, housing, medical and other support to evacuees, children in particular, from the non-designated areas (and) (d) Conduct comprehensive and long-term health check-ups for children in areas with radiation doses exceeding 1mSv/year;"[88] If the recommendation (a) on radiation risk factors were to be applied by the Japanese government, their lifting of evacuation orders in Namie and Iitate would have to be reversed and their plans for the "Difficult to Return" exclusion zones terminated. The UN CRC further called for the Japanese government to implement the highly critical recommendations made UN Special Rapporteur Anand Grover issued in 2013.[89] The UN CRC, concluded that Japan should "take all appropriate measures to ensure that the recommendations contained in the present concluding observations are fully implemented."[90]

The current Japanese government policy is clearly in violation of its obligations under the Convention on the Rights of the Child. Japan is a signatory to the Convention, and is not preventing childhood exposure to radioactive contamination in Fukushima resulting from the 2011 nuclear disaster. This obligation flows naturally from the right of children to physical integrity and from the fact that such exposure makes it nearly impossible to realize every child's right to the highest attainable standard of health, to survival and to maximum development, given their extreme sensitivity to pre- and postnatal exposure.

Conclusion

The Japanese government's response to the Fukushima nuclear disaster has utterly failed to meet its international commitments to protect the human rights of children. It continues to disregard the recommendations made by member states at the United Nations Human Rights Council, while dismissing the risks from radiation exposure, even claiming that exposure to 100 mSv poses no cancer risks, as Masayoshi Yoshino, Japanese Reconstruction Minister stated in 2018.[91] These violations have been, and continue to be, systematic and deliberate. The situation is only set to worsen with the impending lifting of evacuation orders in the highest contaminated areas of Namie, Iitate, Katsurao, Futaba and Okuma during the coming years.

7. The politics of radiation and impacts on citizens affected by the nuclear disaster

Nuclear waste storage areas, Iitate, Fukushima prefecture, October 2018.

A coordinated and orchestrated effort has been underway since 2011, led by the Japanese government, and supported by Japanese institutions and international 'experts', to convince people of the low or even non existent threat from radiation exposure. In advance of the lifting of the evacuation order in March 2017, the Japanese government Cabinet Office for Nuclear Emergency Assistance and Life Support Team Nuclear Emergency Response Headquarters explained in a 2016 brochure given to Iitate citizens the risks of human health risks from radiation.[92] It was highly misleading and does not reflect international radiation standards, nor the need to reduce exposure of populations to the lowest possible dose. On the issue of being exposed to radiation, the government information stated that "the international opinion on radiation exposure and the idea regarding dose levels are as follows: If radiation exposure exceeds approximately 100 mSv, an increase in cancer incidence and mortality is observed. In the exposure dose range of less than 100 mSv, the influence of cancer etc. is caused by other factors. It is so small that it is hidden by the effects of carcinogenesis etc. It is difficult to prove a clear increase in health risk epidemiologically."[93] This deliberate misrepresentation of the actual risks from radiation is deployed to serve the government's objective of lifting evacuation orders in Fukushima, and to justify its policy of permitting annual public exposure up to 20 mSv. By so doing, the government is ignoring the scientific principles of radiation protection.

In the areas of Iitate and Namie where evacuation orders were lifted in March 2017, radioactive contamination levels will remain well above the international maximum safety recommendations for public radiation exposure of 1 mSv/y for many decades. Greenpeace projections on dose rates run to the mid-21st century,[94] and show that they will still be well in excess of the current government long-term target levels of 0.23 μSv/h. It is this target level that the government uses for its calculation to reach an estimated annual exposure level of 1 mSv/y.

The politics of radiation (mis) communication

In October 2018, the Japanese government voiced strong opposition to a United Nations Human Rights Special Rapporteur's report to the UN General Assembly meeting in New York.[95]

The Japanese government chose to selectively misrepresent the recommendations of the International Commission for Radiological Protection (ICRP). The Japanese delegate to the UNGA cited only the 20 mSv level, stating that "with respect to the permissible dose there seems to be a misunderstanding...the 20 mSv per year is in conformity with the recommendation given in 2007 by the ICRP...Let me make clear... the government continues its efforts to attain the long-term target for individual additional exposure to radiation within 1 mSv. We are concerned that the press release of the Special Rapporteur could invite inaccurate media reports... Seven years after the Great East Japan earthquake and Fukushima Daiichi nuclear accident the people in the affected areas are still suffering from inaccurate negative reputation..."[96]

As the government of Japan knows full well, the ICRP 2007 recommendation is for radiation exposure to be a maximum of between 1-20 mSv per year, with the lower end being the recommended level. The ICRP 109 states that, "In general, a reference level of the magnitude used in emergency exposure situations will not be acceptable as a long-term benchmark, as these exposure levels are generally unsustainable from social and political standpoints. As such, governments and/or regulatory authorities will, at some point, identify a new reference level for managing the existing exposure situation, typically at the lower end of the range recommended by the Commission of 1–20 mSv/year."[97] This lower end recommendation is not communicated by the Japanese government, either at the United Nations or to the people of Japan.

Ignoring science and optimization

The largest radiation workers cohort study that assessed 308,297 workers from the United States, the UK and France, concluded in 2015 that "this study provides strong evidence of positive associations between protracted low-dose radiation exposure and leukemia". Importantly this study found significant risk of leukemia for nuclear workers exposed to radiation in the range of 1-5 mSv/y.[98] Such assessments are a direct challenge to the Japanese government policies in Fukushima (and wider Japan) as they continue to claim that there is no evidence of radiation risks below 100 mSv, including to pregnant women. Rather than adopting

international best practice in radiation protection and communicating accurately the risks from low dose radiation, government-backed Japanese radiation scientists claimed in 2018 that "Asian nuclear workers may have different mortality and morbidity rates of leukemia than do workers in the West, due to different characteristics in their lifestyle or varying susceptibility to radiation exposure."[99] The Japanese government is also selectively interpreting the ICRP in regards to the optimization principle. As the ICRP 111 explains, the basic principle of optimization is crucial to reduce the dose to the population as far as "reasonably" possible.[100] ICRP 111 recommends that, "The objective is to implement optimized protection strategies, or a progressive range of such strategies, which aim to reduce individual doses below the reference level."[101] Very importantly, the ICRP recommends that the reference levels should be reduced over time: "The optimization of protection is a forward-looking iterative process aimed at preventing or reducing future exposures." This does not form the basis of the current Japanese government policy for the simple reason that the government knows that its decontamination program has no prospect of lowering exposure levels to 1 mSv in many of the most contaminated areas of Fukushima, including in Namie and Iitate – areas where evacuation orders have already been lifted, and in areas where evacuation orders are planned to be lifted in the 2019-2023 period.

Revision of decontamination target

The Japanese government knows that the long-term decontamination target level of 0.23 μSv/h (equivalent to 1 mSv/y) is unattainable in many of the most contaminated areas of Fukushima. The government has never specified its timeframe for reaching this 0.23 μSv/h target level, nor for attaining the 1 mSv/y level – little wonder, given that it would have to explain it will be many decades and in the highest contaminated areas, well into next century. Rather than transparency, the government has taken a decision to try and 'solve' the radiation problem by moving the goal posts through re-interpretation of exposure levels based on 0.23 μSv/h.

During discussions on dose estimates for returning evacuees, in January 2018, the chair of the Nuclear Regulation Authority (NRA) described the 0.23 μSv/h as a "cautious number... If we don't revise (that calculation) properly, it could hinder evacuees' return home."[102] It was suggested that the 0.23 level could be increased to 0.8 μSv/h or 1.0 μSv/h. This would equate to an annual dose of between 3.46 mSv/y and 4.34 mSv/y. The review of the target was to be conducted under the auspices of the Radiation Council of the NRA.[103] Very few details of this review are in the public domain. In September 2018, it was reported that the issue is still under review, with the Radiation Council committee explaining that the committee said "0.23 is a fixed idea of whether it is safe for residents", and "In the absence of a drop in the dose, 0.23 remains as a major problem."[104]

The rationale that is being used by the Radiation Council to justify the reinterpretation of the 0.23 μSv/h target is that the actual dose received by citizens is less than the expected 1 mSv/y. This would then be used to justify revising the target upwards. However, there is a major flaw in this thinking.

Unreliabilty of glass badge dosimeters

The Japanese government is basing its dose estimates for returning citizens on radio-photoluminescence glass dosimeters, commonly referred to as glass badges. Data collected from glass badges seriously underestimates the impact on the population living in a contaminated area. The glass-badge personal dosimeter gives an overall value that is 30-40% lower than what can be deduced with an apparatus measuring airborne dose rate because they do not measure the same Operational Quantities.[105] One reason for this is that glass badge dosimeters were designed for use in nuclear installations and do not function properly in locations with low doses. Another reason is that people may change their behavior, for example avoiding being outside, including not allowing children to play outside. The recorded doses will thus be lower than the dose they would have received leading a normal lifestyle. If such personal measurements were to be taken as a reference in the decision to lift evacuation orders it would mean that such changed lifestyles are set as a standard. This leads to the contradiction that the more people make an effort to avoid risk, the higher the radiation level can be in the area they are sent back to. This raises a fundamental question regarding quality of life. The government authorities deployed glass-badges without explaining this important fact to the population or elected officials. At a meeting in 2015 in the Fukushima city of Date, radiation expert Mr. Kazumasa Aoki reported that glass badge dosimeters were problematic when used by members of the public. As was stated at the meeting, “It is reckless to use something designed for radiation workers who are often exposed to radiation from one direction for residents’ exposure management.”[106] The executive officer of Chiyoda Techno, the company that produced the radio-photoluminescence glass dosimeters (glass badges) and who was in attendance at the 2015 Date meeting, when confronted with the underestimation of dose of the company’s dosimeters, apologized for not mentioning it.[107]

As Dr. David Boiley, director of the of French radiation laboratory ACRO, explains, “after the calculation is changed, it will likely be applied to the higher limit of 3.8 μSv/h which will no longer give more than 20 mSv/y, but maybe 5 mSv/y. Thus the authorities will have reduced the apparent limit for the return of Fukushima populations without changing anything on the ground by a simple modification of the rules of calculation.”[108] Glass badges are suitable for the use of personal dosimetry for personal protection, but should not be regarded a suitable method for deciding on decontamination levels allowing them to lift the evacuation order in Fukushima municipalities. But that is exactly how they are being applied as a tool by the Japanese government in accelerating its ineffective decontamination program.

Controversy in Community of Date

The controversy over the radiation exposure of Date residents escalated in January 2019, when it was disclosed that Professor Ryugo Hayano of Tokyo University, a leading scientist conducting dose assessments of the city’s population, was forced to admit he had unintentionally, and in error, underestimated the radiation exposure for Date citizens.[109] Questions over the accuracy of the data were raised following its publication in an international science journal.[110] Professor Hayano has played an important role in radiation risk communication in Fukushima, as well as frequently being consulted by government agencies, including the Japanese Cabinet Office. Professor Hayano has been a strong advocate of the use of Chiyoda glass dose badges to inform government policy on radiation exposure standards. The controversy has been compounded by the disclosure that prior consent for the use of radiation data had not been secured from 27,000 Date citizens (out of 59,000), nor had formal review been carried out by the Fukushima Medical University Ethics Committee before publication of Professor Hayano’s analysis. The issue is now under investigation, including by the city authorities of Date.[111]

Eight years after the start of the Fukushima Daiichi nuclear accident, the government’s objective in continuing to misrepresent and communicate misleading information on the risks of radioactive contamination to public health is as clear today as it was in 2011. At that time, the heads of the Fukushima Prefectural People’s

Health Management Survey explained its aim was "to calm the anxiety of the population" and to convince the public that "the health impact of the nuclear accident of Fukushima can be assumed to be very minor."[112] This has neither a sound scientific basis nor a human rights-centered approach to the health protection of Japanese citizens impacted by the Fukushima Daiichi disaster.

Status and Housing of Fukushima Evacuees

"The combination of the government's decision to lift evacuation orders and the prefectural authorities' decision to cease the provision of housing subsidies places a large number of self-evacuees under immense pressure to return," UN Human Rights Special Rapporteur Baskut Tuncak said in October 2018. "The gradual lifting of evacuation orders has created enormous strains on people whose lives have already been affected by the worst nuclear disaster of this century. Many feel they are being forced to return to areas that are unsafe, including those with radiation levels above what the government previously considered safe."[113]

The Japanese government in its response at the United Nations General Assembly in October 2018 deliberately misrepresented the situation with regards to housing and self evacuees. "Regarding housing support for self evacuees, Fukushima prefecture continues to provide housing assistance in the form of financial aid to rent private houses – the expression "stop the housing subsidies" is therefore inaccurate. Self evacuees' return to their original homes is decided solely on the judgment of the individual... the government did not and will not force anybody to return."[114]

In fact, the Japanese government, together with the Fukushima prefectural government, has adopted a policy that artificially reduces the actual official number of Fukushima evacuees. The Reconstruction Agency has not included voluntary or self evacuees in its official statistics, but has included them in the statistics supplied by Fukushima prefecture. However, as of March 2017, the prefecture stopped including these self evacuees in their reporting. As reported in August 2017, "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."[115]

As of July 2017, 89,751 evacuees were living across Japan, a decrease of 29,412 from March 2017. This in large part can be explained by the decision implemented as of 1 April 2017, whereby Fukushima prefecture removed self evacuees from their listings, and thereby they disappeared from the government's listings. The decision to remove self evacuees from the Fukushima prefecture's listing coincided with the termination of housing support for self evacuees. In 2012 the number of self-evacuees was estimated to have been 60,000, all of whom have now disappeared from the official record.[116]

As for housing support, for evacuees from designated areas, the Fukushima prefectural government announced in August 2018 an extension until March 2020 of housing support for citizens of Tomioka, Okuma, Futaba and Namie, and those evacuated from "Difficult to Return" areas of Katsurao village and Iitate village.[117] The decision to extend housing support for officially recognized evacuees can in part be put down to the dedicated efforts of evacuees, their lawyers and civil society, as well as the attention the issue has received at the United Nations. While welcome, the ongoing internal displacement of tens of thousands of Fukushima citizens and the multiple struggles they face will not be resolved by 2020. For people who evacuated from outside of designated evacuation areas, housing support was cut in March 2018. The resulting loss of ability to pay rent has led to examples where eviction legal action has been launched against the evacuees. A further example of human rights violation.

8. Conclusion and recommendations

Workers at school playing field, Namie, Fukushima prefecture, October 2018.

The results of the 2018 radiation survey add further to the urgency for the Abe government to halt its current program of lifting evacuation orders, to comply with its domestic and international human rights obligations and to initiate a comprehensive and publicly accountable review of current policy. This year's report has focused in particular on the impact of the ongoing Fukushima nuclear disaster on some of the most vulnerable in society – children and nuclear workers. They are on the frontline in terms of exposure to radiation – children because they are more vulnerable to radiation and workers as they conduct their hazardous decontamination work, in contaminated areas as well as at the Fukushima Daiichi nuclear plant.

Workers exploitation

Fukushima nuclear workers are still denied their basic rights, which include "the right to remove themselves from conditions they believe are unsafe, and the right to information regarding occupational health and safety."[118] The Greenpeace survey, including in areas directly where workers were operating, show high levels of radiation that if observed in a nuclear facility would require emergency measures. Instead, poorly paid and trained workers are being subjected to radiation exposure on a daily basis. With the misguided and ineffective decontamination program moving into the higher radiation areas, and therefore exposing workers to even greater risk of exposure, the complacency of the Japanese government and their disregard for the rights of workers in Fukushima is unacceptable and a violation of their multiple obligations under international human rights conventions.

Violation of UN children convention

Under the Convention on the Rights of the Child (CRC), Japan is obligated to take the best interest of the child as its guiding principle, and guarantee children's right to life, survival, and development, as well as the right to health.[119] If Japan were to comply with its obligations under the CRC, and the recommendations made by the United Nations Committee on the Rights of the Child in February 2019, it would have to terminate its policy of permitting citizens, including children, to be exposed up to 20 mSv/y, and instead comply with the CRC requirement that the rights of children to the highest standard of health requires the prevention of exposure to toxic chemicals and pollution,[120] by returning to a maximum exposure of 1 mSv/y.

Pressure mounts against government

One year after signaling to United Nations member states that it would accept the recommendations made at the Human Rights Council Universal Periodic Review (UPR), there is no sign that the Abe government has any intention of changing its Fukushima policies and instead prioritize the human rights of evacuees, especially those of children and women.

However, so long as the Japanese government remains committed to its failing program in Fukushima, it will continue to come under domestic and international criticism. Eight years after the start of the nuclear disaster, thousands of evacuees are continuing their legal challenges against both TEPCO and the government. These include the judgement of the Tokyo District Court on the criminal prosecution of three TEPCO executives due in early 2019[121] and the newly initiated lawsuit brought by citizens of Namie.[122]

The Japanese government is defying United Nations human rights specialists who have challenged the policy of lifting evacuation orders, exposing citizens, in particular women, children and workers, to unsafe radiation levels. At the same time, nuclear workers in Fukushima are continuing to suffer a range of exploitation, including low pay, lack of comprehensive access to medical services, and the violation of the right not to be exposed to hazardous radiation. The Greenpeace survey results highlight the scale of the ongoing nuclear crisis in the most contaminated areas of Fukushima and why the United Nations human rights experts are fully justified in expressing their urgent concerns.

Recommendations to the Japanese Government and Fukushima Prefecture

- Suspend its current return policy which ignores Fukushima citizens and which ignores science based analysis, including potential lifetime exposure risks;

- Comply in full with Fukushima recommendations from the United Nations 2017 Universal Periodic Review of Japan, and outstanding United Nations Special Rapporteurs recommendations on all evacuees rights (including those from non designated areas) and workers rights, including to set a maximum radiation exposure to the public of 1 mSv/y and ending worker exploitation;

- Comply in full with its obligations under the Convention of the Rights of the Child, including placing the rights of children at the center of its Fukushima policies and fully implementing the recommendations of the United Nations Committee on the Rights of the Child

- Immediately clarify its long-term decontamination target of 0.23 μSv/h, equal to 1 mSv annual exposure based on the government's calculation,including setting a date for when 0.23 is to be attained, and halt any plans to revise the target level;

- Abandon plans to lift evacuation orders in the six municipalities of Futaba, Okuma, Namie, Tomioka, Iitate and Katsurao; which includes the Namie districts of Tsushima, Murohara, Suenomori and Obori;

- In the interests of worker protection, suspend current decontamination programs in the "Difficult to Return" zones;

- Establish a fully transparent process to reflect and consider residents' opinions on evacuation policy, including opening a council of citizens including all evacuees;

- Provide full compensation and financial support to evacuees, and take measures to reduce radiation exposure based on science and the precautionary principle to protect public health and allow citizens to decide whether to return or relocate 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 Rapporteur in country visits.

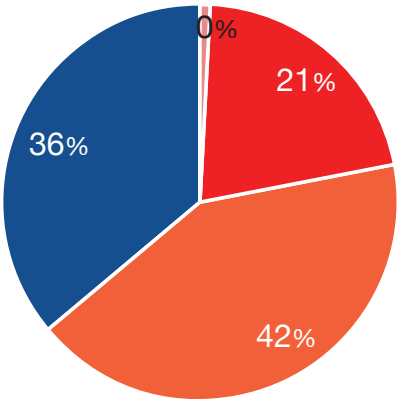
9. Appendix

- Obori, Namie, Difficult to Return Exclusion Zone

Charts: Proportions of radiation dose rates measured in parts of zones by scanning in 2017 and 2018

- > = 5μSv/h
- < 5 and > = 3.8μSv/h
- < 3.8 and > = 2μSv/h
- < 2 and > = 1.5μSv/h
- < 1.5 and > = 1μSv/h
- < 1 and > = 0.5μSv/h
- < 0.5 and > = 0.23μSv/h
- < 0.23μSv/h

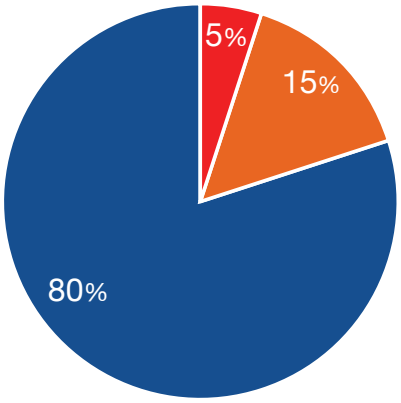
Zone-01; Area of small road south of Route 253, (212 points) at 1m high, **2018**/10/26



Max = 6 uSv/h
Min = 2 uSv/h
Av. = 4.5 uSv/h

100% of points above 1 uSv/h
100% of points above 0.23 uSv/h

Zone-02; Area of small road south of Route 253, (280 points) at 1m high, **2017**/09/26



Max = 9.3 uSv/h
Min = 3.8 uSv/h
Av. = 5.6 uSv/h

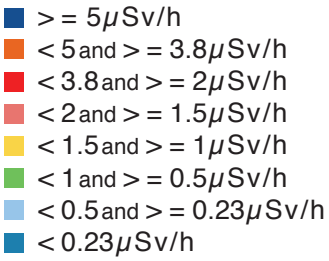
100% of points above 1 uSv/h
100% of points above 0.23 uSv/h

Image: Route 253 and community in Obori showing route of radiation survey area, 2018/10/23

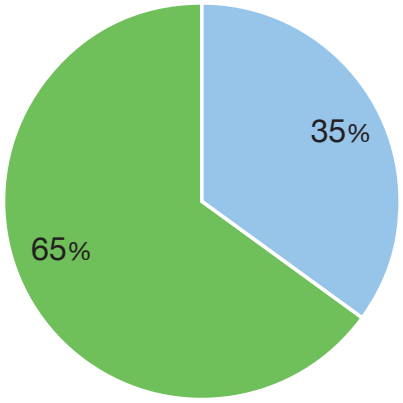
Map data © 2019 Google © 2019 ZENRIN to all map image

- Ms. Kanno's house in Tsushima, Namie, Difficult to Return Exclusion Zone

Charts: Proportions of radiation dose rate by scanning in all zones



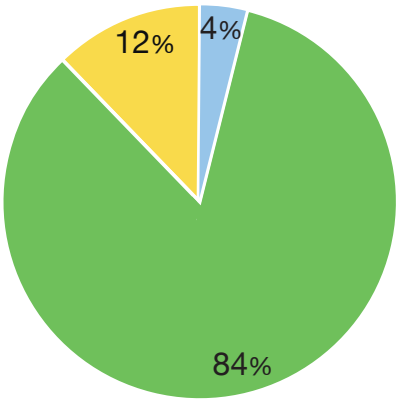
Zone-01; Around the house (walking offroad), (394 points) at 1m high, 2018/10/21



Max = 0.9 uSv/h
Min = 0.3 uSv/h
Av. = 0.6 uSv/h

0% of points above 1 uSv/h
100% of points above 0.23 uSv/h

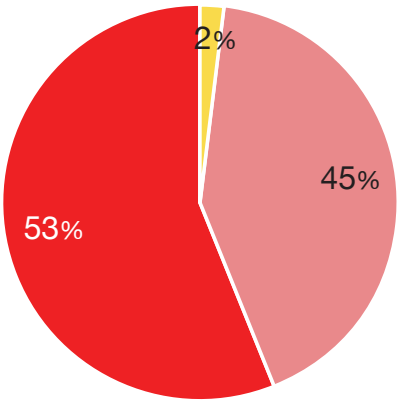
Zone-04; Farmland right of house (walking offroad), (597 points) at 1m high, 2018/10/21



Max = 1.3 uSv/h
Min = 0.5 uSv/h
Av. = 0.8 uSv/h

12% of points above 1 uSv/h
100% of points above 0.23 uSv/h

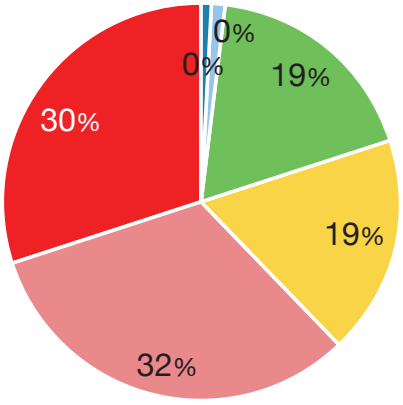
Zone-05; Forest behind house (walking offroad), (330 points) at 1m high, 2018/10/27



Max = 2.4 uSv/h
Min = 1.2 uSv/h
Av. = 2 uSv/h

100% of points above 1 uSv/h
100% of points above 0.23 uSv/h

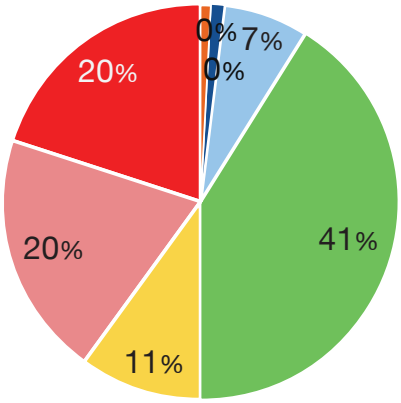
Zone-09; Path to rice field North (walking on-and-off road), (996 points) at 1m high, 2018/10/27



Max = 5.9 uSv/h
Min = 0.6 uSv/h
Av. = 1.6 uSv/h

81% of points above 1 uSv/h
100% of points above 0.23 uSv/h

ALL ZONES; (walking on-and-offroad), (2317 points) at 1m high, 2018/10/27



Max = 5.9 uSv/h
Min = 0.3 uSv/h
Av. = 1.3 uSv/h

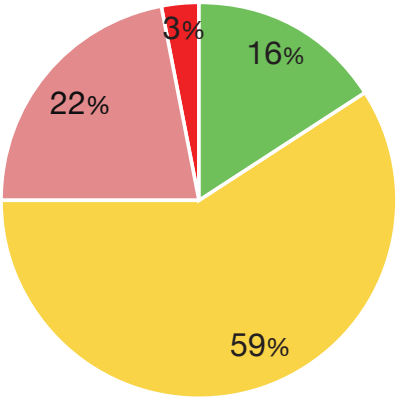
52% of points above 1 uSv/h
100% of points above 0.23 uSv/h

- Tsushima, Namie,
Difficult to Return Exclusion Zone

Charts: Proportions of radiation dose rate in same 2 zones, 2017 and 2018

- >= 5μSv/h
- < 5 and >= 3.8μSv/h
- < 3.8 and >= 2μSv/h
- < 2 and >= 1.5μSv/h
- < 1.5 and >= 1μSv/h
- < 1 and >= 0.5μSv/h
- < 0.5 and >= 0.23μSv/h
- < 0.23μSv/h

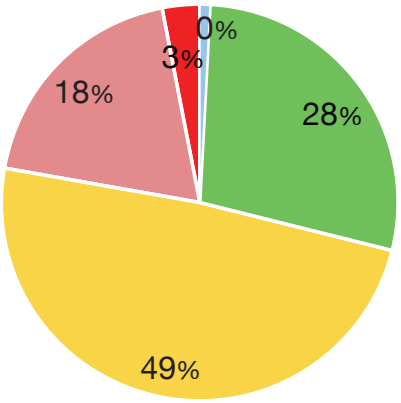
Road from gate to gate (walking on-and-offroad), (1696 points) at 1m high, **2017**/09/25



Max = 2.6 uSv/h
Min = 0.6 uSv/h
Av. = 1.3 uSv/h

84% of points above 1 uSv/h
100% of points above 0.23 uSv/h

Road from gate to gate (walking on-and-offroad), (1609 points) at 1m high, **2018**/10/27



Max = 2.8 uSv/h
Min = 0.4 uSv/h
Av. = 1.2 uSv/h

71% of points above 1 uSv/h
100% of points above 0.23 uSv/h

Image: Radiation survey gate to gate through Tsushima, October 2018

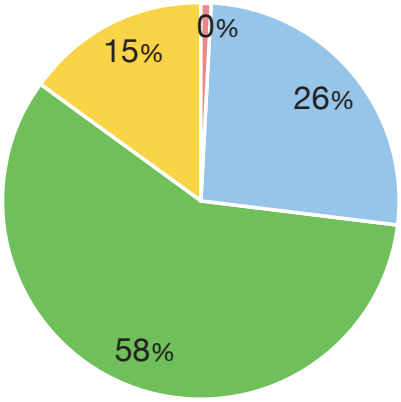
Map data © 2019 Google © 2019 ZENRIN to all map image

- Namie, Lifted Evacuation Areas

Charts: Proportions of radiation dose rates in 2018

- >= 5μSv/h
- < 5 and >= 3.8μSv/h
- < 3.8 and >= 2μSv/h
- < 2 and >= 1.5μSv/h
- < 1.5 and >= 1μSv/h
- < 1 and >= 0.5μSv/h
- < 0.5 and >= 0.23μSv/h
- < 0.23μSv/h

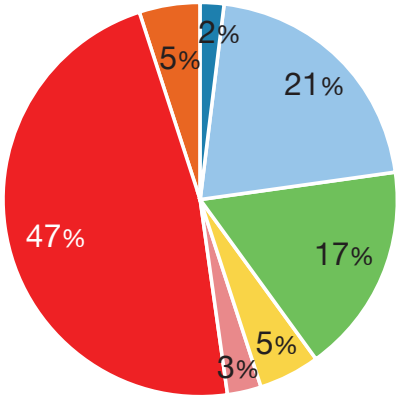
Zone-01; Path along river (walking on-and-offroad), (1354 points) at 1m high, 2018/10/19



Max = 1.5 uSv/h
Min = 0.3 uSv/h
Av. = 0.7 uSv/h

15% of points above 1 uSv/h
100% of points above 0.23 uSv/h

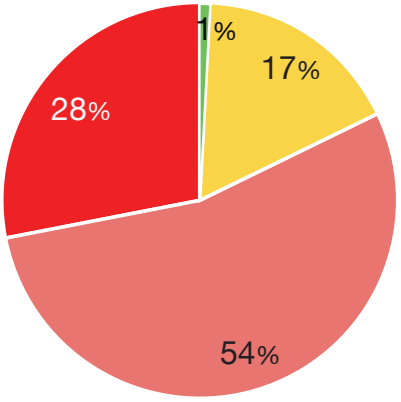
Zone-02; Forest along river (walking on-and-offroad), (2016 points) at 1m high, 2018/10/19



Max = 4.8 uSv/h
Min = 0.2 uSv/h
Av. = 1.9 uSv/h

59% of points above 1 uSv/h
98% of points above 0.23 uSv/h

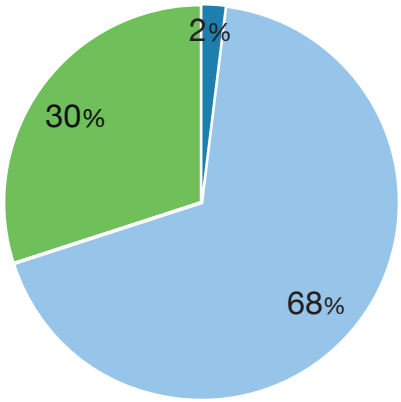
Zone-03; Forest in front of school (walking on-and-off road), (1584 points) at 1m high, 2018/10/19



Max = 2.9 uSv/h
Min = 0.8 uSv/h
Av. = 1.8 uSv/h

99% of points above 1 uSv/h
100% of points above 0.23 uSv/h

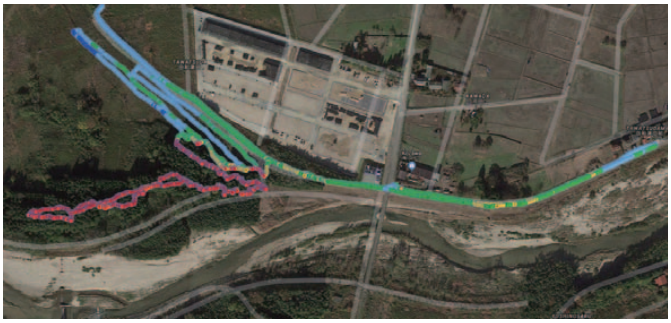
Zone-04; Road in front of school (walking on-and-off road), (690 points) at 1m high, 2018/10/19



Max = 0.8 uSv/h
Min = 0.2 uSv/h
Av. = 0.4 uSv/h

0% of points above 1 uSv/h
98% of points above 0.23 uSv/h

Image: Takase River in Namie (left) and Namie kindergarten and school area (right)



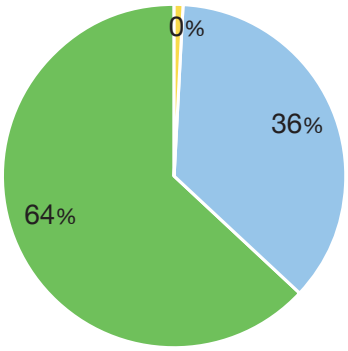
Map data © 2019 Google © 2019 ZENRIN to all map image

- Mr. Anzai's house in Iitate, Lifted Evacuation Area

Charts: Proportions of radiation dose rates in 2018

- > = 5μSv/h
- < 5 and > = 3.8μSv/h
- < 3.8 and > = 2μSv/h
- < 2 and > = 1.5μSv/h
- < 1.5 and > = 1μSv/h
- < 1 and > = 0.5μSv/h
- < 0.5 and > = 0.23μSv/h
- < 0.23μSv/h

Zone-01; Road to house (walking on-and-offroad), (447 points) at 1m high, 2018/10/24

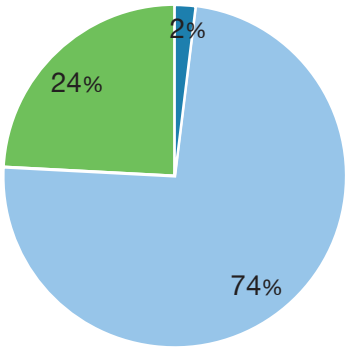


Max = 1 uSv/h
Min = 0.2 uSv/h
Av. = 0.5 uSv/h

0% of points above 1 uSv/h

100% of points above 0.23 uSv/h

Zone-02; front and sides of house (walking on-and-off road), (464 points) at 1m high, 2018/10/24

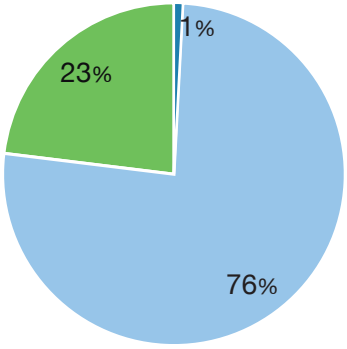


Max = 0.9 uSv/h
Min = 0 uSv/h
Av. = 0.4 uSv/h

0% of points above 1 uSv/h

98% of points above 0.23 uSv/h

Zone-03; under roof of house (walking on-and-off road), (629 points) at 1m high, 2018/10/24

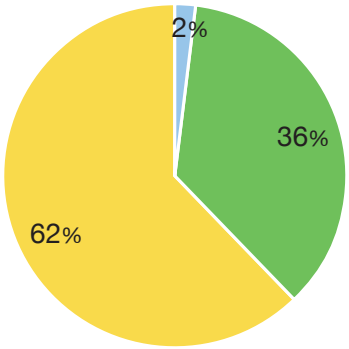


Max = 0.9 uSv/h
Min = 0.2 uSv/h
Av. = 0.4 uSv/h

0% of points above 1 uSv/h

99% of points above 0.23 uSv/h

Zone-04; field up on left of house (walking on-and-off road), (542 points) at 1m high, 2018/10/24

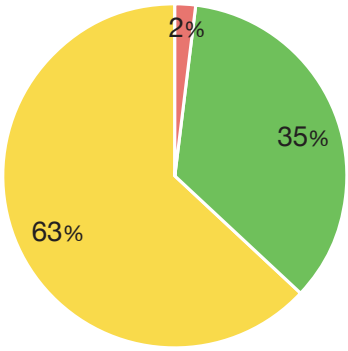


Max = 1.3 uSv/h
Min = 0.5 uSv/h
Av. = 1 uSv/h

62% of points above 1 uSv/h

100% of points above 0.23 uSv/h

Zone-05; forest behind house (walking on-and-off road), (952 points) at 1m high, 2018/10/24

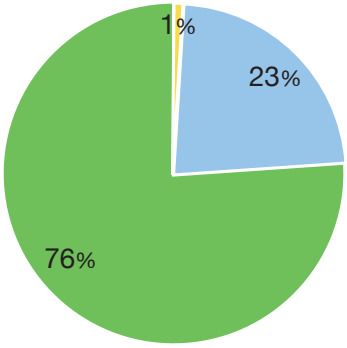


Max = 1.7 uSv/h
Min = 0.5 uSv/h
Av. = 1 uSv/h

65% of points above 1 uSv/h

100% of points above 0.23 uSv/h

Zone-06; field low (walking on-and-offroad), (1018 points) at 1m high, 2018/10/24

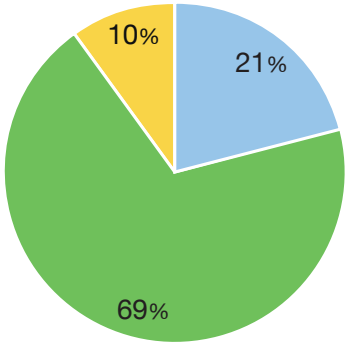


Max = 1.1 uSv/h
Min = 0.3 uSv/h
Av. = 0.6 uSv/h

1% of points above 1 uSv/h

100% of points above 0.23 uSv/h

Zone-07; field high (walking on-and-offroad), (695 points) at 1m high, 2018/10/24



Max = 1.4 uSv/h
Min = 0.3 uSv/h
Av. = 0.7 uSv/h

10% of points above 1 uSv/h

100% of points above 0.23 uSv/h

Decontamination workers, Tsushima, Namie exclusion zone, Fukushima prefecture, October 2018.

Endnote

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accurate information about the risk of radiation exposure and the increased vulnerability of children to radiation exposure; (g) Implement the recommendations made by the Special Rapporteur on the right of everyone to the enjoyment of the highest attainable standard of physical and mental health, (A/HRC/23/41/Add.3), see https://tbinternet.ohchr.org/Treaties/CRC/Shared%20Documents/JPN/CRC_C_JPN_CO_4-5_33812_E.pdf

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