The Current State of Radioactive Substances in Forests and the Regeneration of Forests and Forestry

2018 Edition

Forestry Agency

Contents

I The Current State of Air Dose Rates in Fukushima Prefecture

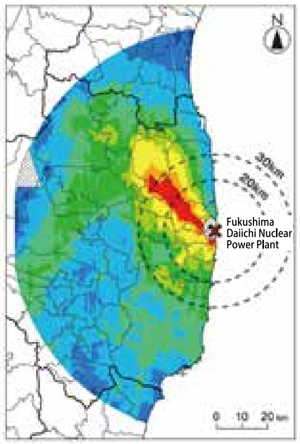
The state of radiation within Fukushima Prefecture and in nearby areas continues to change year by year. This report examines the course of events from immediately after the accident at the Fukushima Daiichi Nuclear Power Plant to the present, and the outlook for the future, presenting the current situation together with actual measurement data produced by detailed monitoring.

Changes Over Time of Air Dose Rate Observed by Airborne Monitoring

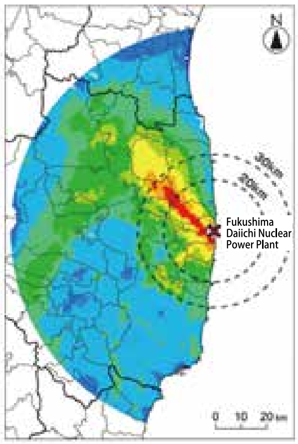
The Nuclear Regulatory Commission has been using aircraft to perform continuous monitoring, both within and outside a zone of 80km around the Tokyo Electric Power Company, Incorporated (TEPCO) Fukushima Daiichi Nuclear Power Plant, in order to check changes of air dose rate in areas affected by radioactive substances from the accident.

The results of airborne monitoring of air dose rates within the 80km zone between September and November 2017 found that air dose rates had declined by approximately 74%*, compared to November 2011, immediately after the accident.

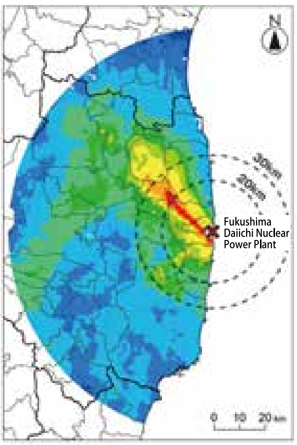
Levels have been confirmed to be falling over time, both in areas of high dosage (a region extending northwest from TEPCO Fukushima Daiichi Nuclear Power Plant) and of low dosage (see Figures).



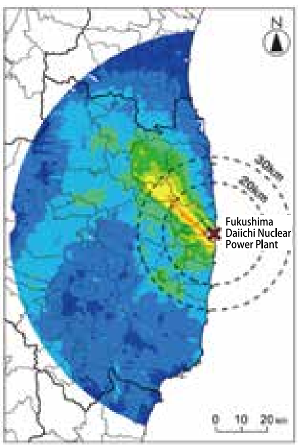
1 month after the accident (2011.04.29)



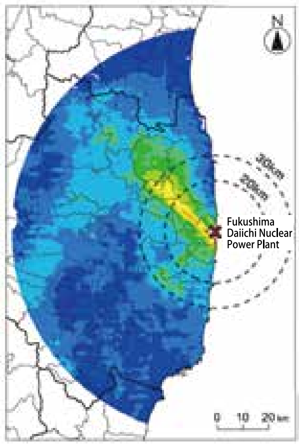
7 months after the accident (2011.11.05)



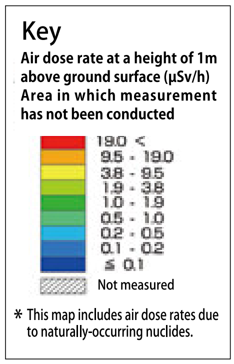
15 months after the accident (2012.06.28)



54 months after the accident (2015.09.29)



78 months after the accident (2017.09.25)



* These values were obtained by dividing the target region with a 250m mesh and calculating from the ratio of measurement results at the center point of each mesh square. It is possible that reduction rates could differ if other comparative methods were used.

[Figure] Movements in the Distribution Map of Air Dose Rates within the 80km Zone

Reference : Nuclear Regulatory Commission "Measurement Results of Monitoring by Aircraft in Fukushima Prefecture and Nearby Prefectures" February 20, 2018, Ministry of the Environment "Unified Basic Reference on the Health Impacts of Radiation" (2017 Edition)

Estimated Future Air Dose Rates Distribution

According to data from a measurement monitoring survey which has been conducted continuously at 362 points in forests in Fukushima Prefecture since August 2011, air dose rates from the time of the accident to the present have fallen in almost the same manner as the physical decay of radioactive cesium. The average value of air dose rate now, in March 2018, is 0.23 μSv/h (see Figure).

Therefore, air dose rates in future are expected to continue to fall in the same manner as the physical decay of radioactive cesium. By 2041, 30 years after the reactor accident, air dose rates are expected to fall to 0.1 μSv/h or less, with the exception of some areas near the areas under evacuation orders.

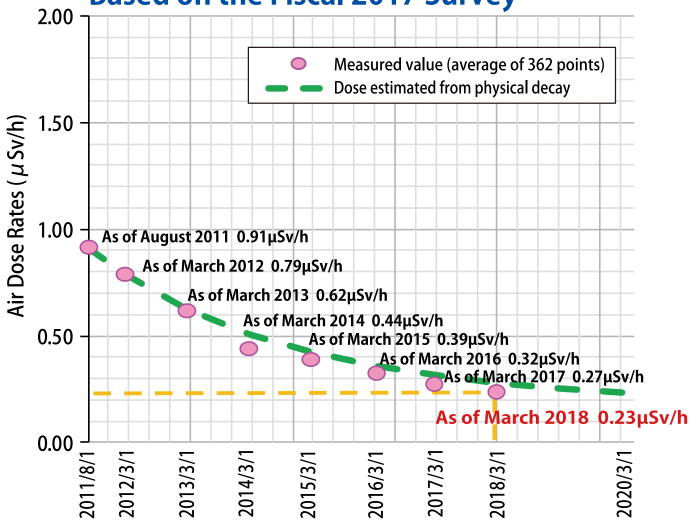
Based on the Fiscal 2017 Survey

※Estimates based on continued surveys at 362 points since August 2011 (Unit: μSv/h)

As of March 2018 (see above)	10 years after the nuclear disaster Estimate of March 2021	20 years after the nuclear disaster Estimate of March 2031	30 years after the nuclear disaster Estimate of March 2041
0.23	0.18	0.13	0.10

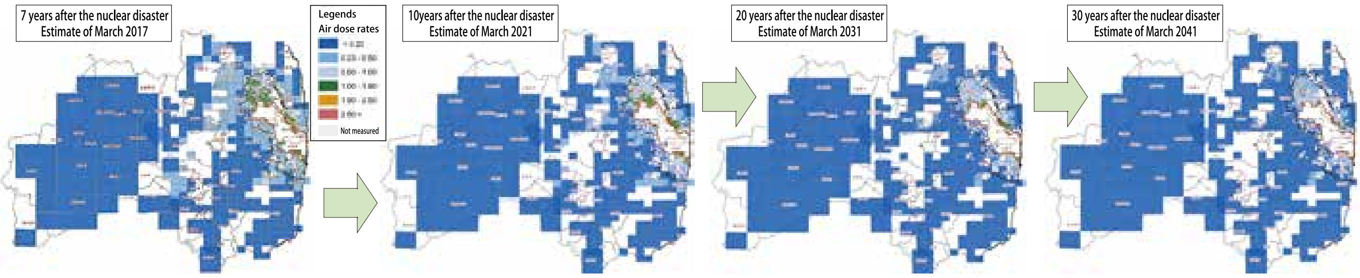
30 years after the nuclear disaster:
Air Dose Rates will decrease to 0.1 μSv/h or lower, except some parts of the areas under evacuation orders.

Based on the Fiscal 2017 Survey



[Figure]Physical Decay Curve of Radioactive Cesium and Its Relationship with the Measured Monitoring Values (average of the values at 362 points)

Reference : Fukushima Prefecture "Long-term Monitoring of Radioactive Material in the Forest and Associated Countermeasures" (2017 Edition)



Reference : Fukushima Prefecture "Long-term Monitoring of Radioactive Material in the Forest and Associated Countermeasures" (2017 Edition)

Comparison of Air Dose Rates between Fukushima Prefecture and the World

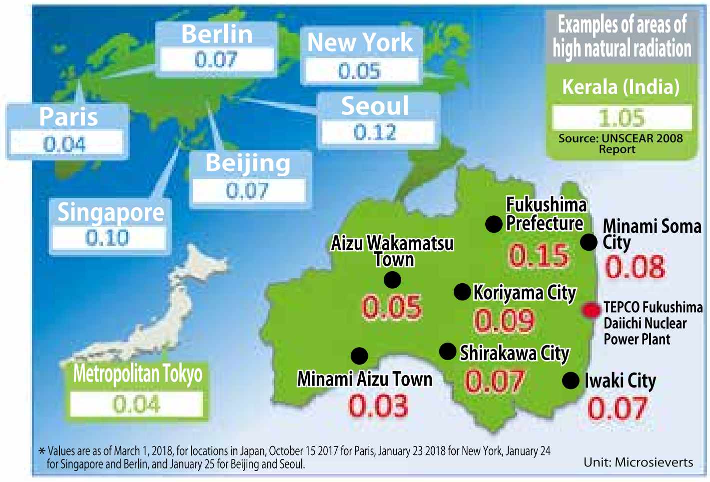
Compared to April 2011, air dose rates in Fukushima Prefecture have greatly declined, and are at close to the same levels as major cities overseas (Figure).

There are places around the world, such as Yangjiang in China, Kerala in India, and Ramsar in Iran, which have levels of natural radiation between two and 10 times higher than in Japan. The high levels of natural radiation in such areas are said to be caused by high content of radioactive substances such as radium, thorium, and uranium in soil.

Epidemiological studies etc. in China and India have not reported markedly increased levels of cancer incidence and mortality in these areas. Analysis of cancer risks in Ramsar is currently under way.

Furthermore, the impact of radiation on the human body is caused by damage to DNA, so the impacts of natural and artificial radiation are the same.

Air dose rates in Fukushima Prefecture are at close to the same levels as major cities overseas.



[Figure] Current Air Dose Rates in Fukushima Prefecture and the World

Reference : Reconstruction Agency "Eliminating Negative Reputation Impact 2018" , Ministry of the Environment "Unified Basic Reference on the Health Impacts of Radiation" (2017 Edition)

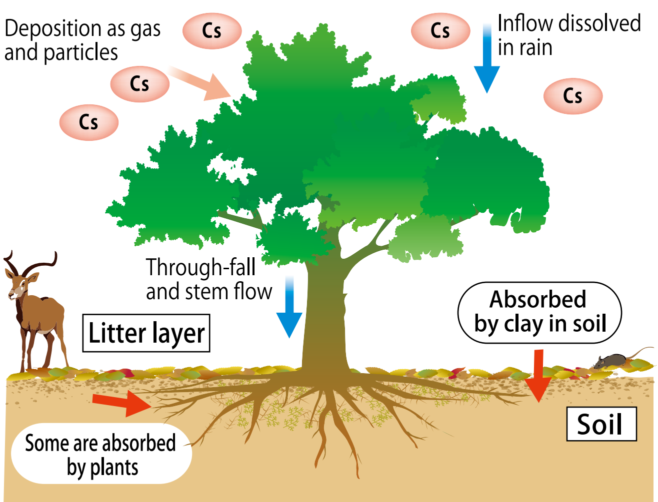
II Dynamics of Radioactive Substances in Forests

Forestry Agency set monitoring sites in three municipalities (Kawauchi Village, Otama Village, and Tadami Town) in Fukushima Prefecture in 2011 to clarify the distribution of radioactive cesium within forests. It investigates the concentrations and accumulated quantities of radioactive cesium in soil, in litter layers, and in the leaves, trunks, and other parts of trees.

Dynamics of Radioactive Substances in Forest Ecosystems

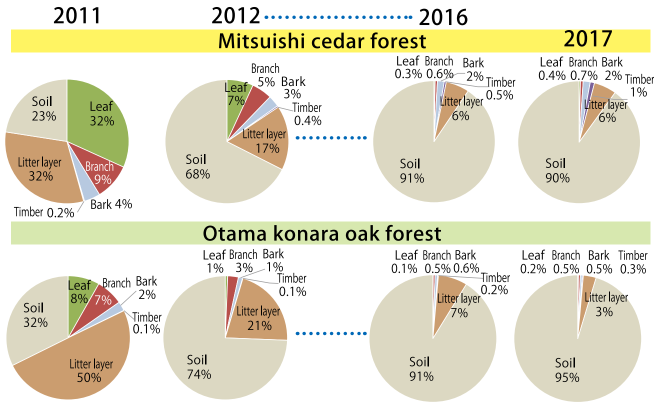
Fallout radioactive cesium into forests was carried as gas and particles in the air, dissolved into rain water, and attached to trees, mainly in the forest canopy (the upper parts of trees, with thick leaf growth). After that, the leaves fall and deposits are washed off by rain, moving into the litter layer on the ground surface. Next, the litter layer is decomposed and moves into the soil (Figure 1). This process was also revealed by investigations after the Chernobyl reactor accident.

Just as in the surveys areas where the Forestry Agency has been continuously taking measurements since 2011 (Mitsuishi cedar forest in Shimo-Kawauchi, Kawauchi Village, Futaba District, Fukushima Prefecture and Otama konara oak forest in Tamai, Otama Village, Adachi District, Fukushima Prefecture), the proportion of radioactive cesium in leaves, branches, and litter layer fell sharply and the proportion in soil rose between 2011 and 2012, the first year after the accident. After that, the proportion of radioactive cesium in soil rose further. In 2017, around 90% of radioactive cesium in forests was in soil, and a majority of that was present in the top layer of soil, at depths of 0-5cm deep (Figure 2).



[Figure 1] Dynamics of Radioactive Cesium in Forest Ecosystems

Reference : 2017 symposium document by the Forestry and Forest Products Research Institute

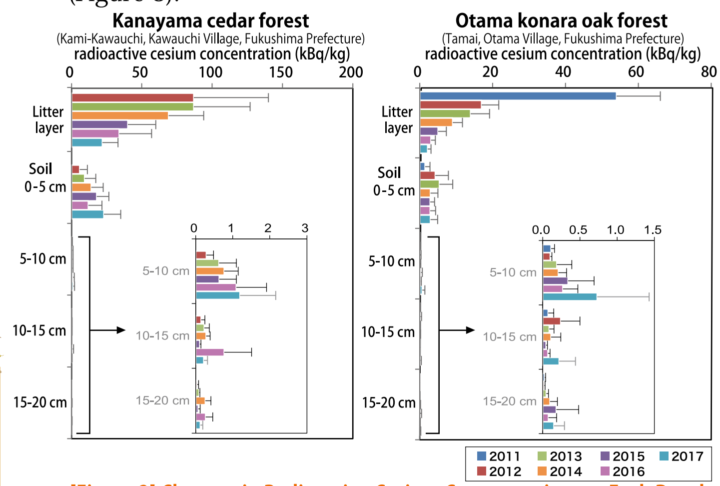


(Note) Survey results between 2013 and 2015 have been omitted.

[Figure 2] Proportion of Accumulated Radioactive Cesium in Each Part in Each Survey Area

Reference : Forestry Agency "Results of a Survey of Radioactive Cesium Distribution in Forests" (2017)

The radioactive cesium concentration at each depth level within soil appears to be shifting gradually over time, from above ground to the litter layer, and then into soil between 0 to 5cm in depth. In some monitoring sites, movement to deeper layers can be seen, so it will be necessary to watch the state of movement closely in future (Figure 3).



[Figure 3] Changes in Radioactive Cesium Concentrations at Each Depth in Soil (examples of Kanayama cedar forest and Otama konara oak forest)

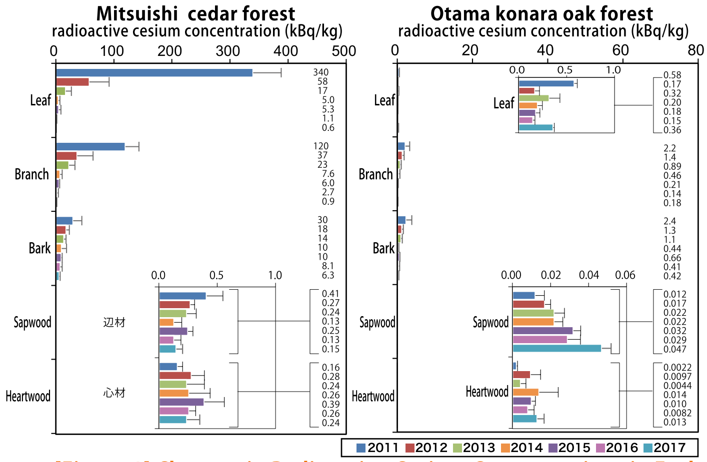
Reference : Forestry Agency "Results of a Survey of Radioactive Cesium Distribution in Forests" (2017)

Distribution of Radioactive Substance Concentrations in Each Part of Trees

Concentrations of radioactive cesium in the leaves, branches, bark, and other parts of trees declined sharply between 2011 and 2012, but after 2012, the decline in concentrations has been more gradual. Also, in every investigation area, the heartwood and sapwood within timber has had lower concentrations than the leaves, branches, bark, and other parts (Figure 1).

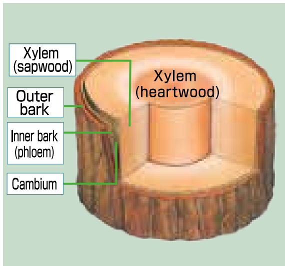
The decline of concentrations in the leaves of evergreen trees such as cedar and Japanese cypress is thought to be influenced by replacement with new leaves as old leaves fall, in addition to washing by rain.

As concentrations of radioactive cesium within wood have not changed greatly since 2011, it appears that most of the radioactive cesium absorbed immediately after the accident accumulated in internal parts of trees. Also, as the leaves of konara oaks, which are grown new every year, include radioactive cesium, and concentration changes are observed in the sapwood and heartwood of cedars and konara oaks, it appears that part of the radioactive cesium concentration is migrating within trees. In cedars, in particular, research to date has revealed a rising trend in radioactive cesium concentrations in heartwood. Furthermore, as radioactive cesium is found even in saplings that were grown after the accident, it is also necessary to investigate the effect of absorption from the root (Figure 3).



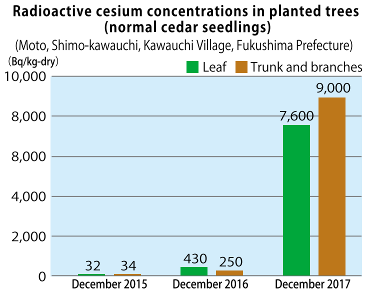
[Figure 1] Changes in Radioactive Cesium Concentrations in Each Part of Trees in Mitsuishi Cedar Forest and Otama Konara Oak Forest

Reference : Forestry Agency "Results of a Survey of Radioactive Cesium Distribution in Forests" (2017)



[Figure2] Structure of a Tree Trunk

Reference : "Data Collection to Know Forest No.1", Zenrinkyou



[Figure3] Changes in Radioactive Cesium Concentrations in Planted Trees

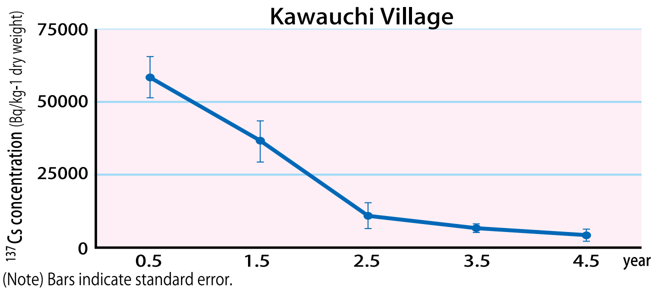
Reference : Forestry Agency "Validation Project for Forestry Revitalization in Districts Preparing for Evacuation Order Lifting" (Futaba District), 2017

Impact of Radioactive Substances on Small Mammals Living in Forests

Since 2011, the Forestry Agency has been running a survey to grasp the real state of radioactive contamination in earthworms and field mice living in forests.

Radioactive cesium concentrations in earthworms collected in Kawauchi Village decreased substantially between 0.5 and 2.5 years after the accident, and then continued with a more gradual decline (Figure 1). To see the ease of radioactive cesium movement into the bodies of earthworms, the ratio between radioactive cesium concentrations in the litter layer that they eat and in the bodies of the earthworms was investigated. Compared to the concentration in the litter layer, the concentration within earthworm bodies tended to be lower. That is thought to be the case because as the absorption of radioactive cesium from the litter layer to clay etc. advances, it becomes harder for it to migrate into earthworms.

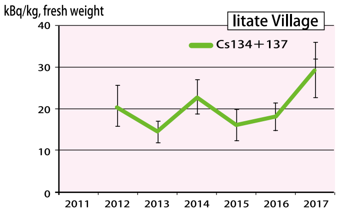
Also, looking at annual changes in radioactive cesium concentrations in the bodies of field mice, there was an increase in levels in field mice in Iitate in 2017, a decrease in Kawauchi Village, and no significant change in Kita-Ibaraki. Patterns of concentration change differed regionally (Figure 2).

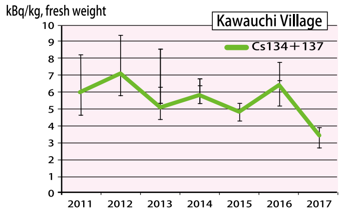


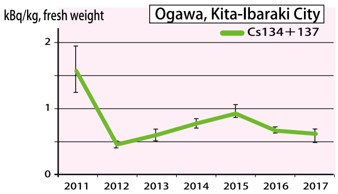
(Note) Bars indicate standard error.

[Figure 1] Changes in Radioactive Cesium Concentrations in Earthworms (gastrointestinal tract content removed, per unit dry weight)

Reference : Forestry Agency "Project Report of Survey on Radioactive Substances in Forests (2015)"







(Note) Bars indicate standard error.

[Figure 2]Annual Changes in Radio-Active Cesium Concentrations in Field Mice in Each Survey Area

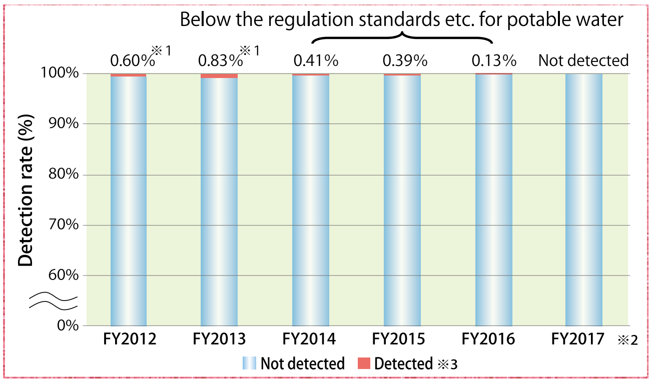
Reference : Forestry Agency "Project Report of Survey on Radioactive Substances in Forests (2017)"

Impact of Radioactive Substances on Mountain Stream Water and Potable Stream Water

In 2012, during the thawing season, the Forestry and Forest Products Research Institute conducted a monitoring survey by measuring the radioactive cesium concentrations at the daily fixed time, at six locations in Fukushima Prefecture, in mountain streams originating in forests. Results indicated that almost no radioactive cesium was detected in mountain stream water flowing out of forests (the lower limit of detection was 1 Bq/L), but it was detected in some samples on days with rainfall. At the times of detection, the water was muddied with particles of fine soil. After filtration, no cesium was detected in the filtered water. From that, it can be inferred that the main source of radioactive cesium in mountain stream water is particles of fine soil etc.

Since December 2012, the Ministry of the Environment has monitored portable stream water etc , in municipalities which have requests in Fukushima Prefecture . According to survey data gathered over five years to date, no cesium was detected in 8,963 of all 9,020 samples (99.4%) in nine municipalities (Iitate Village, Okuma Town, Katsurao Village, Kawauchi Village, Kawamata Town, Tamura City, Namie Town, Naraha Town , and Hirono Town). After filtration, no cesium was detected in the filtered water from any location.

In FY2017, when stream water etc. was sampled at 142 locations and measured for radioactive cesium concentration, no cesium was detected in any sample (detection limit: 1 Bq/L) (Figure).



[Figure] Trend of Detection Rates of Radioactive Cesium in Monitoring of Potable Stream Water

※1 In FY2012 and FY2013, only three samples surpassed the regulatory standard for potable water.
※2 Measurement period: December 2012 - February 2018
※3 Lower limit of detection: 1 Bq/L

[Photo] Example of a Sampling Location (Iitate Village)

[Reference]
- Standards for Foods and Additives, Based on the Food Sanitation Law (potable water) (Ministry of Health, Labour and Welfare Recommendation No.130, March 15, 2012) Radioactive cesium (total of Cs-134 and Cs-137): 10 Bq/L
- Target value for radioactive substances in mains water (Management target value for mains water facilities) (Ministry of Health, Labour and Welfare, Pharmaceutical Safety and Environmental Health Bureau, Water Supply Division manager's notification 0305-1, dated March 5, 2012) Radioactive cesium (total of Cs-134 and Cs-137): 10 Bq/L

Reference : Ministry of the Environment "Measurement Results of Monitoring of Stream Water etc. in Decontamination Special Areas" (Summary of results for the past five years and of samples collected in February 2018)"

Column Main Findings Obtained from the Chernobyl Nuclear Power Plant Accident

How have forests, forestry, and timber-related industries been impacted since the Chernobyl nuclear power plant accident, which happened in 1986 in what was then the Soviet Union? This column examines the main points, with reference to recent bibliography, such as published documents from the Science Council of Japan and the International Atomic Energy Authority.

(Movement of Radioactive Cesium in Forests)

Radioactive cesium which fell on forests after the reactor accident first adhered to the forest canopy and to bark. After that, part of it was absorbed through plant surfaces, and the other part of it settled into bark for the long term, but within a few years, most of the cesium had moved to the forest floor. With the decomposition of organic matter on the forest floor, cesium moved to the soil surface layer, and adsorbed strongly to clay minerals, tending to stay in that surface layer for the long term. Even 10 years and more after the Chernobyl accident, there has been almost no movement of the peak radioactive cesium concentration in soil to lower layers, and movement to deep layers appears to be progressing slowly.

On the other hand, part of fallout radioactive cesium into forests has been moving dynamically, together with the circulation of substances in the forest ecosystem. That is attributed to the fact that radioactive cesium is an alkaline element, like potassium, a major nutrient salt, and has similar properties. Also, within the circulation that makes efficient use of nutrient salts, radioactive cesium stays in a form that is relatively easy for organisms to incorporate. As a result, radioactive cesium remains in relatively high concentrations in living organisms in forest.

(Impact on Mushrooms etc.)

In Belarus, in Easterns Europe, there is long-standing contamination of mushrooms, raspberries, and wild animal meat. Average radioactivity levels in wild animal meat depend on the species, but are high in boar and deer.

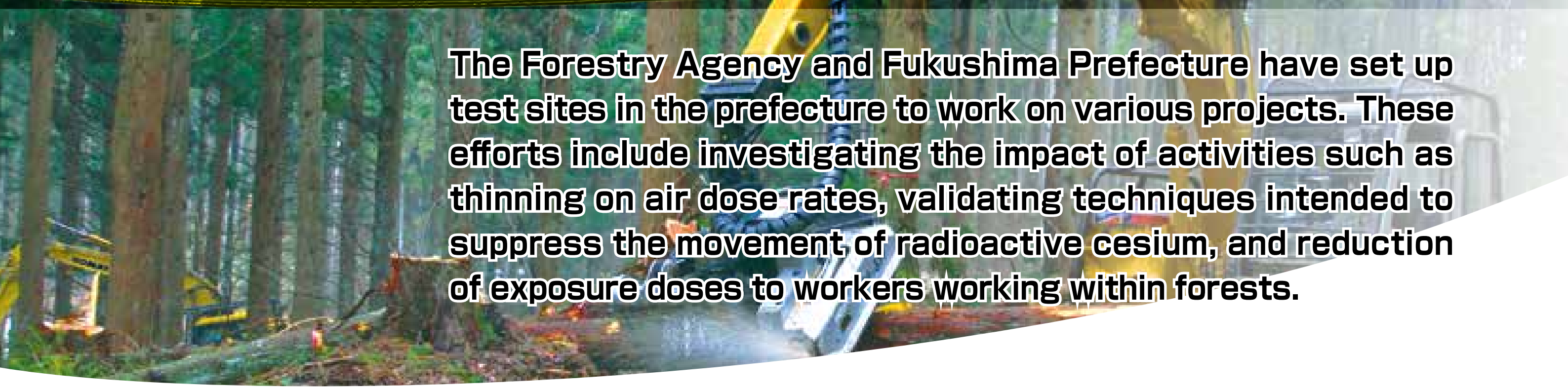
(Radioactive Cesium in Timber)

In Belarus, there is said to be a correlation between radioactive cesium concentration in timber and the amount of cesium deposition in soil.

These findings obtained from the Chernobyl nuclear power plant accident is valuable for predicting the future for forests etc. impacted by the Fukushima accident in 2011. However, Japan and Chernobyl differ in climate, topography, geology, flora, and other aspects, and the utilizing manners of forest products are also different. Therefore, it is important to verify the differences based on resources such as results obtained.

Reference: Science Council of Japan "Radioactive Contamination from the Fukushima Reactor Accident and the Impacts on Forests, Forestry, and Timber-related Industries - Current Status and Problems", September 1, 2014;
IAEA (2006) "Report of the International Atomic Energy Authority Chernobyl Forum Expert Group "Environment" , Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience", (translated by the Science Council of Japan)

III Impact of Radioactive Substance on Forest Management



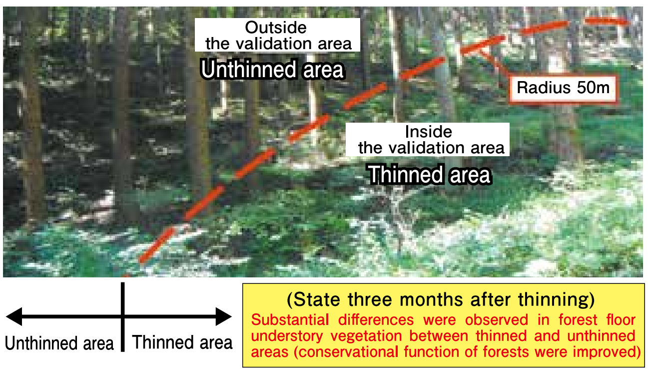
The Forestry Agency and Fukushima Prefecture have set up test sites in the prefecture to work on various projects. These efforts include investigating the impact of activities such as thinning on air dose rates, validating techniques intended to suppress the movement of radioactive cesium, and reduction of exposure doses to workers working within forests.

Effects of Thinning, and Its Impact on Air Dose Rates

In Fukushima Prefecture, a test site in a Japanese red pine forest was set up in Kawauchi Village from 2012 to 2017,and used to survey the impact of thinning on air dose rates. In April 2012, air dose rates were measured before and after thinning and harvesting operation. The air dose rate, which was 4.52 μSv/h before operation, decreased by 12% to 3.87 μSv/h after the operation. By three months after the thinning, undergrowth vegetation had flourished on the forest floor, so the vegetation was obviously different from that before thinning (photo).

Thinning brightens the inside of the forest and promotes the growth of understory vegetation, reducing the direct impact of rain drops on the ground surface, which is expected to suppress the movement of radioactive cesium by suppressing movement of topsoil.

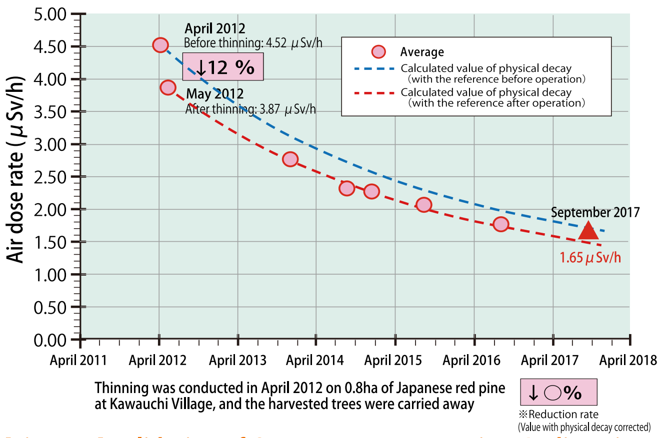
In September 2017, five years and five months later after the thinning, it was confirmed that the air dose rate was continuing to decrease at almost the same rate as the value estimated from physical decay of radioactive cesium (Figure 1). At this moment of seven years and seven months after the reactor accident, most of the radioactive cesium in forests has accumulated in the soil surface layer, and the proportion included in trees is small. Therefore, it seems that the air dose rate does not change greatly between before and after thinning at the current stage.



[Photo] Validation of the Removal of Radioactive Substances from Forests (Effects of Thinning)

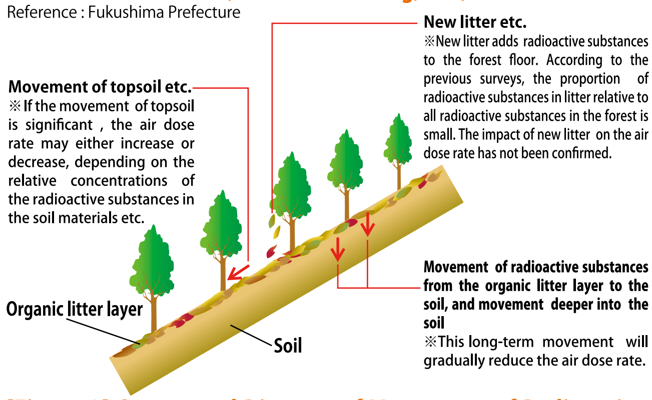
(Note) The validation area was set as a circle of 50m radius of approximately 0.8ha.
Reference : Fukushima Prefecture "Long-term Monitoring of Radioactive Material in the Forest and Associated Countermeasures" (FY2014 and FY2015)

Furthermore, forest management work such as harvesting and thinning improves the light environment in the forest, and raises the soil surface temperature. This would appear to have an effect in promoting movement of radioactive substances to the soil, by assisting decomposition in the litter layer. The illustration below (Figure 2) shows the movement of radioactive substances within forests.



[Figure 1] Validation of Countermeasures against Radioactive Substances in Forests (effects of thinning, etc.)

Reference : Fukushima Prefecture



[Figure 2] Conceptual Diagram of Movement of Radioactive Substances Observed in the Forests

Reference : Forestry Agency (FY2017) "Results of the Validation and Development Project for Countermeasures against Radioactive Substances in Forests"

Monitoring Survey of Impacts of Thinning etc. on Movement of Soil Materials and Radioactive Substances

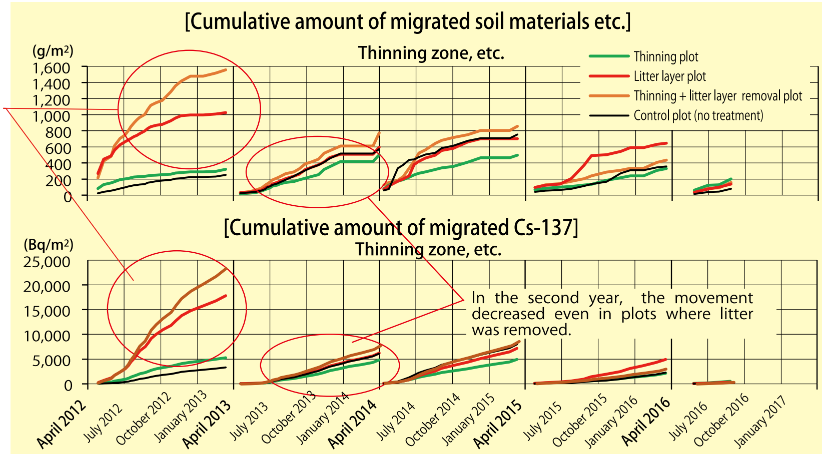
The Forestry Agency set up test sites in Hirono Town from 2012 to 2017, and investigated the amounts of movement of soil material etc. and radioactive cesium due to thinning and the removal treatment of litter layer. Investigation of surface running water and movement of soil etc. within forests observed that almost no radioactive cesium was found in the surface runoff water , and the radioactive cesium in the forest moved mainly together with the sediment.

Measurement results for the following four treatments within the test area are compiled into the graph.

(1)Thinning plot
(2)Litter layer and debris removal plot
(3)Thinning + litter layer removal plot
(4)Control plot (no treatment)

There was no major difference of amount of soil movement between "(1) Thinning treatment" and "(4) Control plot (no treatment)". In the "(2) Litter layer and debris removal plot" and the "(3) Thinning + litter layer removal plot" , the amount of migrated soil material and radioactive cesium greatly increased in the first year. However, it reduced to the same level as the "(4) Control plot (no treatment)" in the second year.

These results indicate that when the forest is thinned, there is little soil material movement if the forest floor is not greatly disturbed, and there appears to be little impact on the movement of radioactive cesium.



[Figure] Trend of Annual Accumulated Migrated Soil and Radioactive Cesium after Forest Management Work

Reference : Forestry Agency (FY2016 and FY 2017) "Results of the Validation and Development Project for Countermeasures against Radioactive Substances in Forests"

Countermeasures against Radiation Exposure While Working within Forests (internal exposure and external exposure)

The Forestry Agency measured the amount of dust generated by each work type and the radioactive cesium concentration of the dust, to investigate workers' internal radiation exposure. The highest internal exposure dose per hour was 0.000046 μSv/h, for working in chip laying. The average air dose rate in the survey area at that time was 0.62 μSv/h.

That means that the internal exposure dose was extremely low, tens of thousands of times smaller than the external exposure dose, so it is important to reduce external exposure in forest work.

The longer the working hours of the work type, the higher the external exposure dose. Also, even within the same type of work, those who spend more time in the cab of a timber processor or a grapple etc. tended to have lower external exposure doses than those working outside. Comparing external exposure doses per unit time, those for land preparation and logging with heavy equipment are around 10% lower than those for manual labor (Figure).

That means that to reduce the exposure involved in working in forests, it would be effective to keep working hours as short as possible, and to use heavy equipment.

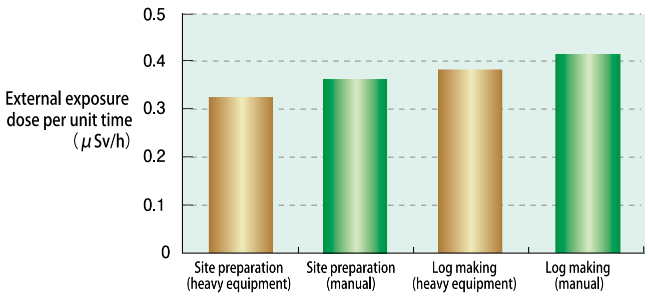
Work type	Average dust concentration mg/m³	Total working time h	Inhaled amount ※1 of dust mg/h	mg	Radioactive cesium ※2 concentration of dust 134Cs Bq/kg	134Cs Bq/kg	Internal exposure dose μSv/h
Improvement cutting	0.29	379.5	0.35	131.3	86	260	0.4×10⁻⁵
Forestry operation road construction ※3	0.17	147.0	0.20	29.6	1500	3800	3.6×10⁻⁵
Regeneration cutting	0.10	120.5	0.16	19.7	220	680	0.5×10⁻⁵
Site preparation	0.10	70.5	0.13	8.8	1500	3800	2.2×10⁻⁵
Mechanized regeneration cutting ※2	0.08	18.5	0.09	1.7	1500	3800	1.7×10⁻⁵
Planting	0.10	336.5	0.12	40.7	1500	3800	2.2×10⁻⁵
Chip laying	1.24	77.0	1.48	114.2	220	680	4.6×10⁻⁵

※1 : Estimation of worker's inhalation of radioactive substances for each work type was calculated based on measurement using a digital dust meter and inhalation quantity of 1.2m3/h (from ICRP Pub 1.23).
※2 : For improvement cutting, the average value of understory vegetation radioactive cesium concentration was used. For forestry operation road construction, site preparation, mechanized regeneration cutting, and planting, the average values of radioactive cesium concentration for litter and soil were used. For regeneration cutting and chip laying, the average value for radioactive cesium concentration of logs was used.
※3 : Forestry operation road construction and mechanized regeneration cutting are jobs done by operators sitting inside heavy equipment, so the amounts of dust inhalation and internal exposure dose can be expected to be greatly reduced, but the same method as for outdoor work was used.

[Table] Internal Exposure Dose Estimated Calculation Results

Reference :Forestry Agency (2014) "Report on Validation Projects in Districts Preparing for Evacuation Order Lifting (Tamura City)"

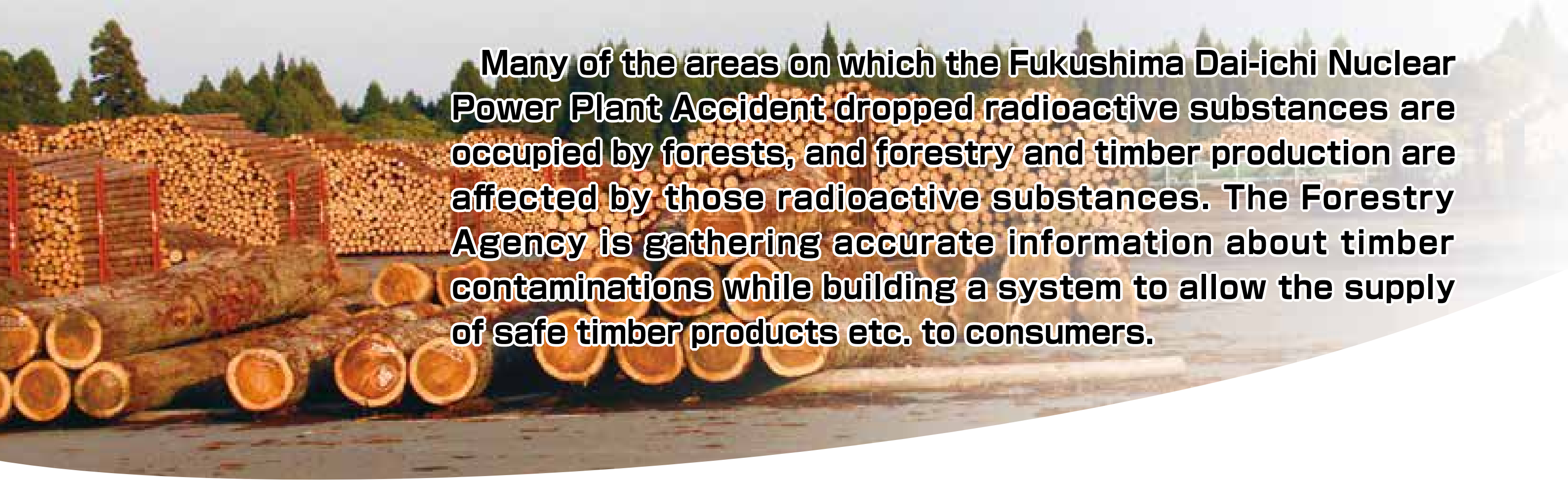
[Photo] Thinning Using Cabin-equipped Forestry Equipment



[Figure] External Exposure Dose Per Unit Time for Each Work Type

Reference : Forestry Agency (2014) "Report on Validation Projects in Districts Preparing for Evacuation Order Lifting (Tamura City)"

Ⅳ Actions to Promote Timber Use



Many of the areas on which the Fukushima Dai-ichi Nuclear Power Plant Accident dropped radioactive substances are occupied by forests, and forestry and timber production are affected by those radioactive substances. The Forestry Agency is gathering accurate information about timber contaminations while building a system to allow the supply of safe timber products etc. to consumers.

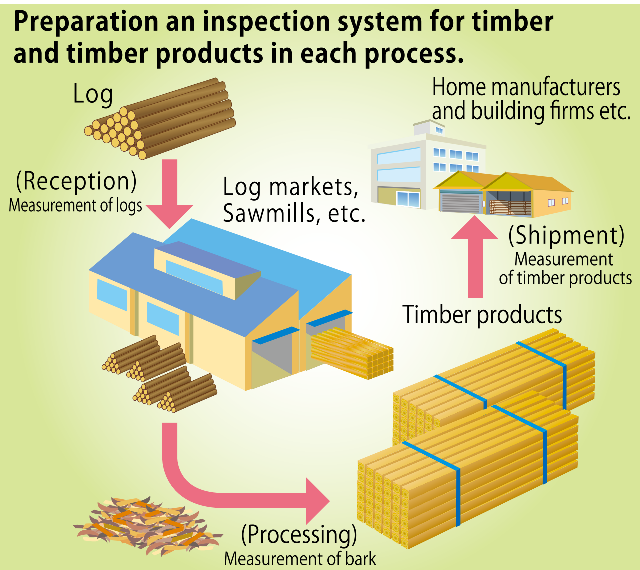
Building Systems to Supply Safe Timber Products etc.

In efforts to ensure safety, timber produced in Fukushima Prefecture is felled and moved according to the "Guidelines for Felling and Moving Trees From Private Forests of Fukushima Prefecture (enacted on December 17, 2014)" by Fukushima Prefecture, and standards for the safe shipment of timber products are set in "Voluntary Management Standard Limit for Radiation Levels in Timber Products (enacted on July 27, 2012) by the Fukushima Prefecture Federation of Timber Cooperatives.

In addition, the Forestry Agency works to provide consumers with safe timber products etc. by performing continuous investigation and analysis (monitoring) of radioactive substances in timber products and working environments etc., for all processes from intake of raw lumber to shipment of timber products. The Agency has installed radioactive substance measurement instruments in raw lumber markets, sawmills, and chip factories, and provides outreach and education to prevent negative reputation impact. These and other measures provide support towards the establishment of a safety certification system for timber products etc. (Figure 1).

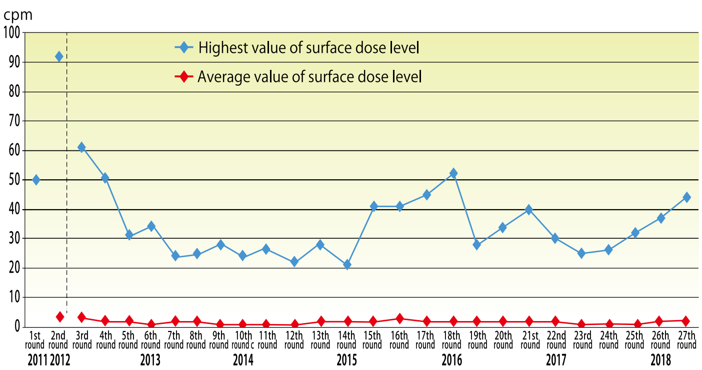
In Fukushima Prefecture, surface dose levels on finished timber products in factories finishing and shipping materials produced in the prefecture have been investigated at regular intervals (once in three months) since 2011. A survey conducted in June 2018 found that when three or more samples were taken of each product type, such as columns, beams, and boards, from all 127 factories preparing and shipping Fukushima-grown materials, the highest value of surface radiation level (unit cpm*1) was 44 cpm (equivalent to 0.001 μSv/h*2) (Figure 2) When this measured value was checked by an expert in radiological protection, their assessment was that it would have no impact on health or the environment.

※1 cpm: Short for counts per minute, which is the value displayed on a Geiger counter or other radiation meter.
※2 For reference, the air dose in Fukushima City before the disaster (on 2010.2.16) was 0.04 μSv/h, while the air dose in Shinjuku ward, Tokyo (on April 2 2018) was 0.0376 μSV/h.



[Figure 1] Development of an Inspection System for Raw Timber and Timber Products

Reference : Forestry Agency "Survey and Validation Project for Impacts on Distribution of Safe Timber Products etc." (FY2018)



[Figure 2] Surface Dose Levels of Timber Products

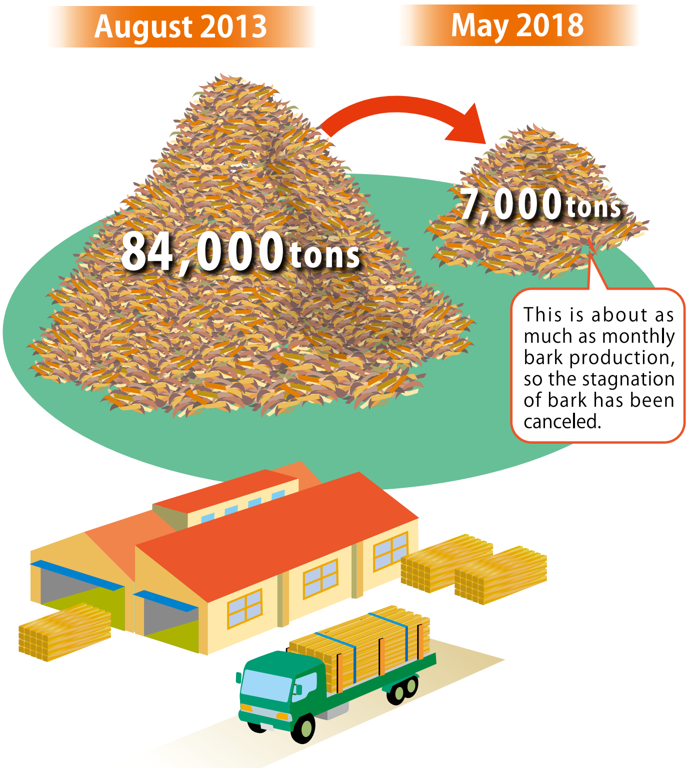
Reference : Fukushima Prefecture "Results of a Survey of Radiation Levels of Timber Lumber Products from Fukushima Prefecture"

Measures to Process Bark Residues in Lumber Factories etc.

Bark, which is a by-product of timber processing has been put to effective use as fuel for boilers, compost, bedding for livestock, and other uses. However, after the Fukushima Daiichi reactor accident, there were reports of cases of burning waste wood, including bark, producing ash containing radioactive cesium at high concentrations. Since then, there has been no progress in the use of bark. That has left bark building up in sawmills and elsewhere.

Stagnated bark reduces the amount of logs that can be accepted, so in 2013 the Forestry Agency, aiming to stabilize the distribution of forestry products in the region, started providing subsidies for the costs of incinerating and temporarily storing bark at waste disposal sites, and for temporary storage costs. As a result, the amount of stagnated bark has declined from a peak of 84,000 tons in August 2013 to 7,000 tons in May 2018, removing the buildup (Figure).

Also, the incineration and disposal of bed logs for mushroom production etc. that had been rendered unusable by the effects of radioactive cesium was not making progress, so the Forestry Agency is paying expenses for their temporary storage etc. Radioactive cesium concentrations at incinerators have been measured since FY2015, to confirm safety while the disposal of bed logs progresses.



[Figure] Promoting the Processing of Stagnated Bark

Reference: Forestry Agency (2018) "Disposal Assistance Project for Forestry Products Damaged by Radioactive Substances"

Approximate Calculation of Exposure Dose of Radiation in an Occupied Room Surrounded by Timber

If someone lived in a room surrounded by timber containing radioactive material, what would be the effects on their body?

In Fukushima Prefecture, the output of materials from forests with air dose rates exceeding 0.5 μSv/h is restricted, in order to smoothly process bark generated by timber processing etc.

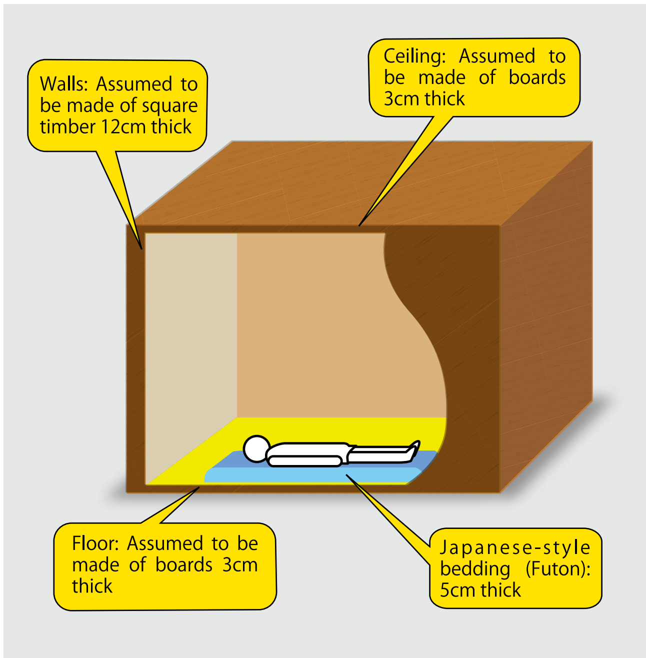
A survey by Fukushima Prefecture of 81 locations in the prefecture in FY2017 found that the average reading from timber at 55 locations with air dose rates not exceeding 0.5 μSv/h was 49 Bq/kg.

If the timber products (*1) from which the highest radioactive cesium concentrations were detected in that survey were used to build all six planes of a house (ceiling, walls, floor), the additional exposure dose was estimated at 0.007μSv/h, for an annual dose of 0.048 mSv (*2). These values are extremely small, even compared to 2.1mSv, which is the annual exposure dose from natural radiation.

Given the above, it appears that even living in a wooden home using timber produced in Fukushima Prefecture would have almost no impact on the environment or on health.

※1 2,000 Bq/kg (collected from a survey area adjacent to a difficult-to-return area)

※2 Approximate calculation based on the Forestry Agency document "Approximate Calculation of Exposure in an Occupied Room Surrounded by Timber, IAEA - TEC-DOC - 1376"



[Figure] Assumption of Living Room Surrounded by Timber Used in Trial Calculation

[Note] In an ordinary Japanese wooden house (timber framework house), the amount of timber used is considerably smaller than in this calculation, so the exposure dose can also be expected to be much lower.

Reference : Fukushima Prefecture (2017) "Status and Forecast of Radioactive Substances in Forests"

V Supply of Safe Non-wood Forest Products Such as Mushrooms

Mushrooms and wild vegetables grown or gathered within Fukushima Prefecture for the purpose of shipment and sale are inspected to confirm their safety. The produced mushrooms etc. can be shipped if it can be confirmed that they were grown under appropriate management and are adequately below the standard limit for radioactive cesium in general foodstuffs.

Shipment Restriction and Its Release of Non-Wood Forest Products Such as Mushrooms

For mushrooms and wild vegetables etc. to be shipped and sold, they must be below the standard limit for radioactive cesium concentration in general foodstuffs (100Bq/kg).

As of August 6, 2018, there are shipment restrictions on 23 types of non-wood forest products, including log-cultivated shiitake mushrooms, wild mushrooms, bamboo shoots, shuttlecock fern, Chengiopanax sciadophylloides, butterbur shoot, Aralia sprout, ostrich fern, and bracken, from 189 municipalities in 13 prefectures nationwide. On the other hand, there are moves towards lifting the restrictions, and as of August 6, 2018, shipments of log-cultivated shiitake mushrooms had resumed from 65 municipalities in six prefectures.

The Forestry Agency is supporting the stable supply of mushroom logs, as a step towards producers of mushrooms etc. being able to continue or resume production. In November 2015, it announced “Inspection and other specific operations towards the lifting of restrictions on shipments of wild mushrooms etc.”, which detailed inspection methods and shipment management in order to facilitate the lifting of shipment restrictions on wild mushrooms and wild vegetables. Since then, there has been gradual progress in lifting shipment restrictions.

※The results of monitoring inspections for radioactive cesium concentration etc. are open to public in newspapers, and on the Fukushima Prefecture website. Caution is required, because varieties for which shipment is restricted cannot be used as raw materials for processed foods either.

[Photo] Radiation Measurement Inspection

Reference: Website of Forest, Forestry, and Vegetation Association of Fukushima Prefecture “Mushroom Promotion (Mushroom Promotion Center)” ; Fukushima Prefecture website “Monitoring of Mushrooms and Wild Vegetables and Varieties with Shipment Restrictions for Each Municipalities”

Actions towards Shipment of Safe Mushrooms

In October 2013, the Forestry Agency has formulated "Guidelines on the Management of Cultivation of Log Shiitake Mushrooms, to Reduce Radioactive Substances", which stipulated cultivation management methods to keep log mushrooms below the standard limit for general foodstuffs (100Bq/kg).

[Required Procedures]

Actions to keep mushroom logs and bed logs below the current index value (50Bq/kg), and inspections of grown mushrooms to confirm safety.

- Checking and management of radioactive cesium concentration when mushroom logs and bed logs are purchased
- Management of mushroom bed logs before emerging of fruit body (inspection for radioactive substances, etc.)
- Disposal or re-inspection of mushroom logs and bed logs which exceed the index value
- Inspection of sprouted mushrooms to confirm safety

[Important Processes]

Actions to reduce the impact of radioactive substances

- Washing mushroom logs and bed logs
- Measurement of air dose rates in mushroom bed log laying yards and other working areas
- Environmental improvement etc. in mushroom bed log laying yards and other working areas

The radioactive substance countermeasure check sheet in the "Fukushima Prefecture Safe Mushroom Cultivation Manual" organizes countermeasures according to the cultivation environment, enabling management of production processes. Shipment of mushrooms produced according to this process is permitted, provided it can be confirmed that they are below the standard limit for general foodstuffs (100Bq/kg).


[Photo 1] Washing Mushroom Bed Logs


[Photo 2]Covering the Ground with Sheets


[Photo 3] Placing Sheets So That the Logs Do Not Touch the Ground

Reference : Forestry Agency Press Release "Formulation of the 'Management Guidelines for the Reduction of Radioactive Substances'", October 16, 2013; Fukushima Prefecture "Safe Mushroom Cultivation Manual"; Forestry Agency "Forests and Forestry White Paper 2017"

Monitoring Radioactive Substances in Mushrooms and Wild Vegetables

In Fukushima Prefecture, mushrooms and wild vegetables grown or gathered within Fukushima Prefecture for the purpose of shipment and sale are given monitoring inspections for radioactive substances to confirm their safety. Results are constantly updated on the Fukushima Prefecture "Fukushima new launch" website.

Before cultivated mushrooms can be shipped, each producer measures the radioactive cesium concentration in materials (bed logs, mushroom beds, etc.) before the mushrooms sprout, to confirm that they do not exceed the nationally-stipulated current index values. *(50Bq/kg for mushroom logs and bed logs, and 200Bq/kg for mushroom beds). After that, monitoring inspections are performed on mushrooms before they are shipped, to confirm that they do not exceed the standard limit (100Bq/kg) for general foodstuffs.

Monitoring inspections are performed on wild mushrooms and wild vegetables at an early stage before they are shipped.

Inspections were performed on 61 varieties of mushroom and wild vegetables in FY2017. Inspection results to date are as shown in the table. Items exceeding the standard limit are decreasing every year.

※Index values defined by the government for bed logs and mushroom beds, so that emerged mushrooms do not exceed food standards. 50Bq/kg for mushroom logs and bed logs, 200Bq/kg for mushroom beds.

	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Number of inspections	1,083	1,180	1,457	1,564	1,562	1,832	2,111
Over standard limit	127	90	80	25	7	2	1

(Note) If inspection results show that the standard has been exceeded, shipment restrictions apply and the items concerned are never shipped.

[Table] Monitoring Inspection Results for Mushrooms and Wild Vegetables

Reference : Fukushima Prefecture "Monitoring inspection Results So Far (aggregated by year)" ; Fukushima Prefecture website "Monitoring of Mushrooms and Wild Vegetables and Varieties with Shipment Restrictions for each Municipalities" as of May 2, 2018

Measures to Regenerate Mushroom Log Plantations

Since the reactor accident, mushroom log plantations exceeding the index value for mushroom logs have been found even in regions with relatively low impact from radioactive substances, so production of mushroom logs is stopped even in those areas.

In FY2014, Fukushima Prefecture began its “Hardwood Forest Regeneration Project” to regenerate the hardwood forests that provide the next generation of mushroom log plantations for the stable future supply of mushroom logs. Specifically, the following efforts are made to provide stable supplies of mushroom logs from existing mushroom log plantations.

- Checking for exceeded index values before project implementation (mushroom log measurement)
- Follow-up survey of radioactive cesium concentration in sprout branches after harvesting (three years)
- Measurement of air dose rate levels (before and after cutting)
- Measurement of radioactive cesium concentration litter layer and soil

The timber cut by this project is never used for mushroom bed logs or for firewood for cooking, but it provides the necessary care for areas that have been cut, to encourage growth as a mushroom log plantation for bed logs.

The project implemented areas are expanding every year, from 10.51ha in FY2014 (one forestry cooperative in three municipalities) to 28.76ha (two forestry cooperatives in five municipalities) in FY2017.

[Photo 1] Landscape after Harvesting (Minami Aizu Town)

Reference : Fukushima Prefecture “Summary of Hardwood Forest Regeneration Project in Fukushima Prefecture”

[Photo 2] A Follow-up Survey of Radioactive Cesium Concentration of Sprout Branches Are Conducted after Harvesting (Minami Aizu Town)

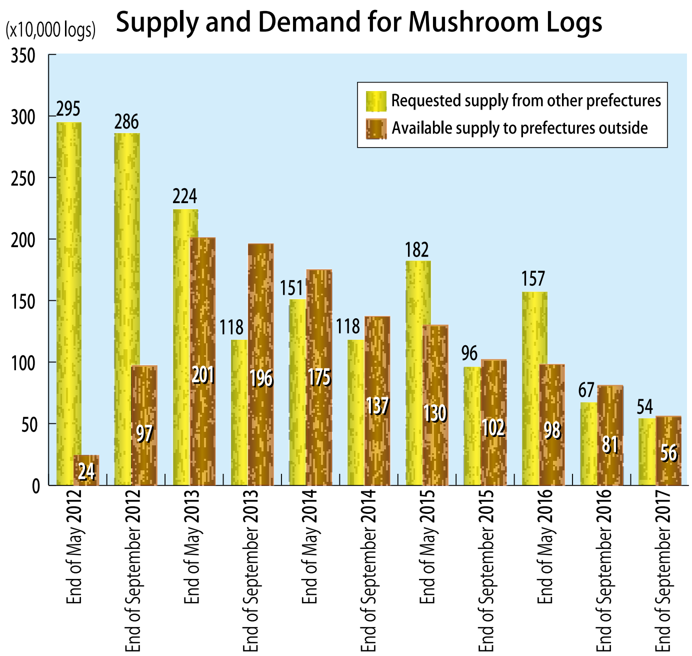
Stable Supply of Mushroom Logs

Many mushroom logs from before the Great East Japan Earthquake were supplied from Fukushima Prefecture, so the nuclear accident had an impact on stable procurement of mushroom logs in many prefectures.

Since 2011, the Forestry Agency has been tracking the state of supply and demand for mushroom logs nationwide, and helping to match users and suppliers so that mushroom producers can continue the production.

As a results, since September 2013, the amounts of mushroom logs that forest owners are able to supply has surpassed those of mushroom logs required by mushroom producers etc., and the matching of mushroom logs appears to be making good progress. However, at the end of September 2017, the demand for konara oak accounted for about 90% of the 540,000 logs of desired amount, while around 90% of the 560,000 logs of potential supply was mainly consisted of sawtooth oak, so there was a mismatch in terms of tree types.

The Forestry Agency will continue to find potential supply volume, mainly of konara oak, for which the demand volume is large, and work on mushroom logs matching.



[Figure] Supply and Demand for Mushroom Logs

Reference : Forestry Agency (2012) “Promotion of Action for Stable Supply of Mushroom Logs” (2012), Forestry Agency “Forests and Forestry White Paper 2017”

VI Specific Efforts Actions for the Regeneration of Forests and Forestry

Ministries and agencies concerned are working together for the regeneration of forests and forestry in Fukushima Prefecture, taking action to secure the safety of living environments, restore satoyama forest around residential areas, conduct future-oriented investigative research, work on communication, and disseminate information.

Satoyama Forest Restoration Model Project

In March 2016, the Reconstruction Agency, the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of the Environment compiled “Comprehensive Efforts towards the Regeneration of Forests and Forestry in Fukushima”. The main measure in this project is the “Satoyama Forest Restoration Model Project”.

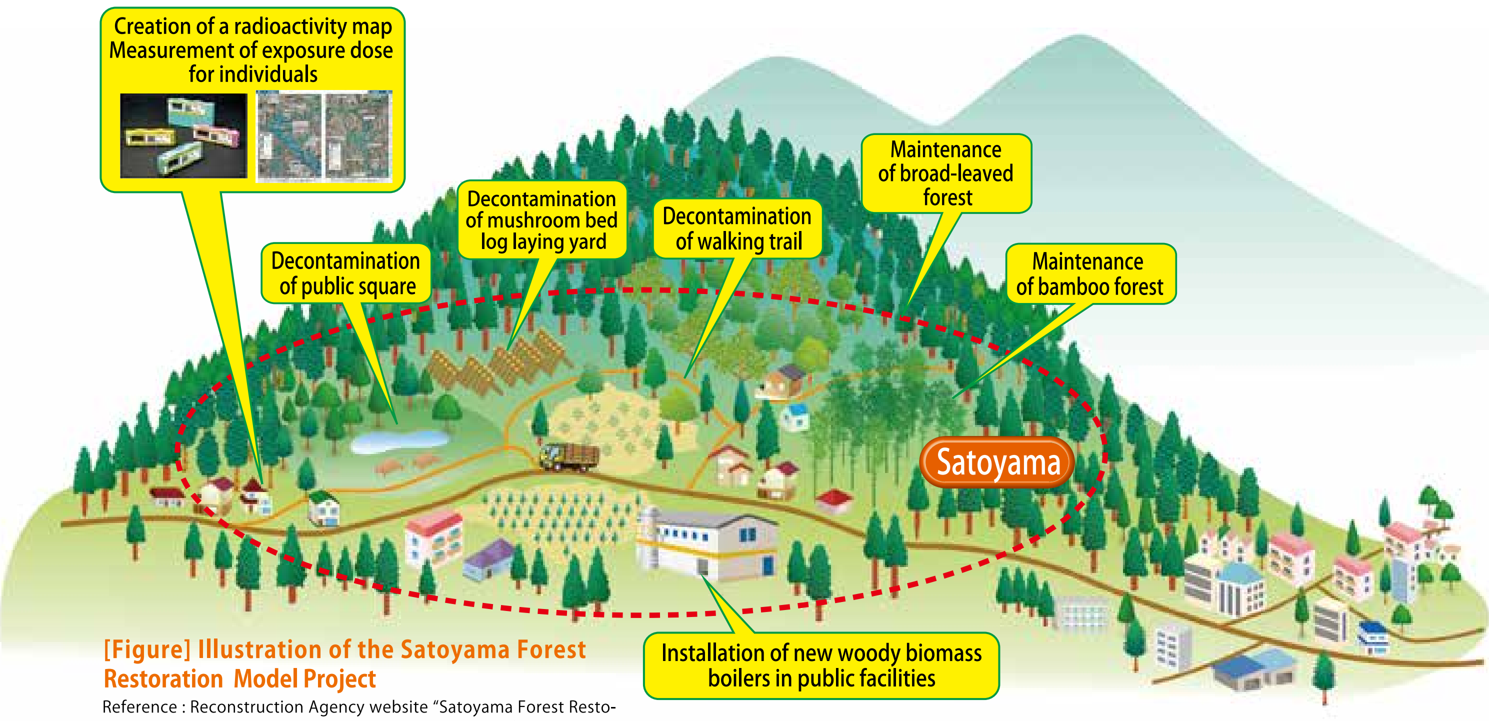
The “Satoyama Forest Restoration Model Project” aims to comprehensively advance action to promote satoyama forest restoration in selected model areas according to community requests, and to reflect the results in reliable measures, which includes the following point measures:

(1)Create radiation maps in model areas

(2)Implement appropriate decontamination in the forests where people have daily access and use as a place for relaxing

(3)Implement measures on forest management for timber production and scenic improvement.

Various projects have been promoted such as air dose rate monitoring, decontamination works, and forest management in selected 14 districts as of June 2018.



[Figure] Illustration of the Satoyama Forest Restoration Model Project

Reference : Reconstruction Agency website “Satoyama Forest Restoration Model Project (summary)”, “Comprehensive Efforts towards Regeneration of Forests and Forestry in Fukushima” (March 2016)

Fukushima Forest Regeneration Project

If thinning and other forest management slow down, forests degraded increase, and the multiple functions that forest previously had are no longer fully available. For example, there is concern that functions for watershed conservation and preventing landslides could decline, impacting everyday living.

Since FY2013, Fukushima Prefecture has been working on the "Fukushima Forest Regeneration Project", which improves forests to maintain and enhance their public functions, and performs radioactive substance countermeasures that are necessary for the implementation of such improvements. The Fukushima Forest Regeneration Project is led by municipalities and other public entities, and implements forest management etc. on intensive survey areas of contamination etc. (including areas for which evacuation orders have been lifted). Main measures in the project include the following:

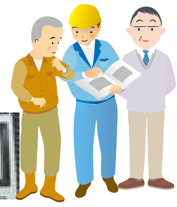
(1) Surveying air dose rates and obtaining the consent of forest owners
(2) Measures to suppress movement of soil material (installation of log terracing, etc.)
(3) Forest management (thinning, regeneration cutting, etc.)
(4) Development of Road network maintenance (construction of forestry operation road etc.).

Since 2013, so far, the project has been implemented in 44 municipalities. By the end of March 2018, it had performed work such as thinning on 4,888ha, and built 559km of forestry operation roads.

Forest surveys etc. to select areas for validation

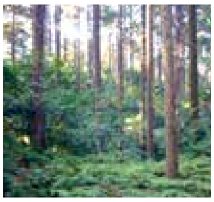
- Overview surveys of forest radiation levels etc. to select validation areas
- Investigation of validation target forests for the purpose of studying working plans
- Providing forest owners with explanations and obtaining their consent.


Overview surveys etc.


Obtaining consent

Forest management by public entities

- Thinning etc. by public entities, such as prefectures and municipalities, for planted forests where maintenance is difficult due to the effects of radioactive substances.



Appropriate forest management through thinning etc.

Validation of countermeasures for radioactive substance

To counter the impact of radioactive substances,
- Crushing, packing, and migrating foliage produced in the course of forest management
- Installing terracing to suppress the movement of radioactive substances are implemented as validation.


Validation of crushing


Installation of log terracing

[Figure] Summary of the Fukushima Forest Regeneration Project

Validation Project for Forestry Regeneration

With efforts making progress towards residents' return, such as the lifting of areas under evacuation orders, it is important to resume the forestry and timber industries, which are core industries for the region, in order to secure places for residents to live and work. From FY2014, the Forestry Agency has been working on validation projects against radioactive substances, using knowledge gained so far. These projects target districts where evacuation instructions had been issued, and are intended to enable the smooth resumption of forest maintenance and forestry livelihoods and activities (Figure).

Safety measures for working in forests


Use of elite trees to save work on undergrowth clearing


Raising working efficiency to shorten radiation exposure time

Forest management measures to suppress movement


Movement suppression through thinning

Measurement of concentrations of radioactive substances


Measurement of radioactive concentrations in each part of trees


Measurement of concentrations of radioactive substances in the bark of living trees

Changes in air dose rates associated with forest management


Measurement of air dose rates at harvesting / planting site

[Figure] Validation Project for Forestry Regeneration in Districts Where Evacuation Orders Have Been Lifted

Reference : Forestry Agency "Summary of the Validation Project for Forestry Regeneration in FY2016 in Districts Where Evacuation Orders Have Been Lifted" ; Ministry of Agriculture, Forestry and Fisheries "Action to Regenerate Forests and Forestry in Fukushima Prefecture", February 5, 2016

Basic Knowledge of Radioactive Substances

Differences between Radiation, Radioactivity, and Radioactive Substances

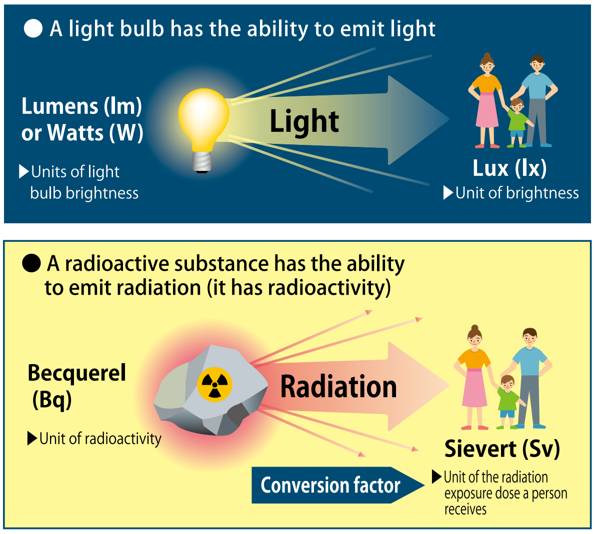
"Radiation" is like light that can pass through objects. The ability to emit radiation is called "radioactivity" (the unit for the amount of radioactivity is the Becquerel (Bq)), and substances which have that ability are called "radioactive substances".

The unit of Sievert (Sv) is used for the radiation exposure dose how much human body is affected by radiation.

If a radioactive substance is placed in a sealed container, radiation is emitted from the container, but the radioactive substance itself is not.

If we look at the example of a light bulb, the light is like radiation, the bulb is like the radioactive substance, and the ability to emit light is like radioactivity. The greater the radioactivity, the more radiation the radioactive substance emits.

The radiation exposure dose varies with distance between the radioactive substance and the exposed person. The strength of radiation increases with proximity to the source, and decreases with distance. That is like the way even a bright light bulb looks dim from a distance.



※Sieverts are related to the impact of radiation

[Figure] What Are Radiation, Radioactivity, and Radioactive Substances?

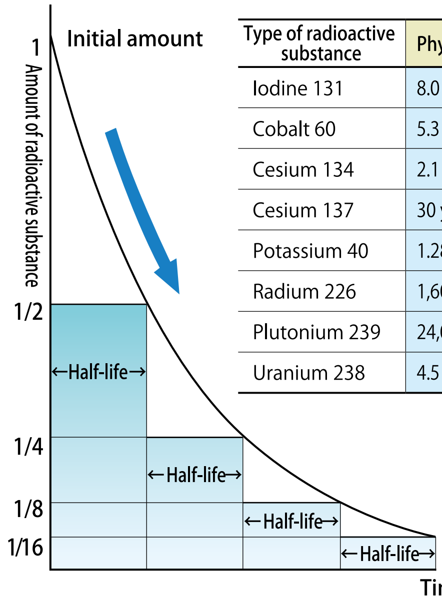
Reference : Ministry of the Environment "Unified Basic Reference on the Health Impacts of Radiation, FY2017 Edition"; Consumer Affairs Agency "Food and Radiation Q&A, 12th edition", March 8, 2018; Ministry of the Environment "Unified Basic Reference on the Health Impacts of Radiation, FY2017 edition"

Half-life of Radioactive Substances

As radioactive substances emit radiation, they transform into stable substances which do not emit radiation. Therefore, the radioactive substances dispersed from a reactor accident do not remain in the natural environment eternally, because their quantity decreases over time. The time required for that radiation decay is determined for each type of radioactive substance, and the time it takes for the amount of radioactive substance to halve is called the physical half-life. For example, the half-life of iodine 131 is around 8 days, while that for cesium 134 is around two years, and for cesium 137 is around 30 years (Figure).

Radioactive substances taken into the bodies of organisms are expelled from the body through metabolism and the excretory effects of defecation, urination, perspiration, respiration, etc. The time required for those processes to halve the amount of radioactive substance is called the biological half-life. The biological half-life of cesium 137 in humans is around 9 days in people aged up to one year, around 38 days in those aged up to nine, around 70 days in those aged up to 30, and around 90 days in those aged up to 50. Biological half-life is shorter in children because of their faster metabolism. For example, if cesium 137, which has a long physical half-life of 30 years, enters the body of a person aged 50, half of the cesium has been expelled from the body after around three months.

(Reference) Physical half-life



Type of radioactive substance	Physical half-life
Iodine 131	8.0 days
Cobalt 60	5.3 years
Cesium 134	2.1 years
Cesium 137	30 years
Potassium 40	1.28 billion years
Radium 226	1,600 years
Plutonium 239	24,000 years
Uranium 238	4.5 billion years

[Figure] Physical Half-life

Reference : Ministry of Agriculture Forestry and Fisheries (2012) "Basics of Radioactive Substances"; Consumer Affairs Agency "Food and Radiation Q&A, 12th edition", March 8, 2018; Ministry of the Environment "Unified Basic Reference on the Health Impacts of Radiation, FY2017 edition"

Radiation around Us

Radioactive substances are originally present in the natural world, and we receive some amount of radiation all the time (the average in Japan is 2.1mSv per person per year). We also receive radiation from medical procedures such as CT scans and X-ray imaging. The effect of radiation on the human body occurs when part of the DNA that forms the body of genes within cells is damaged, but most cells either return to normal or are replaced by healthy cells. Therefore, we do not need to think about radiation during our daily lives. However, if we are exposed to more than a certain amount of radiation in a short time, health impacts occur, in acute forms such as hair loss and bleeding, and there may be a marked increase in cancer risk.

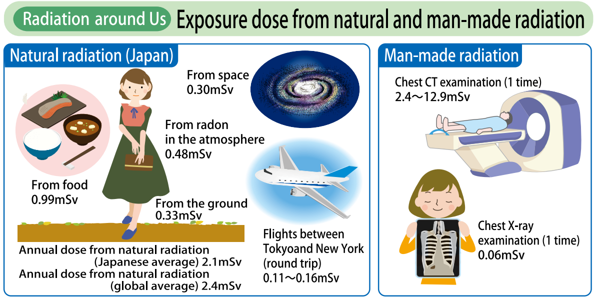
The increase in risk of carcinogenesis due to radiation is so small at low doses of 100mSv or less that it is obscured by the carcinogenesis risks of smoking and other factors, and it is considered difficult to prove a clear increase in cancer risk due to radiation (Figure, Table).

Smoking	Equivalent to 1,000 – 2,000 mSv
Obesity ※1	Equivalent to 200 – 500 mSv
Passive smoking ※2	Equivalent to 100 – 200 mSv
Lack of vegetables ※3	Equivalent to 100 – 200 mSv

※1：The risk for a group with BMI (Body Mass Index, an indicator of obesity calculated from height and weight) ≧30, compared to the risk of the group with BMI 23.0 - 24.9.
※2：The group risk of women whose husbands do smoke, compared to the group of women whose husbands do not smoke.
※3：The risk (median) for a group which consumes 420g of vegetables per day, compared to the risk (median) of the group which consumes 110g per day.

[Table] Comparison of Radiation with Other Carcinogenesis Factors

Reference：Reconstruction Agency "FAQ Concerning Radiation Risks Often Mentioned at Evacuee Briefings etc.", December 25, 2012



[Figure] Radiation around Us

Reference：Ministry of the Environment "Unified Basic Reference on the Health Impacts of Radiation, 2017 Edition";
Consumer Affairs Agency "Food and Radiation Q&A, 12th edition", March 8, 2018;
Reconstruction Agency "FAQ Concerning Radiation Risks Often Mentioned at Evacuee Briefings etc.", December 25, 2012;
Cabinet Office, Ministry of Agriculture, Forestry and Fisheries, and others "The Basics of Radiation Risks", revised February 2, 2016

Designation Status of Areas under Evacuation Orders

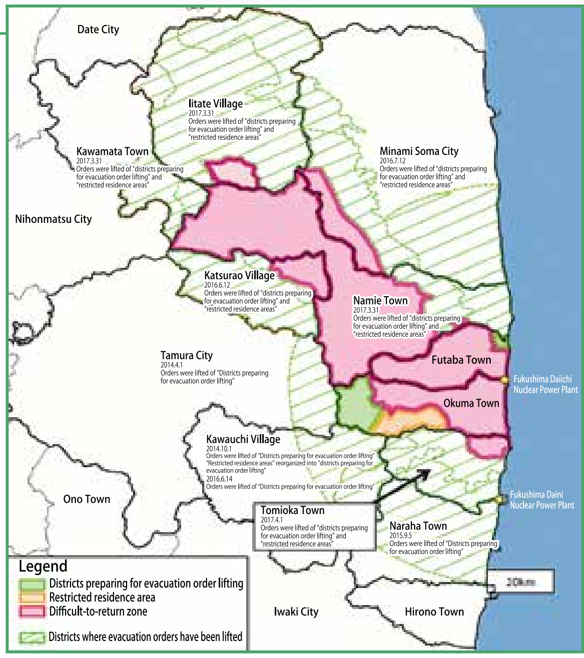
The accident at the Fukushima Daiichi Nuclear Power Plant, caused by the Great East Japan Earthquake, led the national government to issue evacuation orders immediately after the accident, to keep local residents from danger to lives and health due to damage to the reactor and the release and dispersion of radioactive materials. As the severity of the accident deepened, areas under evacuation orders were gradually specified.

When it became clear that the reactors are in a state of cold shutdown, area status was reviewed into the three types, of districts preparing for evacuation order lifting, restricted residence area, and difficult-to-return zones, according to the average annual dose (April 1, 2012). That was a step for making environmental improvements and advancing the recovery and regeneration, towards residents' return. After that, evacuation orders were lifted for the urban parts of Tamura City, Kawauchi Village, Naraha Town (with the exception of some areas), Katsurao Village (with the exception of some areas), Minami Soma City (with the exception of some areas), the Yamakiya district of Kawamata Town, Iitate Village (with the exception of some areas), Namie Town (with the exception of some areas), and Tomioka Town (with the exception of some areas). The districts which residents are allowed to return to have been increasing gradually.

The map shows the current status of areas under evacuation orders.

[District Classifications]

- **Districts preparing for evacuation order lifting**
  Districts where rapid support measures for restoration and recovery are conducted, aiming for environmental improvements that will allow residents to return home.
- **Restricted residence area**
  Districts where planned decontaminations are conducted, aiming for the future return of residents and the rebuilding of communities, and districts intended for the restoration of infrastructure facilities which are essential for early recovery.
- **Difficult-to-return zone**
  Zones where radiation levels are extremely high, so barricades and other physical protection measures have been erected and residents are asked to evacuate.



[Figure] Status of Areas under Evacuation Orders in Fukushima Prefecture (As of April 1, 2017)

Reference: Fukushima Prefecture website "Fukushima Revitalization Station - Status of Areas under Evacuation Orders";
Fukushima Prefecture website "Fukushima Revitalization Station - Status of Areas under Evacuation Orders" , "Fukushima Revitalization Station - Commentary on Changes in Evacuation Zones", updated February 28, 2018

<Specfic Rebirth and Regeneration Base Districts>

The Amendment to the Act on Special Measure for the Rebirth of Fukushima (May 2017) made it possible to set "Specific Rebirth and Regeneration Base Districts", lifting evacuation orders and allowing residence, within difficult-to-return zones where residence had been restricted over the future.

Mayors of municipalities can set Special Recovery and Regeneration Center Districts, and formulate plans for environmental improvements (such as decontamination and development of infrastructure etc.) in those districts. Such plans are subject to approval by the Prime Minister.

As of August 2018, districts had been approved in six municipalities (the towns of Futaba, Okuma, Namie, and Tomioka, and the villages of Iitate and Katsurao).

Data 1 Various Standards and Indices

Standard limit for mushrooms etc. (unit: Bq/kg)

Applicable items	Standard limit	Publication
Mushrooms and wild vegetables (general foodstuffs standard) ※1	100	April 2012

Current index values for mushroom logs, firewood, charcoal, pellets, etc.

Applicable items	Current index value	Publication
Mushroom logs and bed logs ※2	50	March 2012
Mushroom bed medium	200	March 2012
Firewood ※3	40	November 2011
Charcoal	280	November 2011
Wood pellets (white pellets, whole-tree pellets) ※4	40	November 2012
Wood pellets (bark pellets)	300	November 2012

※1 The upper limit for exposure dose from foods which include radioactive substances is set at 1mSv per year, and that is the basis for determining standard limit for radioactive cesium.

※2 Based on measurement results for radioactive cesium concentration in bed logs (per unit dry weight), mushroom bed medium (per unit dry weight) and sprouted shiitake mushrooms (per unit fresh weight) which have been affected by radioactive substances, a value deemed to be close to the upper limit for transfer factor was estimated statistically. As a result, the values of transfer factor are 2 for mushroom logs (bed logs), and 0.5 for mushroom bed medium (mushroom beds). By the formula below, the current index values for mushroom logs and bed logs were set at 50Bq/kg and 200Bq/kg for mushroom bed medium and mushroom beds.
Current index value = 100Bq/kg (new standard limit for general foodstuffs)/(transfer factor (2 for mushroom logs, 0.5 for mushroom bed medium)
References: Forestry Agency "Q&A on the Setting of Current Index Values for Mushroom Logs and Mushroom Bed Medium, etc.", 2012

※3 Demonstration experiments produced data that burning 1kg of firewood left 5g of ash, while burning 1kg of charcoal left 30g of ash, and approximately 90% of the radioactive cesium included in that firewood and charcoal remained in the ash. That means that the concentration of radioactive cesium per 1kg of ash is 182 times higher than that in 1kg of firewood, and 28 times higher than that in 1kg of charcoal.
Therefore, the index value for firewood was set at 40Bq/kg (8,000÷182 = 44≒40) and the index value for charcoal was set at 280Bq/kg (8,000÷28 = 286≒280), so that ash produced by burning such firewood and charcoal does not exceed the radioactive substance concentration of 8,000Bq/kg. That concentration allows landfill disposal at final disposal sites for general waste, without applying measures such as solidification in cement.

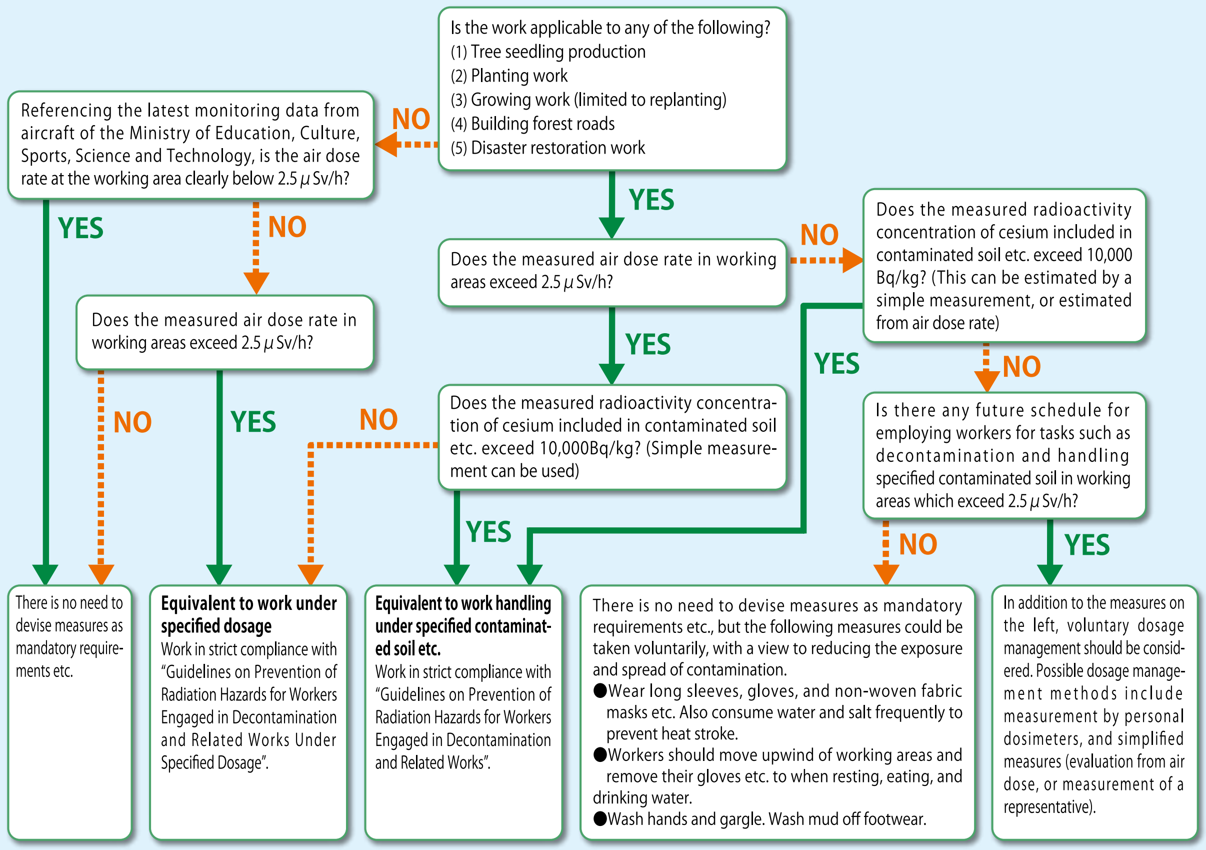
※4 For white pellets and whole-wood pellets, first the ratio (proportion of radioactive cesium condensation) between the radioactive cesium concentrations of the pellets before burning and the ash after burning was calculated. From that ratio, the upper limit of radioactive substance concentration in pellets was set so that the radioactive substance concentration of ash after burning would, with a 90% probability, not exceed the upper limit value of 8,000Bq/kg for disposal as general waste. The condensation ratio for that calculation was estimated at 210. On that basis, the near-term index value was calculated as follows: (8,000 Bq/kg÷210 times = 38.1Bq/kg≒ 40Bq/kg).
For bark pellets, the number of samples was smaller, so the maximum value of condensation ratio (25 times) was used, and the current index value was calculated as follows: (8,000Bq/kg÷25 times = 320Bq/kg≒300 Bq/kg).

Reference : Forestry Agency "Q&A on the Setting of Curremt Index Values for Wood Pellets, and Their Inspection Methods" 2012

Data 2 Working Safety Guide

Standards for work and radiation levels in forests in decontamination special areas etc.

Flow chart for working in decontamination special areas and intensive contamination survey areas



Reference : Forestry Agency "Flow Chart for Working in Decontamination Special Areas and Intensive Contamination Survey Areas"

A Request to Utilize This Booklet

This booklet is a comprehensive summary of the current status of radioactive substances in forests, and of the impact of such substances on timber, mushrooms, and other forest products.

The impacts of radioactive substances are still under various ongoing investigations, including monitoring by national and prefectural governments and the Forestry and Forest Products Research Institute. Information and data presented in this document is the latest available in 2018.

Please read this document yourself, and together with your family, co-workers, and community members, to learn about the impacts and actual situation of radioactivity on forests, and on forestry products such as timber. Use this document as reference material for the future regeneration of forests and forestry.

Various information sources

- Portal site concerning the relationships between forests, forestry, and radioactivity (Forestry and Forest Products Research Institute)— Search for "Forests and Radioactivity"
  http://www.ffpri.affrc.go.jp/rad/
- Information about the Great East Japan Earthquake (Ministry of Agriculture, Forestry and Fisheries) — Search for "Information about the Great East Japan Earthquake"
  http://www.maff.go.jp/j/kanbo/joho/saigai/
- Information about the Great East Japan Earthquake (Forestry Agency)—Search for "Information about the Great East Japan Earthquake")
  http://www.rinya maff.go.jp/j/kouhou/jisin/
- Inspection results about radioactive cesium concentrations in agricultural produce (Ministry of Agriculture, Forestry and Fisheries)— Search for "Radioactive cesium concentrations in agricultural produce"
  http://www.maff.go.jp/j/kanbo/joho/saigai/s_chosa/
- Results of a Survey of Radiation Levels in Fukushima-grown Timber Materials (Fukushima Prefecture) — Search for "Materials produced in Fukushima Prefecture radiation"
  http://www.pref.fukushima.lg.jp/site/portal/ps-kensanzaityousa.html
- Fukushima Prefectural Forestry Research Centre — Search for "Fukushima Prefectural Forestry Research Centre"
  https://www.pref.fukushima.lg.jp/sec/37370a/
- About forest decontamination-Decontamination Information Plaza (Ministry of the Environment, Fukushima Prefecture)— Search for "Decontamination Information Plaza"
  http://josen.env.go.jp/plaza/
- Portal site about relevant ministries and prefectures etc. — Search for "Agricultural, livestock, and fisheries produce impact"
  http://www.maff.go.jp/noutiku_eikyo/

The Current State of Radioactive Substances and the Regeneration of Forests and Forestry, 2018 edition

Edited by the Forestry Agency, published November 2018
Editorial assistance Fukushima Prefecture, Forestry Research and Management Organization