

## [Survey 3] Results of FY2019 Survey on Concentrations of Radioactive Cesium Contained in Male Flower of Cedar

### 1. Purpose of Survey

For the concern over re-spreading of fallout radioactive cesium into forests due to cedar pollen scattering, in 2011, the Forestry Agency started a survey to estimate the radioactive cesium concentrations in cedar pollen from male flowers. As a result of past surveys, the radioactive cesium concentrations in male flowers of cedar have shown a general trend of decreasing each year, but they tend to be high when air dose rates are high. This year, continuing from the previous year, the Forestry Agency conducted a survey on radioactive cesium concentrations in male flowers of cedar, especially at sites with relatively high air dose rates.



Photo 1 Sampling



Photo 2 Cedar male flower

### 2. Survey Method

The survey was conducted at 16 sites with relatively high air dose rates in Fukushima Prefecture. Among them, 10 sites have been continuously surveyed since 2011, and five sites were newly selected in FY2017. One site has been continuously surveyed since FY2017 and the Agency was planning to survey that site. However, this year, a landslide caused by Typhoon 19 (Hagibis) prevented access to the site. For that reason, one site was selected among sites that had been surveyed until FY2016.

Male flowers of cedar were sampled in November 2019, and while doing so air dose rates at a height of 1 m from the ground were measured near the sampled trees. In this period, male flowers (pollen) are fully mature and have fallen dormant, and the concentrations are nearly the same as those in the pollen scattered in spring the following year. The number of trees from which male flowers were collected was about three per site. Samples were collected from the

same trees from which samples were collected in the previous year as much as possible. If male flowers were not available, samples were collected from nearby different trees.

The sampled male flowers were washed, dried, gathered up per site, and subjected to gamma-ray spectrometry using a germanium semiconductor detector to measure radioactive cesium (Cs-134 and Cs-137) concentrations. This year's measurements were normalized to February 1, 2020.

### **3. Results**

The results of the survey on the concentrations of radioactive cesium (sum of Cs-134 and Cs-137) contained in male flowers of cedar collected from 16 sites are shown in Reference 1.

The trend of higher radioactive cesium concentrations in male flowers in areas with higher air dose rates was observed this year as well. This year, the highest radioactive cesium concentration in male flowers was 12,200 Bq/kg, which is approximately 5% of the highest value observed immediately after the accident at the Fukushima Dai-ichi Nuclear Power Station (occurred in FY2011).

Compared with the survey conducted in the previous year at 15 sites, this year's values of radioactive cesium concentration in male flowers and air dose rate were 80% and 90% of the results in the previous year (FY2018), respectively. Looking at the 10 sites for which the survey has been continued since FY2011, the radioactive cesium concentrations in male flowers were about 2% of the values immediately after the accident (FY2011).

From the results above, under the conditions used in FY2011, the radiation dose a person receives when the highest concentration of radioactive cesium as measured in this year's survey is scattered into the air carried by cedar pollen and the person inhales the air was estimated. The maximum estimated value was 0.0000113  $\mu$ Sv per hour, which was about 6% of the value (0.000192  $\mu$ Sv) estimated in FY2011 (Reference 2).

Result of FY2019 Survey on Concentration of Radioactive Cesium Contained in Male Flower of Cedar

No.	Location of cedar forest	(Reference) Result in the past														Site code				
		Result in FY2019		FY2018		FY2017		FY2016		FY2015		FY2014		FY2013			FY2012		FY2011	
		Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)		Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)	Air dose rate (μSv/h)	Concentration of radioactive cesium in male flower of cedar (Bq/kg dry weight)
1	Murohara, Namie Town, Fuaba District, Fukushima Pref.	5.84	2,270	6.44	8,430	5.88	9,390	7.15	7,750	.. <sup>(1)</sup>	.. <sup>(1)</sup>	10.80	18,700	14.78	10,500	19.60	57,300	23.20	72,300	514
2	Nagadoro, Iitate Village, Soma District, Fukushima Pref.	4.37	2,910	4.50	3,580	4.61	3,510	4.03	4,080	4.97	3,820	7.34	6,810	8.71	6,980	8.44	25,800	10.80	49,300	457
3	Hiso, Iitate Village, Soma District, Fukushima Pref.	0.45	ND	0.60	139	0.49	499	.. <sup>(1)</sup>	.. <sup>(1)</sup>	0.44	1,810	2.27	2,420	3.47	6,020	3.53	22,800	4.81	57,600	434
4	Maeta, Iitate Village, Soma District, Fukushima Pref.	0.76	ND	0.89	334	0.84	301	0.88	422	1.31	1,380	1.89	2,910	2.47	1,360	3.17	10,400	3.55	18,200	437
5	Uwabara, Kasahira Ward, Minamisoma City, Fukushima Pref.	0.78	185	0.64	1,050	0.82	616	0.69	567	0.63	240	1.11	1,130	1.49	2,170	1.69	4,370	1.95	16,400	519
6	Shidazawa, Haramachi Ward, Minamisoma City, Fukushima Pref.	0.29	ND	0.29	293	0.37	159	0.88	464	0.60	1,050	0.79	1,540	0.91	2,750	1.34	6,140	1.28	18,300	537
7	Kitausushi, Furehiki Town, Tamura City, Fukushima Pref.	0.30	ND	0.35	115	0.36	73	0.34	130	0.34	217	0.59	270	0.64	2,790	0.87	1,200	1.01	5,100	410
8	Oaza Iwasawa, Miyakoji Town, Tamura City, Fukushima Pref.	0.27	141	0.35	131	0.40	200	0.28	ND	0.34	333	0.53	250	0.75	842	1.61	869	1.96	5,500	463
9	Koisunagi, Kawamata Town, Date District, Fukushima Pref.	0.24	ND	0.26	392	0.23	161	0.27	219	0.36	242	0.45	712	0.47	400	0.84	741	1.09	1,220	412
10	Shimokawauchi, Kawamura Village, Fuaba District, Fukushima Pref.	0.24	ND	0.28	157	0.28	82	0.27	198	0.30	ND	0.41	256	0.45	389	0.82	1,690	0.82	4,710	510
11	Omari, Namie Town, Fuaba District, Fukushima Pref.	2.37	2,110	2.45	1,300	2.67	1,370	..	..	..	..	..	..	..	..	..	..	..	..	532B
12	Murohara, Namie Town, Fuaba District, Fukushima Pref.	1.46	12,200	2.16	3,660	2.19	20,600	..	..	..	..	..	..	..	..	..	..	..	..	533B
13	Baba, Hara Town, Minamisoma City, Fukushima Pref.	2.10	464	2.63	1,200	2.70	1,720	..	..	..	..	..	..	..	..	..	..	..	..	516B
14	Ohara, Hara Town, Minamisoma City, Fukushima Pref.	0.95	821	1.39	908	1.18	982	..	..	..	..	..	..	..	..	..	..	..	..	500B
15	Ohara, Hara Town, Minamisoma City, Fukushima Pref.	0.57	1,420	0.50	692	0.51	902	..	..	..	..	..	..	..	..	..	..	..	..	518B
16	Ohara, Hara Town, Minamisoma City, Fukushima Pref. <sup>(2)</sup>	0.63	796	..	..	..	..	0.90	1,380	1.06	1,300	1.63	1,800	1.90	2,530	2.07	22,600	2.20	12,300	518A

ND is less than 100 Bq/kg. (1) Not surveyed for not being able to enter the forest. (2) Conducted at a site surveyed until 2016 as a substitute of a site unable to reach due to typhoon damage. --- Newly established and no past measurements.

\* Rounding: Rounded to ones for 3-digit numbers, to tens for 4-digit numbers, and to hundreds for 5-digit numbers. A number with two digits or less is ND.

(Reference 2)

## Estimation of Radiation Dose Human Body Receives Based on 2019 Survey Results

Assuming that the concentration of radioactive cesium in cedar pollen is the same as the highest concentration (12.2 kBq/kg) in male flowers of cedar measured in the FY2019 survey, the radiation dose a person receives when the pollen is scattered into the air and the person inhales it was estimated. The result was 0.0000113  $\mu$ Sv per hour at maximum.

Category (condition)		Cesium-137	Cesium-134
Concentration of radioactive cesium contained in cedar pollen (1)		11.3 kBq/kg	0.9 kBq/kg
The highest count of pollen scattered in the air measured to date (2)		2,207 pollen/m <sup>3</sup>	
Weight of one cedar pollen		12 ng	
Concentration of radioactive cesium contained in cedar pollen scattered in the air (Calculated from the concentration (1), count (2), and pollen weight)		0.000301 Bq/m <sup>3</sup>	0.000023 Bq/m <sup>3</sup>
Radiation dose an adult person receives by inhaling the air (Calculated by the concentration above and (3) and (4))	In 1 hour	0.0000113 $\mu$ Sv	
	Total over pollen scattering period (February to May)	0.0000325 mSv	

Conditions:

- (1) For the concentration of radioactive cesium contained in cedar pollen, the highest measurement value in male flowers of cedar surveyed in FY2019 (12,200 Bq/kg) was used. (The concentration of radioactive cesium contained in pollen is assumed to be the same as that in male flowers.)
- (2) For the count of cedar pollen scattered in the air, the highest measurement result by the Pollen Information System of the Ministry of the Environment (2,207 pollen/m<sup>3</sup>) was used.
- (3) For the amount of air an adult person inhales a day, the value by the International Commission on Radiological Protection (22.2 m<sup>3</sup>) was used, which was divided by 24 to give inhalation amount per hour.
- (4) For the effective dose coefficient (inhalation), 0.039  $\mu$ Sv/Bq was used for Cs-137 and 0.020  $\mu$ Sv/Bq for Cs-134.

[Past estimation results (radiation dose per hour)]

FY2011: 0.000192  $\mu$ Sv FY2012: 0.0000715  $\mu$ Sv FY2013: 0.0000484  $\mu$ Sv FY2014: 0.0000215  $\mu$ Sv  
FY2015: 0.0000077  $\mu$ Sv FY2016: 0.0000069  $\mu$ Sv FY2017: 0.0000187  $\mu$ Sv FY2018: 0.0000224  $\mu$ Sv

Radiation dose measured in Shinjuku-ku, Tokyo (On February 28, 2020)	In 1 hour	0.036 $\mu$ Sv
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