

## Site Description

Location: Notoriba-yama, Yamakiya, Kawamata Town, Fukushima Prefecture (N37.5853, E140.6906)

Altitude: 533 m

Mean slope: 20°

Dominant vegetation: *Cryptomeria japonica* (31-year-old plantation as of 2011)

### Mature cedar forest



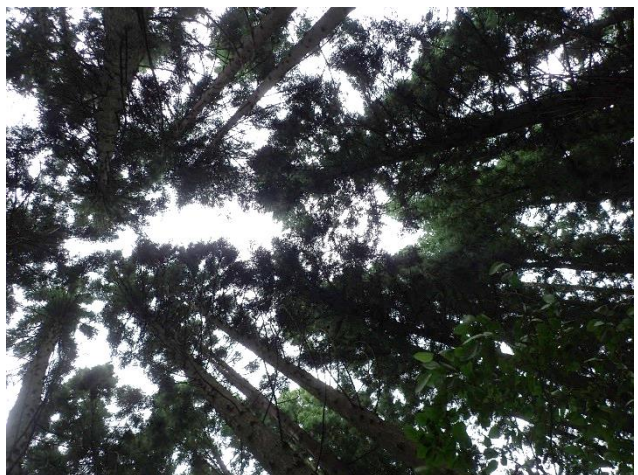
### Young cedar forest



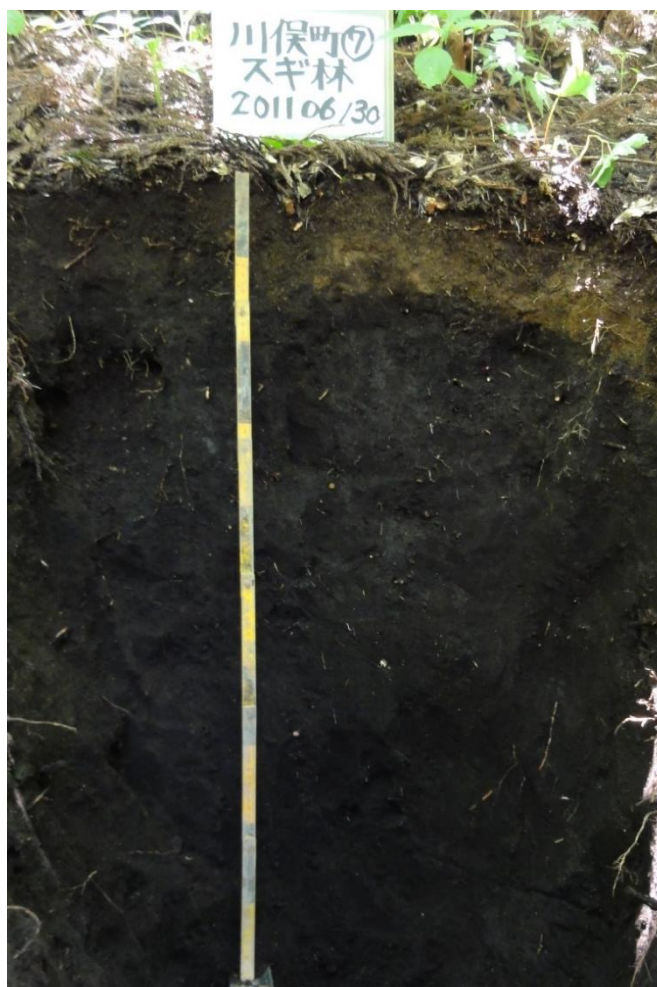
**Picture 1** Mature and young cedar forest sites (July 2, 2017)



**Picture 2** Sampling plot (June 30, 2011)



**Picture 3** Canopy openness (August 2, 2017)

**Soil profile**

**Soil group:** Non-allophanic Andsol (Soil Classification System of Japan), Silandic Andsol (WRB)

**Basement rock:** [Metamorphic rocks \(Mesozoic Early Cretaceous Aptian - Albian\)](#)

**Parent material (landform covered material):** Volcanic ash

**Mode of deposition:** Eolian, Creep

**Rock outcrop:** None

Horizon	Depth (cm)	Horizon boundary	Color (moist)	Soil texture	Rock fragment	Soil structure	Hardness (mm)*	AI
A1	0-6	Wavy Gradual	10YR4/4	CL	None	CR, WE, F		++
A2	6-25	Wavy Gradual	10YR4/5	CL	None	SB, WE, F		+++
A3	25-38	Wavy Gradual	10YR3/2	CL	None	SB, WE, F-M		+++
A4	38-65	Wavy Gradual	10YR2/2	LiC	None	SB, WE, F-M		+++
A5	65-100+		10YR2/2	LiC	None	SB, WE, F-M		+++

\*Measurement values using soil hardness tester (DIK-5553).

**Table 1** Chemical properties of soil profile.

Horizon	Depth (cm)	pH H <sub>2</sub> O	pH KCl	pH NaF	TC (g kg <sup>-1</sup> )	TN (g kg <sup>-1</sup> )	C/N	Exchangeable cation (cmol <sub>(c)</sub> kg <sup>-1</sup> )				CEC (cmol <sub>(c)</sub> kg <sup>-1</sup> )	BS (%)
								Na <sup>+</sup>	K <sup>+</sup>	Mg <sup>2+</sup>	Ca <sup>2+</sup>		
A1	0-6	4.67	4.25		165.2	13.5	12.0	0.10	0.98	1.85	7.57	58.1	18.1
A2	6-25	4.90	4.33		99.9	7.40	13.5	0.05	0.26	0.85	5.13	55.9	11.3
A3	25-38	5.07	4.43		97.4	6.77	14.4	0.12	0.11	0.61	2.23	52.5	5.8
A4	38-65	5.13	4.38		87.1	5.62	15.5	0.04	0.05	0.35	2.26	51.3	5.3
A5	65-100+	5.38	4.34		108.5	5.94	18.3	0.07	0.21	0.92	3.56	46.5	10.2

TC, total carbon content; NC, total nitrogen content; CEC, cation exchangeable capacity; BS, base saturation.

**Table 2** Extractable Al, Fe and Si of soil profile.

Horizon	Depth (cm)	Extractable Al, Fe, Si (g kg <sup>-1</sup> )							Al <sub>o</sub> +1/2Fe <sub>o</sub> (g kg <sup>-1</sup> )	Al <sub>p</sub> /Al <sub>o</sub>	(Al <sub>o</sub> -Al <sub>p</sub> )/Si molar ratio	Fe <sub>o</sub> /Fe <sub>d</sub>
		Al <sub>o</sub>	Fe <sub>o</sub>	Si <sub>o</sub>	Al <sub>p</sub>	Fe <sub>p</sub>	Al <sub>d</sub>	Fe <sub>d</sub>				
A1	0-6	16.9	8.3	6.4	11.4	3.8			21.1	0.67	0.90	
A2	6-25	20.0	7.8	6.1	6.4	2.2			23.9	0.32	2.46	
A3	25-38	22.2	7.1	5.2	13.5	4.4			25.7	0.61	1.75	
A4	38-65	23.6	7.2	5.9	14.1	4.6			27.2	0.60	1.68	
A5	65-100+	29.3	10.7	7.9	15.2	5.6			34.6	0.52	1.86	

Al<sub>o</sub>, Fe<sub>o</sub>, Si<sub>o</sub>, oxalate-extractable Al, Fe, Si; Al<sub>p</sub>, Fe<sub>p</sub>, pyrophosphate-extractable Al, Fe; Al<sub>d</sub>, Fe<sub>d</sub>, dithionite-citrate extractable Al, Fe.

**Table 3** Physical properties of soil profile.

Depth (cm)	Three phases distribution (Volume %)			Micropore (Volume%)	Macropore (Volume%)	Bulk density (g cm <sup>-3</sup> )	Specific Gravity (g cm <sup>-3</sup> )	K <sub>20</sub> (cm s <sup>-1</sup> )
	Solid	Liquid	Gaseous					
0-5	8.1	28.8	63.1	57.1	34.5	0.30	3.28	1.4×10 <sup>-1</sup>
15-20	16.7	44.8	38.5	67.7	15.7	0.43	2.78	5.4×10 <sup>-2</sup>
30-35	18.4	46.9	34.7	74.5	8.4	0.46	2.89	4.3×10 <sup>-2</sup>
60-65	15.6	47.3	37.0	69.9	15.5	0.43	3.02	2.0×10 <sup>-2</sup>

K<sub>20</sub>, saturated hydraulic conductivity converted at 20°C.

### Vertical distribution of Cs-137 concentration

The vertical distribution of Cs-137 concentration in mineral soil layers without litter layer was fitted using the following equation (Takahashi et al., 2019).

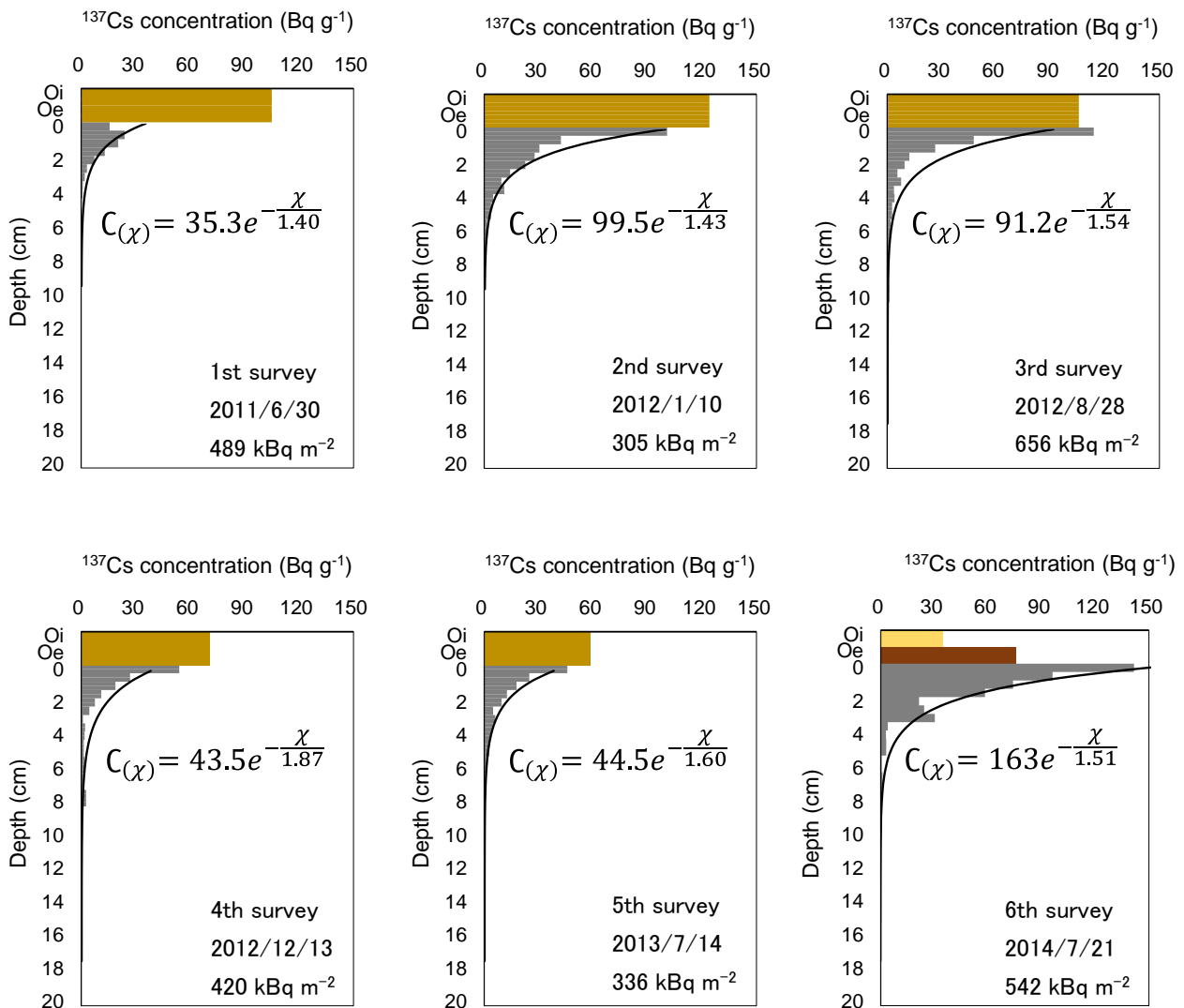
$$C_{(\chi)} = C_{(0)} e^{-\frac{\chi}{\alpha}} \quad \cdots(1)$$

where  $C_{(\chi)}$  and  $C_{(0)}$  are the Cs-137 concentration ( $\text{Bq kg}^{-1}$ ) at depth  $\chi$  (cm) and  $\chi=0$ , respectively. The parameter  $\alpha$  (cm) is the relaxation depth (cm), indicating the necessary distance which  $C_{(0)}$  decreases to  $1/e$  ( $\doteq 1/2.7$ ).

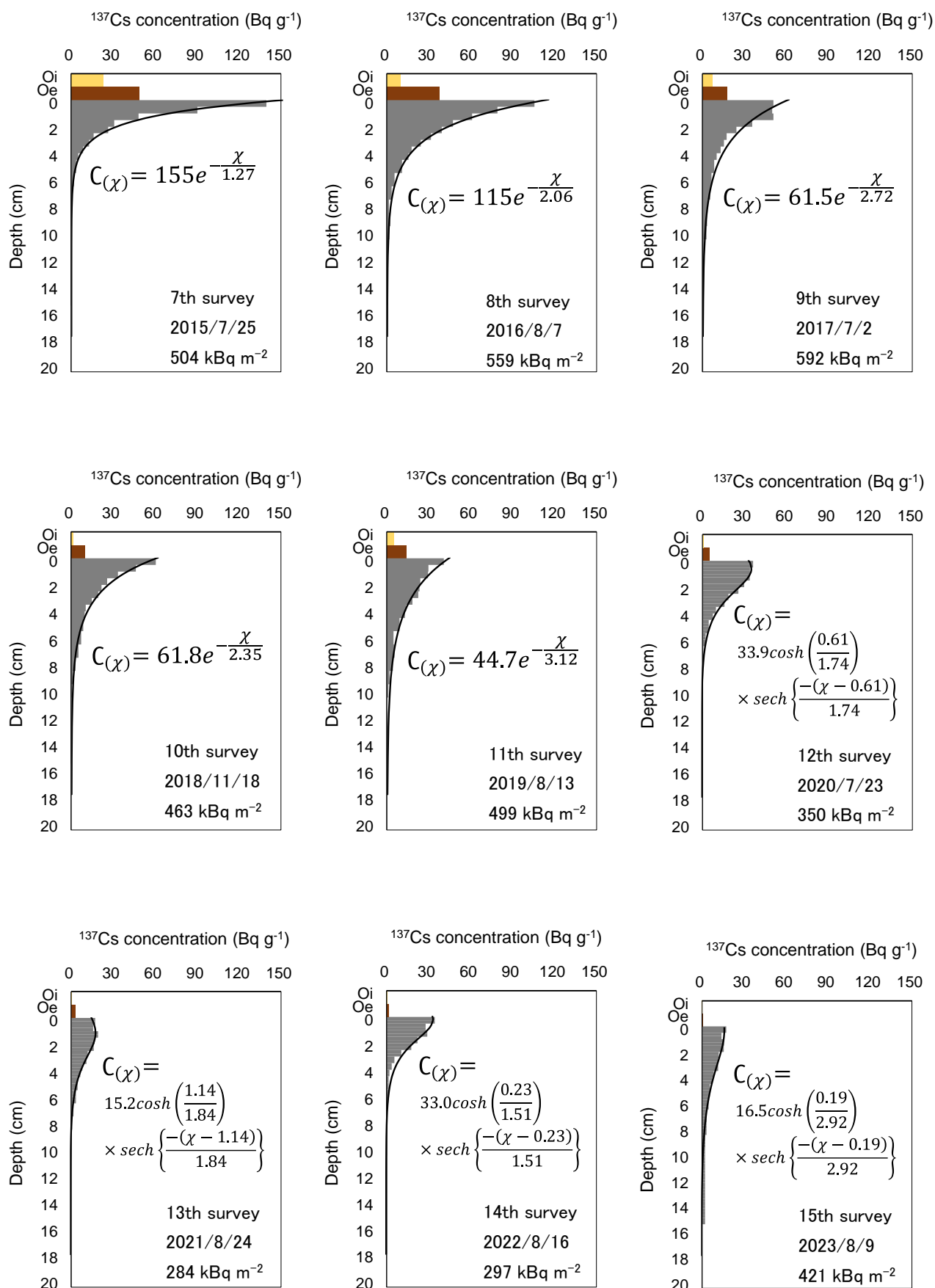
If the maximal Cs-137 concentration in the soil shifted progressively to deeper layers with time, an analytical function was defined on the basis of the hyperbolic secant (sech) and hyperbolic cosine (cosh) functions as follows (Matsuda et al., 2015).

$$C_{(\chi)} = C_{(0)} \cosh\left(\frac{\chi_m}{\alpha}\right) \times \text{sech}\left\{\frac{-(\chi - \chi_m)}{\alpha}\right\} \quad \cdots(2)$$

where  $\chi_m$  is the depth at which the cesium-137 concentration reaches its maximum.







## References

- Matsuda, N., Mikami, S., Shimoura, S., Takahashi, J., Nakano, M., Shimada, K., Uno, K., Hagiwara, S., Saito, K., 2015. Depth profiles of radioactive cesium in soil using a scraper plate over a wide area surrounding the Fukushima Dai-ichi Nuclear Power Plant, Japan. *J. Environ. Radioact.* 139, 427–434. <https://doi.org/10.1016/j.jenvrad.2014.10.001>
- Takahashi, J., Onda, Y., Hihara, D., Tamura, K., 2019. Six-year monitoring of the vertical distribution of radiocesium in three forest soils after the Fukushima Dai-ichi Nuclear Power Plant accident. *J. Environ. Radioact.* 192, 172–180. <https://doi.org/10.1016/j.jenvrad.2018.06.015>

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