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Supplemental report

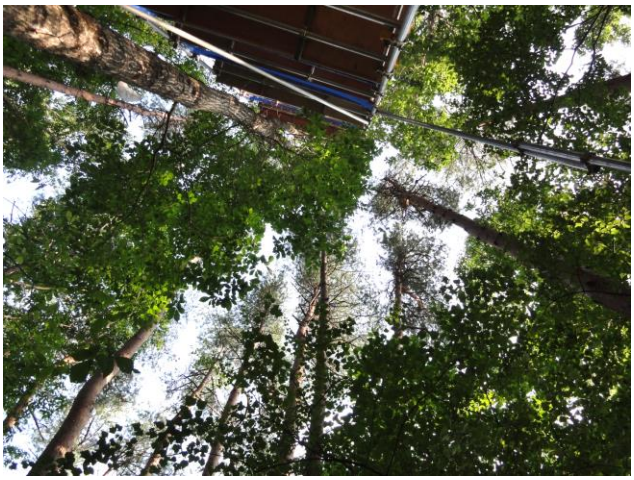
Site Description

Location: Kozuka-yama, Yamakiya, Kawamata Town, Fukushima Prefecture (N37.6025, E140.6771)

Altitude: 575 m

Mean slope: 10°

Dominant vegetation: *Pinus densiflora, Quercus serrata*



Picture 1

Tall vegetation in the study area (July 1, 2011)

Picture 2

Sampling plot (July 1, 2011)

Picture 3

Study site after decontamination (October 4, 2021)

Picture 4

Soil sampling using scraper plate (October 4, 2021)

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Soil profile

Soil group: Allophanic Andsol (Soil Classification System of Japan), Silandic Andsol (WRB)

Basement rock: terrace deposit (Cenozoic Quaternary late Middle Pleistocene)

Parent material (landform covered material): Volcanic ash

Mode of deposition: Eolian

Rock outcrop: None

Horizon	Depth (cm)	Horizon boundary	Color (moist)	Soil texture	Rock fragment	Soil structure	Hardness (mm)*	Al
A1	0-5	Wavy Clear	7.5YR2/2	CL	None	CR, MO, F	7	+++
A2	5-15	Wavy Gradual	10YR2/3	CL	None	SB, WE, F	13	+++
AB	15-38	Wavy Gradual	7.5YR3/4	LiC	None	SB, WE, F-M	14	+++
Bw1	38-60	Smooth Clear	10YR4/6	LiC	None	SB, MO, F-C	15	+++
Bw2	60-80+		7.5YR4/6	LiC	None	SB, WE, F-M	18	+++

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

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Table 1 Chemical properties of soil profile.

Horizon	Depth (cm)	pH H_2O	pH KCl	pH NaF	TC (g kg^{-1})	TN (g kg^{-1})	C/N	Exchangeable cation (cmol$_{(c)}$ kg^{-1})				CEC (cmol$_{(c)}$ kg^{-1})	BS (%)
								Na^+	K^+	Mg^{2+}	Ca^{2+}		
A1	0-5	4.10	3.91		115.5	5.92	19.5	0.05	0.24	0.40	0.65	44.3	3.02
A2	5-15	5.06	4.41		56.8	3.33	17.1	0.03	0.06	0.13	0.24	30.0	1.53
AB	15-38	5.20	4.59		14.9	1.09	13.4	0.05	0.08	0.22	0.19	27.3	1.98
Bw1	38-60	5.41	4.36		10.7	0.95	11.3	0.06	0.07	0.71	0.38	25.3	4.82
Bw2	60-80+	5.53	4.61		9.9	0.92	10.9	0.03	0.08	0.58	0.48	24.5	4.78

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^{-1})							Al_o+1/2Fe_o (g kg^{-1})	Al_p/Al_o	(Al_o-Al_p)/Si molar ratio	Fe_o/Fe_d
		Al_o	Fe_o	Si_o	Al_p	Fe_p	Al_d	Fe_d				
A1	0-5	8.6	5.8	1.6	7.93	4.74			11.5	0.92	0.42	
A2	5-15	20.8	9.6	5.7	7.97	2.83			25.5	0.38	2.23	
AB	15-38	23.7	9.8	7.5	6.56	1.59			28.6	0.28	2.30	
Bw1	38-60	15.4	13.4	5.1	3.56	0.78			22.1	0.23	2.32	
Bw2	60-80+	18.1	13.1	7.0	3.25	0.52			24.6	0.18	2.11	

Al_o, Fe_o, Si_o, oxalate-extractable Al, Fe, Si; Al_p, Fe_p, pyrophosphate-extractable Al, Fe; Al_d, Fe_d, dithionite-citrate extractable Al, Fe.

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Table 3 Physical properties of soil profile.

Depth (cm)	Three phases distribution (Volume%)			Micropore (Volume%)	Macropore (Volume%)	Bulk density (g cm^{-3})	Specific Gravity (g cm^{-3})	K_{20} (cm s^{-1})
	Solid	Liquid	Gaseous					
0-5	11.1	25.7	63.2	47.0	41.9	0.31	2.82	1.1×10^{-1}
15-20	19.1	39.8	41.1	69.0	13.1	0.50	2.67	3.8×10^{-2}
30-35	16.8	42.9	40.3	69.2	13.3	0.58	3.18	2.2×10^{-2}
60-65	23.1	45.0	32.0	63.3	13.7	0.67	2.99	4.8×10^{-3}

K_{20}, saturated hydraulic conductivity converted at 20°C.

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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).

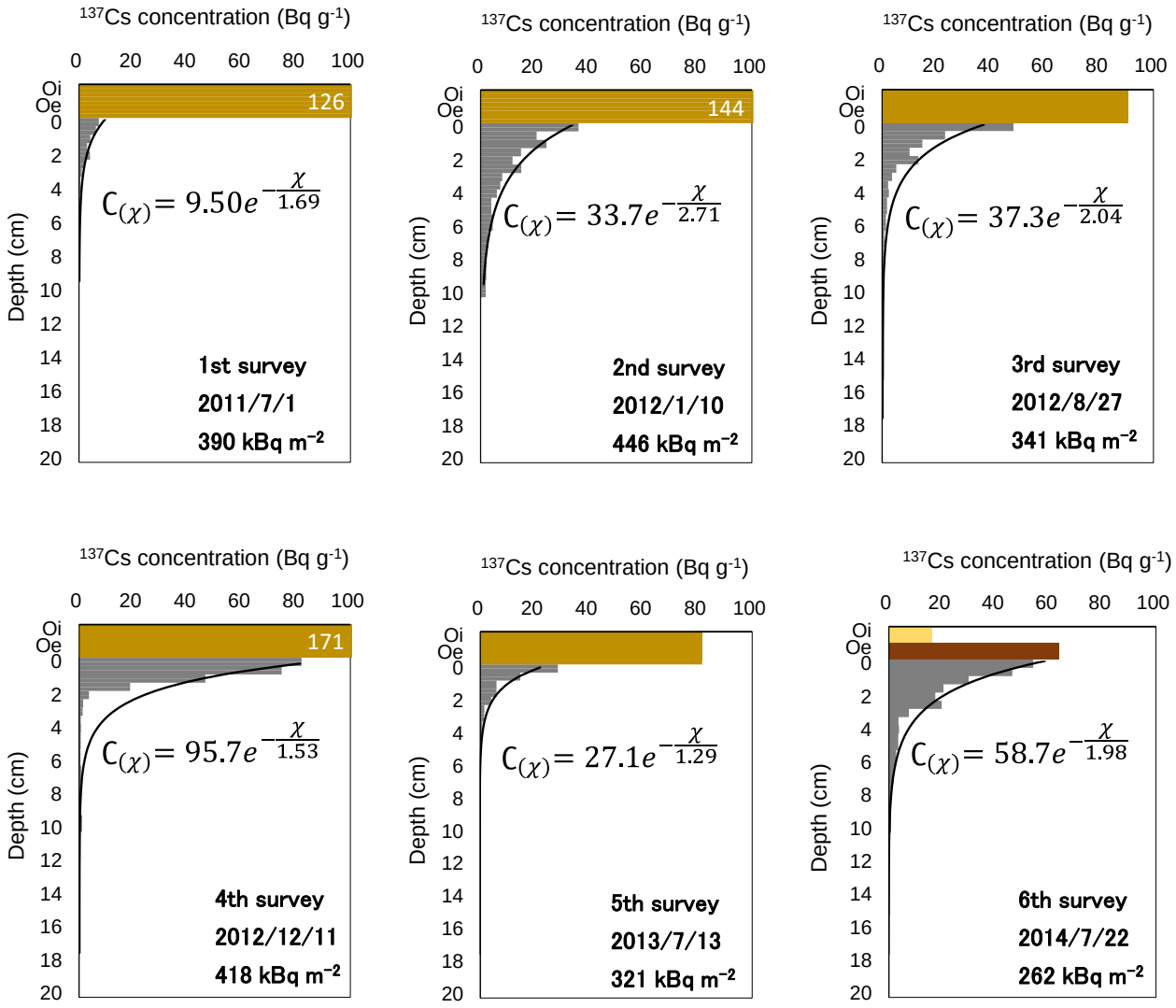
$$C_{(\chi)} = C_{(0)} e^{-\frac{\chi}{\alpha}} \qquad \cdots(1)$$

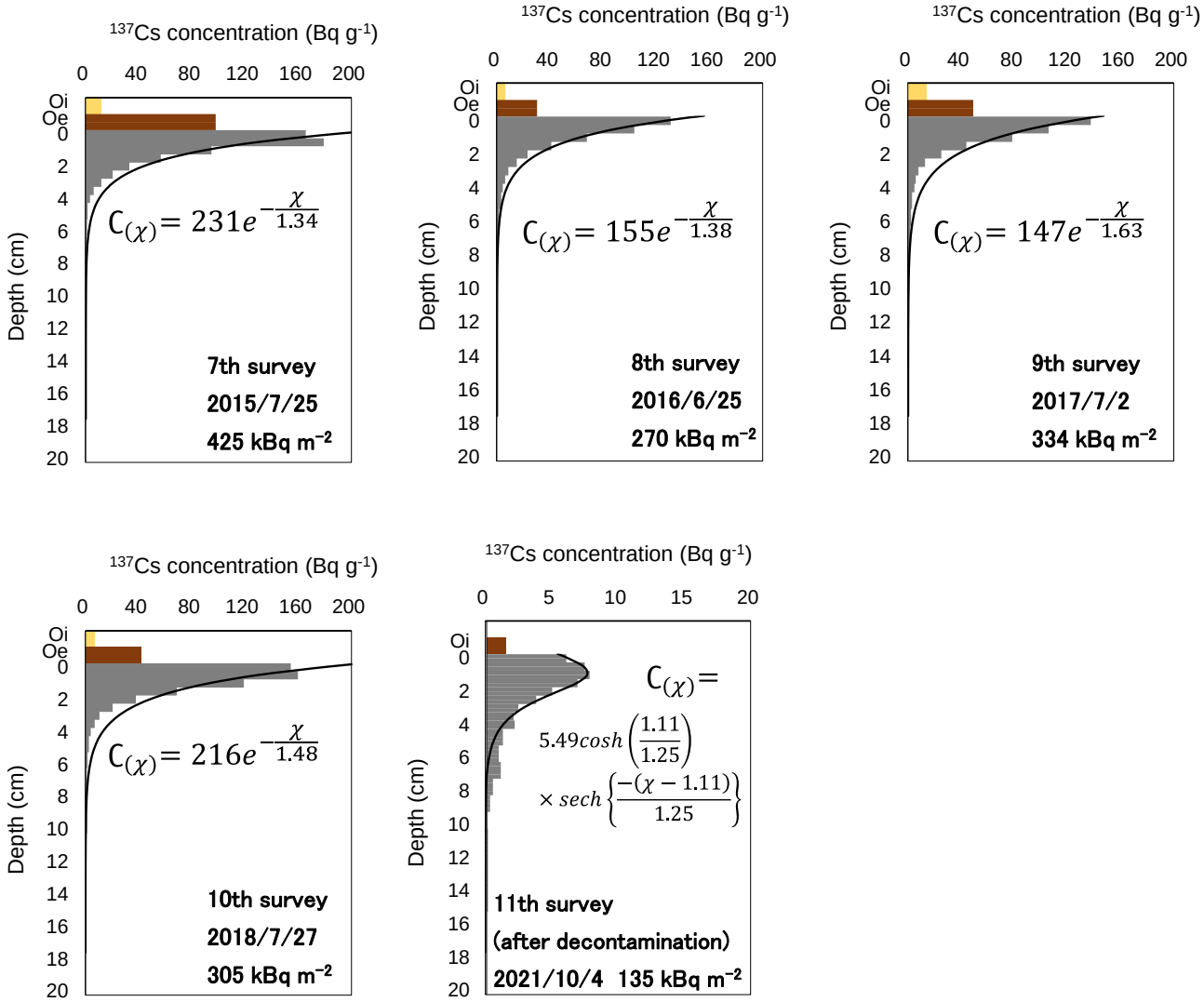
where $C_{(\chi)}$ and $C_{(0)}$ are the Cs-137 concentration (Bq kg^{-1}) at depth χ (cm) and χ=0, respectively. The parameter α (cm) is the relaxation depth (cm), indicating the necessary distance which $C_{(0)}$ decreases to 1/ e(≒1/2.7).

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).

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

where X_m is the depth at which the cesium-137 concentration reaches its maximum.





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Acknowledgments

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