

The Network Center for  
the Acid Deposition Monitoring Network in East Asia

**Report of the Inter-laboratory Comparison Project 2000**  
**on Soil**  
2<sup>nd</sup> Attempt

November 2001  
Acid Deposition and Oxidant Research Center

## Contents

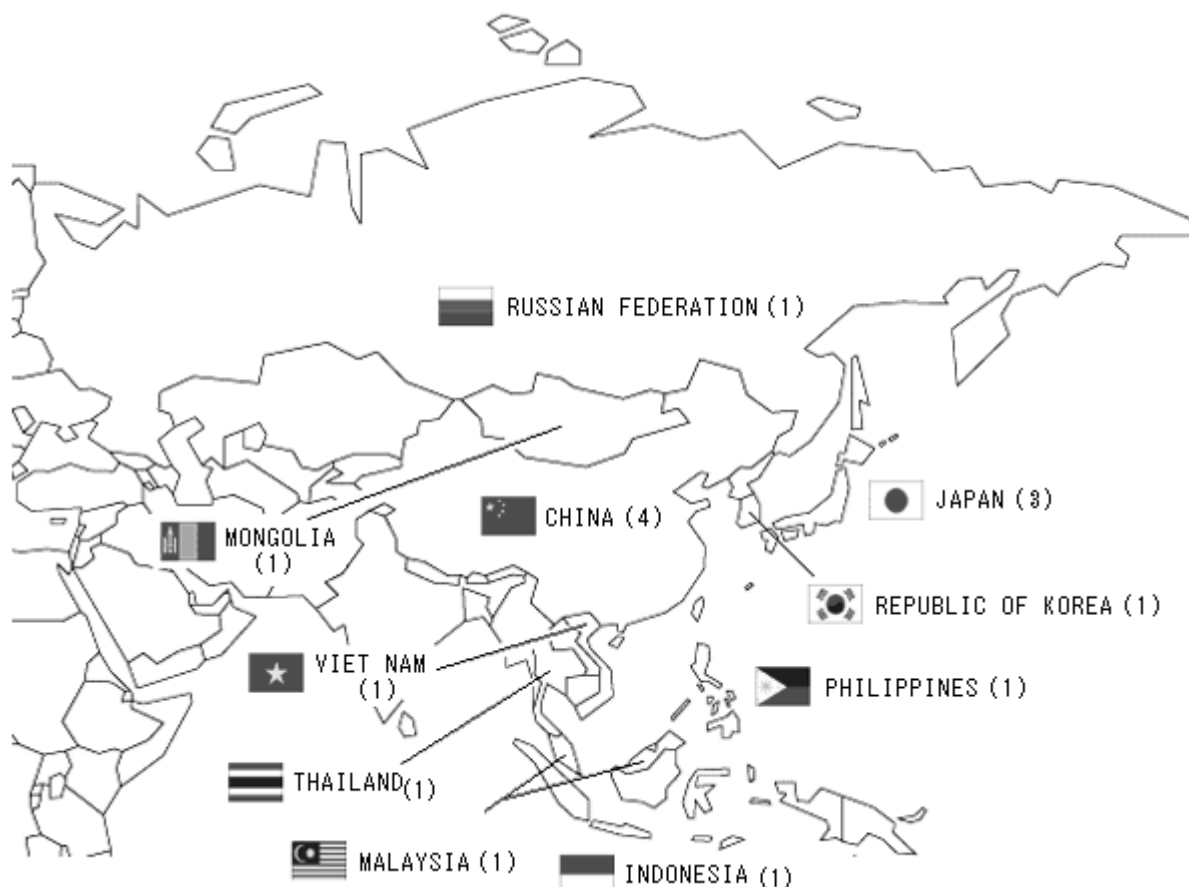
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## 1. INTRODUCTION

Since 1998, according to the QA/QC programs in EANET, the National Centers and the Interim Network Center (INC) have carried out various QA/QC activities for the EANET monitoring. The Inter-laboratory comparison project on soil samples is one of the activities on the QA/QC programs, and the results can be used for estimation of data quality on the monitoring.

As the 2<sup>nd</sup> project, Network Center (NC) dispatched two soil samples, Sample No. 001 and 002, to laboratories for soil monitoring in the participating countries in December 2000. 15 laboratories of 10 countries analyzed chemical properties of the soil samples, and the results were submitted to NC by mid of November 2001.

In this report, the data from various laboratories were analyzed statistically according to the QA/QC program for soil monitoring, and the results may be utilized for estimation of inter-laboratory variability in soil monitoring, and provide useful information for the future activities of EANET.



**Figure 1. Laboratories participating in this Inter-laboratory comparison project of EANET**

Number of parenthesis shows the number of laboratories of each country.

## 2. PROCEDURE

### 2.1. Dispatched Soil Sample

The characteristics of the samples were as follows:

#### Sample No. 001: Cambisols

The soil was collected from forest area in the University Forest in Aichi, The University of Tokyo (Seto City, Aichi Prefecture).

#### Sample No. 002: Andosols

The soil was collected from chestnuts forest area in Tochigi Prefectural Forest Research Center (Utsunomiya City, Tochigi Prefecture).

The soil samples were air-dried for 1-2 weeks, sieved, mixed well, bottled by 500 grams, and sterilized using radioisotope (20kGy). Chemical characteristics of these samples were not informed for fair evaluation of the program.

The real values of parameters were unknown since the natural soils were used for the samples. Five bottles for each sample were analyzed, and variations of analytical parameters among bottles were checked (Appendix 5).

### 2.2. Parameters

All the participating laboratories were expected to measure the mandatory parameters and hopefully recommended parameters (Table 1).

**Table 1. Parameters to be measured**

Parameters	Unit	Criterion
a) Moisture content	wt%	M
b) pH (H <sub>2</sub> O) and pH (KCl)		M
c) Exchangeable Base Cations (Ca, Mg, K and Na)	cmol(+) kg <sup>-1</sup>	M
d) Exchangeable Acidity	cmol(+) kg <sup>-1</sup>	M
e) Exchangeable Al, H	cmol(+) kg <sup>-1</sup>	O*
f) Effective Cation Exchangeable Capacity (ECEC)	cmol(+) kg <sup>-1</sup>	M
g) Total Carbon Content	g kg <sup>-1</sup>	O
h) Total Nitrogen Content	g kg <sup>-1</sup>	O
i) Available Phosphate	P mg g <sup>-1</sup>	O
j) Sulfate	S mg g <sup>-1</sup>	O

M: Mandatory items; O: Optional items; \*: Recommended items. ECEC could be calculated as sum of Exchangeable cations

“Exchangeable” were abbreviated to “Ex-“ in the following report; e.g. Ex-Ca, Ex-Mg, etc.

### 2.3. Procedures for chemical analysis

All the procedures for chemical analysis were carried out basically according to the “Technical Manual

for Soil and Vegetation Monitoring in East Asia (2<sup>nd</sup> ISAG, 2000)”.

For the estimation of analytical quality in the respective laboratory, all the parameters were analyzed twice on within-laboratory-reproducibility condition that part or all of analyst, time, and instrument are different. Thus, all the analytical procedures should be repeated twice in each laboratory. Moisture contents were analyzed with three replicates, and the average was used for calculation of all the parameters.

#### **2.4. Statistical analysis**

Data obtained from repeat analyses in the participating laboratories were statistically analyzed according to the following procedures described in the Technical Manual for Soil and Vegetation Monitoring in East Asia (2<sup>nd</sup> ISAG, 2000). The pH data with 1 decimal place and other mandatory and recommended parameters' data with 2 decimal places were used for the analysis.

1) Verification of data

Evenness of within-laboratory precision was verified by Cochran methods, then the laboratory averages was verified by Grubbs methods.

2) Analysis of variance and estimation of precision

Total variation among laboratories includes within-laboratory and inter-laboratories variation. As described in the following equation, Total sum of square ( $S_T$ ) can be divided into Sum of square inter-laboratories ( $S_R$ ) and Sum of square within-laboratory ( $S_{RW}$ ).

$$S_T = S_R + S_{RW}$$

Based on the above equation, Inter-laboratories variance and Within-laboratory-reproducibility variance were calculated, and then the precisions were estimated.

3) Calculation of permissible tolerance

Permissible tolerances were calculated based on the above precisions.

### 3. RESULTS

Basic statistics calculated from the laboratory averages are shown in Table 2.1 and 2.2, and especially coefficients of variation (CVs) among laboratories were shown in Figure 2. For calculation of the statistics, verified data by Cochran and Grubbs methods were used.

In pH (H<sub>2</sub>O) and pH (KCl), CV was lowest (less than 4%). This is the same trend as the 1<sup>st</sup> project in 1999. Simple procedure for pH may be one of the reasons for small variation although value of pH was log scale and relatively stable parameters. The results of Exchangeable basic cations (Na, K, Mg, Ca) were significantly varied (CV, 46-84%), especially for Sample No.001. Low concentration of these cations may be one of the causes of variation. CVs of Exchangeable acidity were relatively low, probably due to simple procedures of analysis.

**Table 2.1. Statistics of Verified data: Soil Sample No.001**

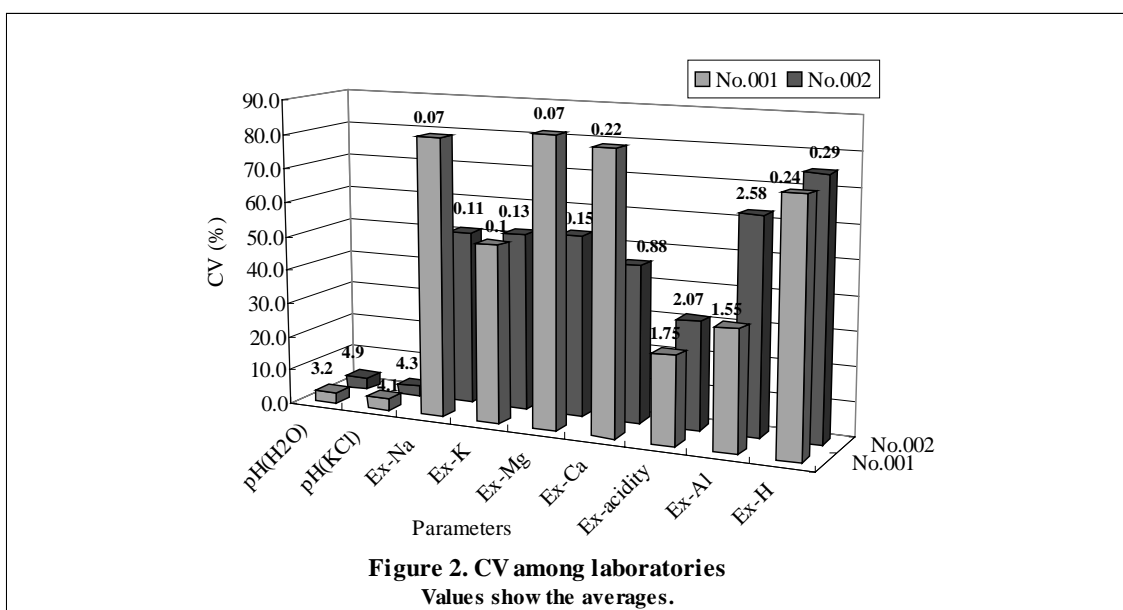
Statistics	pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
			cmol (+)/kg						
Number of laboratorie	12	15	12	12	10	8	13	12	11
Total average	4.5	4.2	0.07	0.10	0.07	0.06	1.77	1.55	0.26
Maximum	4.7	4.4	0.19	0.18	0.18	0.14	2.72	2.35	0.56
Minimum	4.2	3.9	0.02	0.01	0.02	0.01	1.06	0.58	0.03
Standard deviation	0.1	0.1	0.06	0.05	0.06	0.05	0.46	0.54	0.19
CV (%)	3.2	3.5	81.2	51.7	83.6	81.0	25.7	34.7	72.1

Data has been verified by the methods of Cochran and Grubbs, and outliers have been removed. Ex-H of minus value were also treated as outliers.

**Table 2.2. Statistics of Verified data: Soil Sample No.002**

Statistics	pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
			cmol (+)/kg						
Number of laboratorie	13	15	11	13	11	13	12	12	10
Total average	4.9	4.3	0.12	0.13	0.14	0.87	2.14	2.58	0.30
Maximum	5.1	4.5	0.23	0.29	0.31	1.44	3.31	5.30	0.78
Minimum	4.5	4.1	0.02	0.03	0.03	0.09	0.69	0.64	0.05
Standard deviation	0.2	0.1	0.06	0.07	0.08	0.40	0.67	1.61	0.22
CV (%)	3.5	2.8	51.1	51.9	52.7	45.7	31.5	62.7	75.1

Data has been verified by the methods of Cochran and Grubbs, and outliers have been removed. Ex-H of minus value were also treated as outliers.



Note: Coefficient of variation (%) = standard deviation/average\*100

### 3.1. Verification of data

#### 1) Detection of outliers

The average and range (difference) of values in the respective laboratory, which were calculated from two data of repeat analysis, were shown in Figure 3.1 to Figure 6.2 for representative parameters. The outliers judged by Cochran and Grubbs methods were marked with asterisk c and g.

Laboratories, which have remarkably large range, were judged as outliers by Cochran method (examination of the evenness of within-laboratory precision): e.g. “1B20” and “1F02” for pH (H<sub>2</sub>O) in No. 001 (Figure 3.1.b)). Then, laboratories, which have remarkably large average, were judged as outliers by Grubbs method (examination of the average value in each laboratory): e.g. “1D23” for pH (H<sub>2</sub>O) in No.001 (Figure 3.1 a)). For all parameters except pH (KCl), a few outliers were detected.

Ex-H could be calculated from two steps titration for Ex-acidity and Ex-Al, and sometimes the results could be minus value due to rough operation and/or low level of the concentration. In the laboratory “1718”, data were minus, and the data were treated as outliers for calculation of precision.

The results of verification were shown in Table 3.1 and 3.2.

#### 2) Analytical condition

Information on analytical conditions and staff in the respective laboratory was shown in Table 4.1 to 5.2.

For the exchangeable cations, all the laboratories used same extractants according to the Technical Manual (Table 4.1). For elemental analyses of Ex-Na and K, Flame Emission Photometry (FEP) or Atomic Absorption Spectrometry (AAS) was used in most laboratories (Table 4.2). For Ex-Mg and Ca, AAS or ICP-AES was used in most laboratories although the laboratories “1714” and “1711” used Titration method. Ex-acidity, Al and H were analyzed by Titration method in all the laboratories. Temperatures for measurement of pH were varied from 17.3 to 33 °C, and most were around 20 °C. Concerning the number of staff, one to three staffs were in charge of measurements (Table 5.1). In the laboratory “1804”, all the parameters might be repeated by two persons, and it seems that same persons might analyze all the parameters in 7 laboratories. The years of experiences were varied, and some of staffs have 1 year or less than 1 year experiences (Table 5.2).

The implication between analytical conditions and outliers was not clarified. Other factors, which have not been reported, might affect on the results.

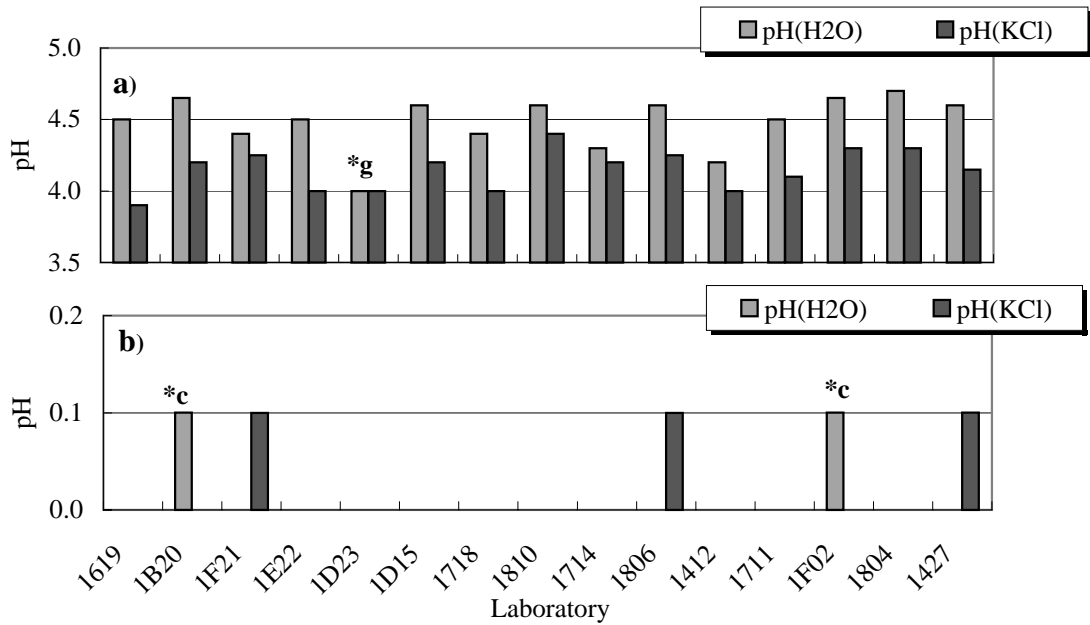


Figure 3.1. Laboratory average a) and range b) of pH (H<sub>2</sub>O) and pH (KCl) for No. 001

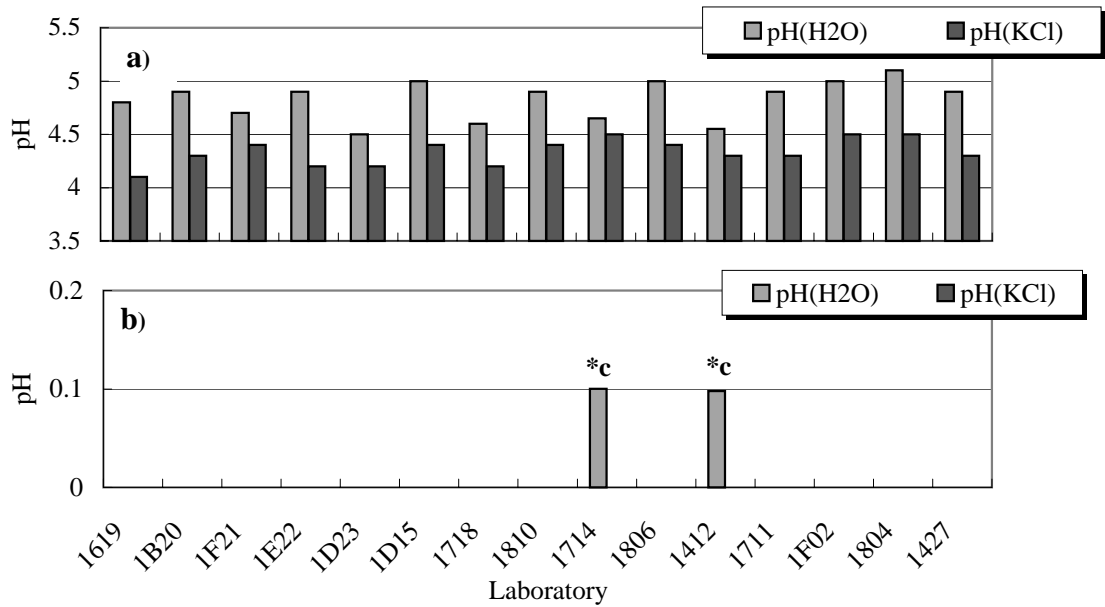


Figure 3.2. Laboratory average a) and range b) of pH (H<sub>2</sub>O) and pH (KCl) for No. 002

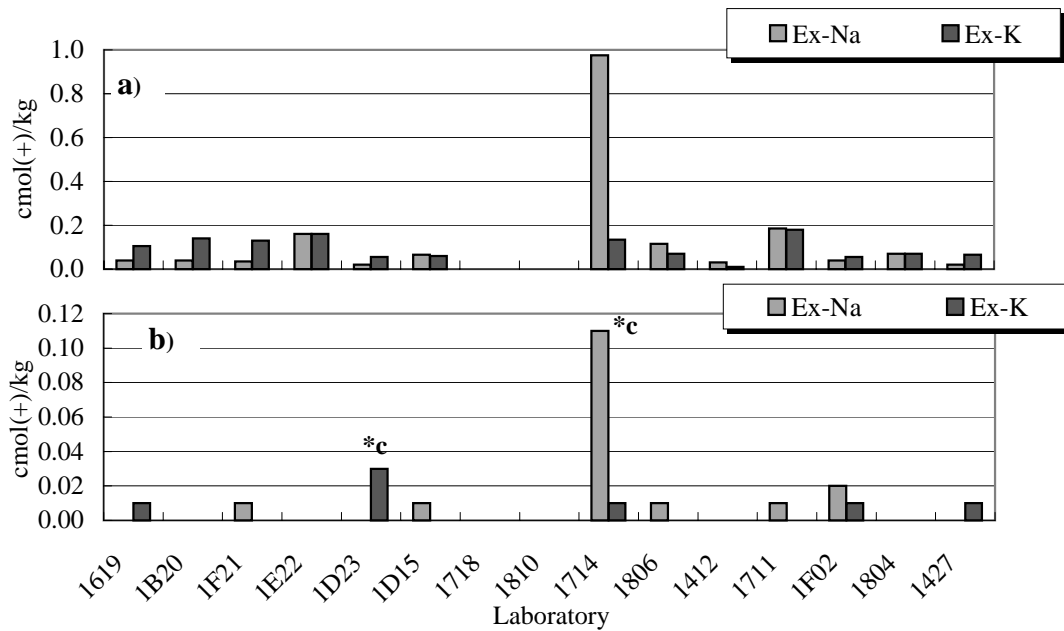


Figure 4.1. Laboratory average a) and range b) of Ex-Na and K for No. 001

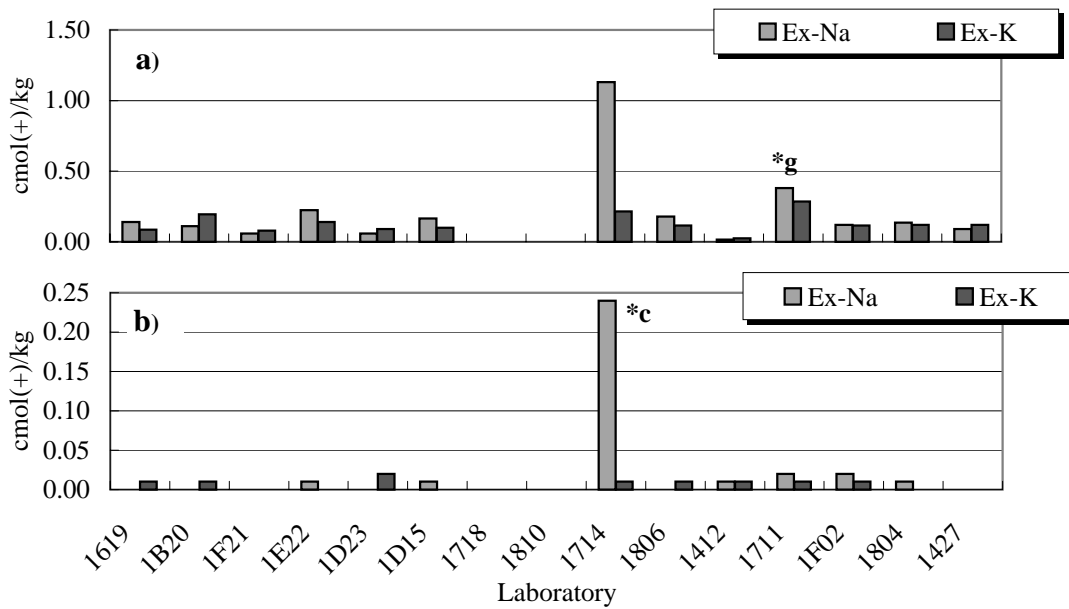
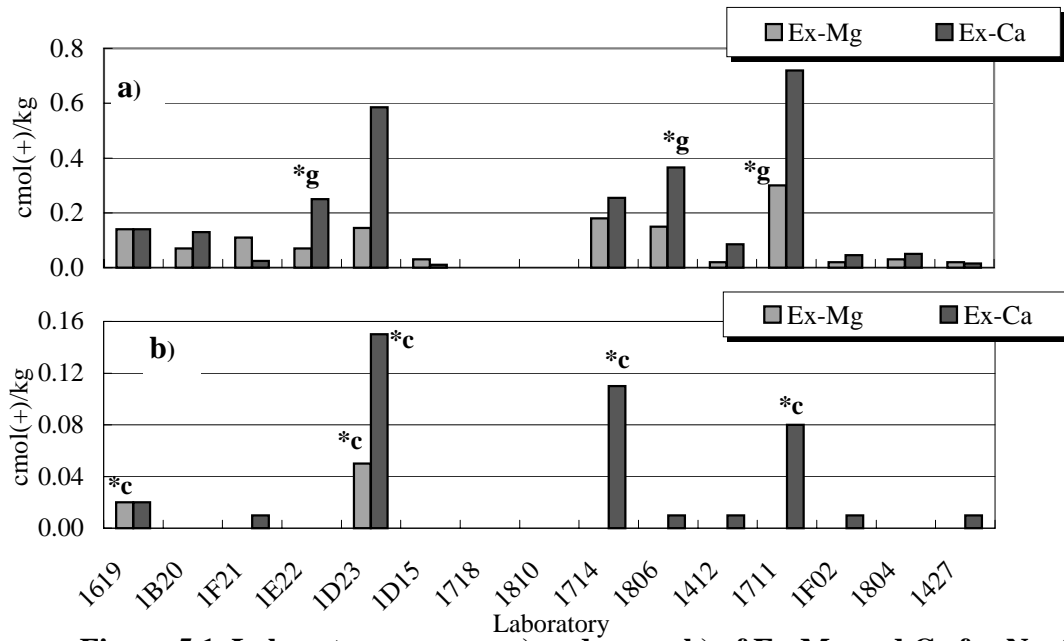
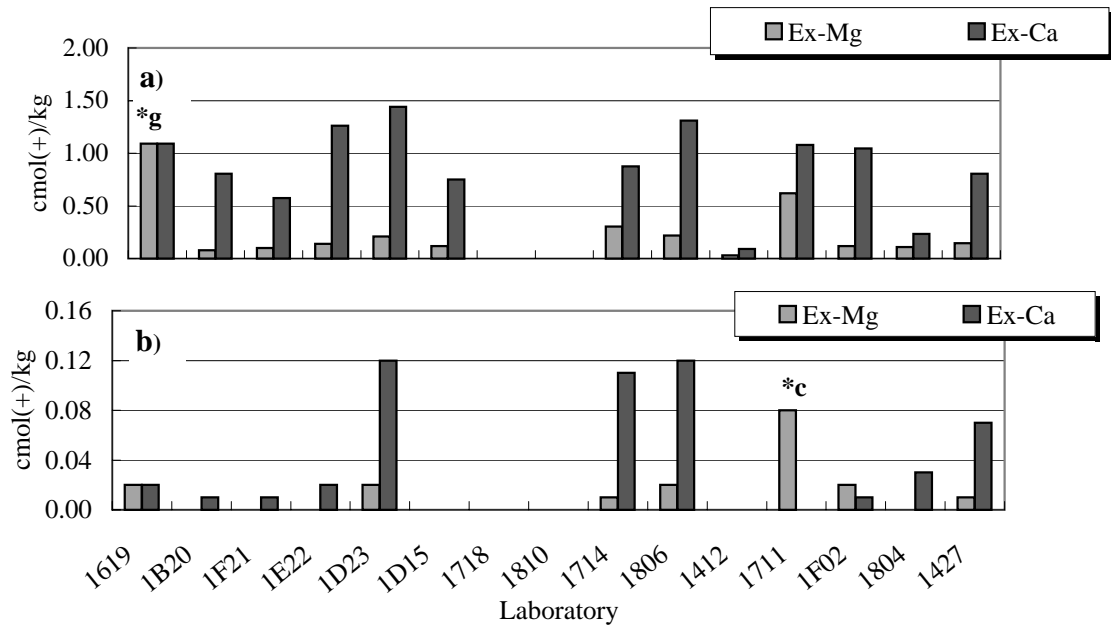


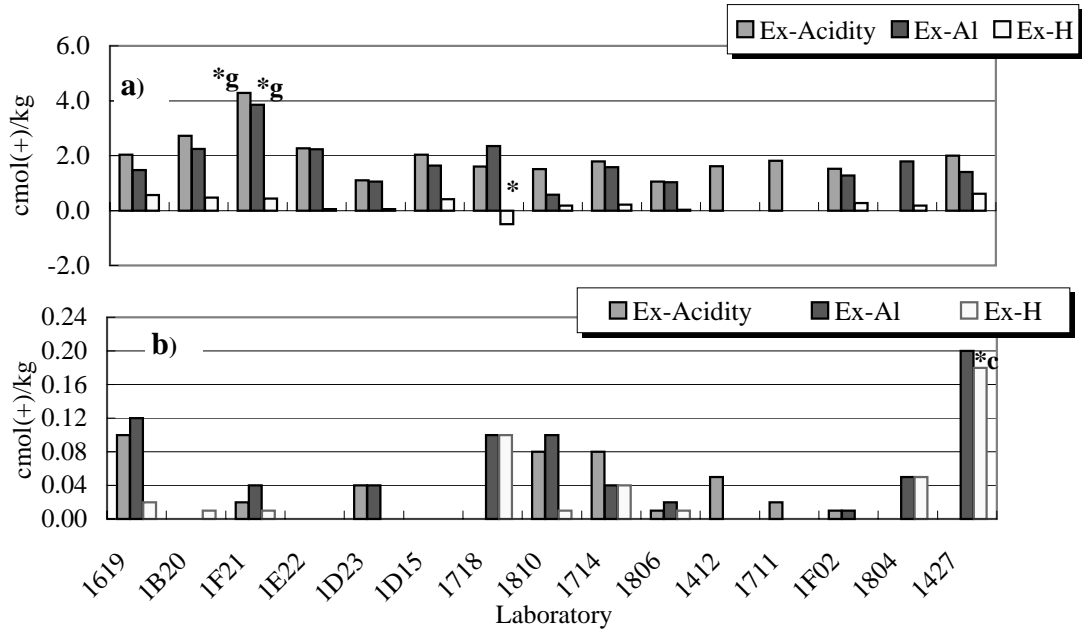
Figure 4.2. Laboratory average a) and range b) of Ex-Na and K for No. 002



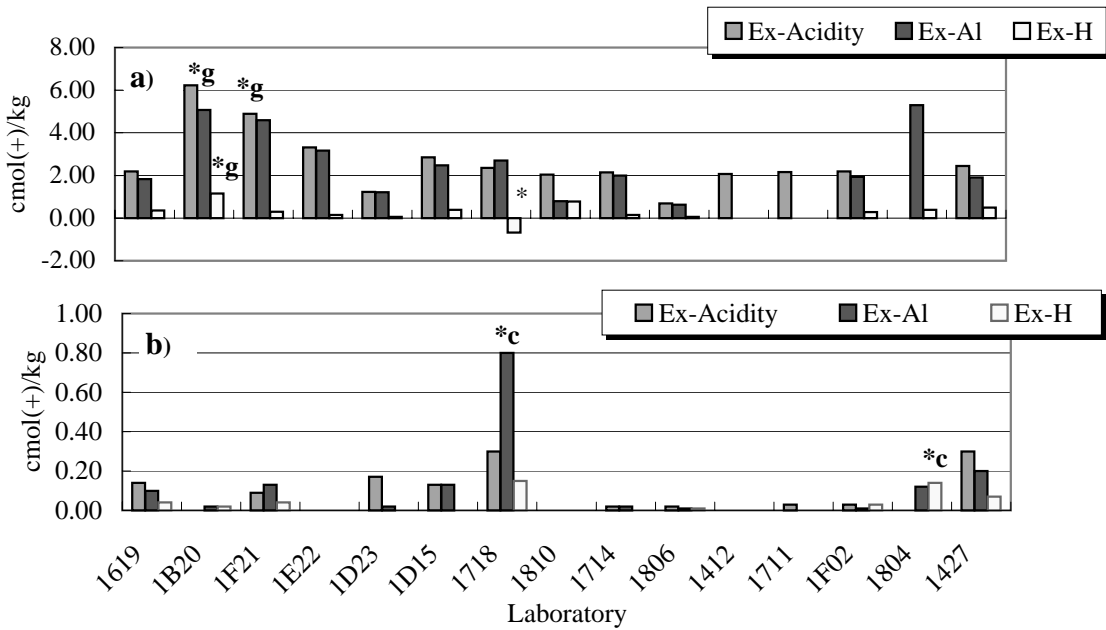
**Figure 5.1. Laboratory average a) and range b) of Ex-Mg and Ca for No. 001**



**Figure 5.2. Laboratory average a) and range b) of Ex-Mg and Ca for No. 002**



**Figure 6.1. Laboratory average a) and range b) of Ex-Acidity, Al and H for No. 001**



**Figure 6.2. Laboratory average a) and range b) of Ex-Acidity, Al and H for No. 002**

**Table 3.1. Data tested by Cochran's and Grubbs' methods: Soil Sample No.001**

ID	Analysis	pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
1619	1st	4.5	3.9	0.04	0.10	0.13*c	0.13	2.08	1.53	0.55
	2nd	4.5	3.9	0.04	0.11	0.15*c	0.15	1.98	1.41	0.57
1B20	1st	4.6*c	4.2	0.04	0.14	0.07	0.13	2.72	2.24	0.47
	2nd	4.7*c	4.2	0.04	0.14	0.07	0.13	2.72	2.24	0.48
1F21	1st	4.4	4.2	0.04	0.13	0.11	0.02	4.30*g	3.88*g	0.43
	2nd	4.4	4.3	0.03	0.13	0.11	0.03	4.28*g	3.84*g	0.44
1E22	1st	4.5	4.0	0.16	0.16	0.07	0.25*g	2.27	2.23	0.05
	2nd	4.5	4.0	0.16	0.16	0.07	0.25*g	2.27	2.23	0.05
1D23	1st	4.0*g	4.0	0.02	0.07*c	0.17*c	0.66*c	1.12	1.08	0.05
	2nd	4.0*g	4.0	0.02	0.04*c	0.12*c	0.51*c	1.08	1.04	0.05
1D15	1st	4.6	4.2	0.07	0.06	0.03	0.01	2.04	1.64	0.41
	2nd	4.6	4.2	0.06	0.06	0.03	0.01	2.04	1.64	0.41
1718	1st	4.4	4.0					1.60	2.30	0*
	2nd	4.4	4.0					1.60	2.40	0*
1810	1st	4.6	4.4					1.47	0.63	0.18
	2nd	4.6	4.4					1.55	0.53	0.17
1714	1st	4.3	4.2	0.92*c	0.14	0.18	0.31*c	1.83	1.60	0.23
	2nd	4.3	4.2	1.03*c	0.13	0.18	0.20*c	1.75	1.56	0.19
1806	1st	4.6	4.3	0.11	0.07	0.15	0.36*g	1.06	1.04	0.02
	2nd	4.6	4.2	0.12	0.07	0.15	0.37*g	1.05	1.02	0.03
1412	1st	4.2	4.0	0.03	0.01	0.02	0.09	1.59		
	2nd	4.2	4.0	0.03	0.01	0.02	0.08	1.64		
1711	1st	4.5	4.1	0.18	0.18	0.30*g	0.68*c	1.80		
	2nd	4.5	4.1	0.19	0.18	0.30*g	0.76*c	1.82		
1F02	1st	4.6*c	4.3	0.03	0.05	0.02	0.05	1.53	1.27	0.27
	2nd	4.7*c	4.3	0.05	0.06	0.02	0.04	1.52	1.28	0.27
1804	1st	4.7	4.3	0.07	0.07	0.03	0.05		1.77	0.16
	2nd	4.7	4.3	0.07	0.07	0.03	0.05		1.82	0.21
1427	1st	4.6	4.2	0.02	0.06	0.02	0.01	2.00	1.30	0.70*c
	2nd	4.6	4.1	0.02	0.07	0.02	0.02	2.00	1.50	0.52*c

Note: Asterisk shows outliers judged by the methods of Cochran (c) and Grubbs (g). Ex-H of "1718" were also treated as outliers since they were minus value.

**Table 3.2. Data tested by Cochran's and Grubbs' methods: Soil Sample No.002**

ID	Analysis	pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
1619	1st	4.8	4.1	0.14	0.08	1.10*g	1.10	2.12	1.78	0.34
	2nd	4.8	4.1	0.14	0.09	1.08*g	1.08	2.26	1.88	0.38
1B20	1st	4.9	4.3	0.11	0.20	0.08	0.80	6.23*g	5.08	1.15*g
	2nd	4.9	4.3	0.11	0.19	0.08	0.81	6.23*g	5.06	1.17*g
1F21	1st	4.7	4.4	0.06	0.08	0.10	0.57	4.93*g	4.66	0.27
	2nd	4.7	4.4	0.06	0.08	0.10	0.58	4.84*g	4.53	0.31
1E22	1st	4.9	4.2	0.23	0.14	0.14	1.25	3.31	3.16	0.15
	2nd	4.9	4.2	0.22	0.14	0.14	1.27	3.31	3.16	0.15
1D23	1st	4.5	4.2	0.06	0.10	0.22	1.38	1.31	1.22	0.05
	2nd	4.5	4.2	0.06	0.08	0.20	1.50	1.14	1.20	0.05
1D15	1st	5.0	4.4	0.17	0.10	0.12	0.75	2.92	2.54	0.38
	2nd	5.0	4.4	0.16	0.10	0.12	0.75	2.79	2.41	0.38
1718	1st	4.6	4.2					2.20	3.10*c	0*
	2nd	4.6	4.2					2.50	2.30*c	0*
1810	1st	4.9	4.4					2.04	0.79	0.78
	2nd	4.9	4.4					2.04	0.79	0.78
1714	1st	4.7*c	4.5	1.25*c	0.21	0.31	0.93	2.13	1.99	0.14
	2nd	4.6*c	4.5	1.01*c	0.22	0.30	0.82	2.15	2.01	0.14
1806	1st	5.0	4.4	0.18	0.11	0.21	1.25	0.68	0.63	0.05
	2nd	5.0	4.4	0.18	0.12	0.23	1.37	0.70	0.64	0.06
1412	1st	4.6*c	4.3	0.01	0.02	0.03	0.09	2.07		
	2nd	4.5*c	4.3	0.02	0.03	0.03	0.09	2.07		
1711	1st	4.9	4.3	0.37*g	0.28	0.58*c	1.08	2.15		
	2nd	4.9	4.3	0.39*g	0.29	0.66*c	1.08	2.18		
1F02	1st	5.0	4.5	0.11	0.11	0.11	1.04	2.20	1.93	0.29
	2nd	5.0	4.5	0.13	0.12	0.13	1.05	2.17	1.94	0.26
1804	1st	5.1	4.5	0.14	0.12	0.11	0.22		5.36	0.45*c
	2nd	5.1	4.5	0.13	0.12	0.11	0.25		5.24	0.31*c
1427	1st	4.9	4.3	0.09	0.12	0.14	0.77	2.60	2.00	0.52
	2nd	4.9	4.3	0.09	0.12	0.15	0.84	2.30	1.80	0.45

Note: Asterisk shows outliers judged by the methods of Cochran (c) and Grubbs (g). Ex-H of "1718" were also treated as outliers since they were minus value.

**Table 4.1. Analytical conditions-1**

ID	Extractant used for the analysis					
	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-Acidity	Ex-Al, H
1619	A	A	A	A	B	B
1B20	A	A	A	A	B	B
1F21	A	A	A	A	B	B
1E22	A	A	A	A	B	B
1D23	A	A	A	A	B	B
1D15	A	A	A	A	B	B
1718	-	-	-	-	B	B
1810	-	-	-	-	B	B
1714	A	A	A	A	B	B
1806	A	A	A	A	B	B
1412	A	A	A	A	B	-
1711	A	A	A	A	B	-
1F02	A	A	A	A	B	B
1804	A	A	A	A	-	B
1427	A	A	A	A	B	B

Note: -, Not determined; A, 1M CH<sub>3</sub>COONH<sub>4</sub> (pH 7.0); B, 1M KCl. Shadow cells mean outliers for No.001 and/or 002.

**Table 4.2. Analytical conditions-2**

ID	Analytical methods						Temperature (°C)	
	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-Acidity	Ex-Al	pH 1st analysis	pH 2nd analysis
1619	AAS	AAS	AAS	AAS	Titration	Titration	25	25
1B20	AAS	AAS	AAS	AAS	Titration	Titration	24.5	24.5
1F21	AAS	AAS	AAS	AAS	Titration	Titration	17.9	17.9
1E22	AAS	AAS	AAS	AAS	Titration	Titration	33	33
1D23	FEP	FEP	AAS	AAS	Titration	Titration	26-27	26-27
1D15	ICP-AES	ICP-AES	ICP-AES	ICP-AES	Titration	Titration	20	20
1718	-	-	-	-	Titration	Titration	28.8	28.6
1810	-	-	-	-	Titration	Titration	22.1	21.1
1714	FEP	FEP	Titration	Titration	Titration	Titration	33	33
1806	AAS	AAS	AAS	AAS	Titration	Titration	22	22
1412	AAS	AAS	AAS	AAS	Titration	-	30	30
1711	FEP	FEP	Calc.	Titration	Titration	-	18.4	18.4
1F02	ICP-AES	ICP-AES	ICP-AES	ICP-AES	Titration	Titration	18.7	18.6
1804	FEP	FEP	AAS	AAS	-	Titration	17.5	17.3
1427	AAS	AAS	AAS	AAS	Titration	Titration	25	25

Note: -, Not determined; AAS, Atomic absorption spectrometry; FEP, Flame (emission) photometry; Calc., Calculation from Ex-Ca and hardness; IC, Ion chromatography. Shadow cells mean outliers for No.001 and/or 002.

**Table 5.1. Staff in charge of measurement**

ID	Total	Moisture content	pH	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-Acidity	Ex-Al, H
1619	3	A	A	B	B	B	B	C	C
1B20	2	A	A	A	A	A	A	B	B
1F21	3	A	B	C	C	C	C	A	A
1E22	1	A	A	A	A	A	A	A	A
1D23	3	A	B	C	C	C	C	B	B
1D15	+	+	+	+	+	+	+	+	+
1718	1	A	A	-	-	-	-	A	A
1810	2	A	A	-	-	-	-	B	B
1714	1	A	A	A	A	A	A	A	A
1806	1	A	A	A	A	A	A	A	A
1412	1	A	A	A	A	A	A	A	-
1711	3	A	B	B	B	C	C	C	-
1F02	1	A	A	A	A	A	A	A	A
1804	2	A,B	A,B	A,B	A,B	A,B	A,B	-	A,B
1427	1	A	A	A	A	A	A	A	A

Note: -, Not determined; +, No information; "A", "B", and "C" represent individual staffs in each laboratory who are in charge of measurement. Shadow cells mean outliers for No.001 and/or 002.

**Table 5.2. Years of experience of staff**

ID	Moisture content	pH	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-Acidity	Ex-Al, H
1619	15	15	16	16	16	16	8	8
1B20	2	2	2	2	2	2	2	2
1F21	2	2	5	5	5	5	2	2
1E22	10	10	10	10	10	10	10	10
1D23	20	5	30	30	30	30	5	5
1D15	+	+	+	+	+	+	+	+
1718	2	2	-	-	-	-	2	2
1810	2	2	-	-	-	-	6	6
1714	24	24	24	24	24	24	24	24
1806	4	4	4	4	4	4	4	4
1412	0.5	0.5	1	1	1	1	1	-
1711	1	1	1	1	1	1	1	-
1F02	5	5	5	5	5	5	5	5
1804	7.2	7.2	7.2	7.2	7.2	7.2	-	7.2
1427	1	1	1	1	1	1	1	1

Note: -, Not determined; +, No information. Shadow cells mean outliers for No.001 and/or 002.

### 3.2. Analysis of variance and estimation of precision

For the verified data, not including the outliers judged by Cochran and Grubbs methods, “within-laboratory-precision” and “inter-laboratories-precision” were estimated (Table 6.1 and 6.2. For detailed information of analysis of variance (ANOVA), see Appendix 3 and 4). Ex-H data of minus value from the laboratory “1718” were also treated as outliers.

#### 1) Within-laboratory-precision

Within-laboratory standard deviations were relatively small in all the parameter, and in most parameters, the CVs were less than 10%. Especially in pH (H<sub>2</sub>O) and pH (KCl), the CVs were less than 1%.

As similar to the results of the 1<sup>st</sup> attempt of this project, the within-laboratory-precision (CV) was remarkably lower than the inter-laboratories precision (CV). It was suggested that the results might include data not only in the within-laboratory-reproducibility condition, but also in the repeatability condition. At least, it may be suggested that the participating laboratories could analyze the parameters with their own standard procedures.

#### 2) Inter-laboratories-precision

Inter-laboratories-precision was relatively high in pH (H<sub>2</sub>O) and pH (KCl): CVs were less than 5%. In other parameters except in Ex-acidity, the precision was very low even if variation among the bottles also could affect on the Inter-laboratories-reproducibility (Appendix 5). In Ex-acidity, CVs were relatively low (26 and 31%).

In the 1<sup>st</sup> project, CV for Ex-acidity was low (12.3%) for No. 991 with higher concentration (total average, 5.7 cmol (+)/kg), and significantly high (76.3%) for No. 992 with lower concentration (0.1 cmol (+)/kg). Sample No. 001 and 002 have moderate values: 1.8 and 2.1 cmol (+)/kg, respectively. It seems that the precision was slightly improved for Ex-acidity. Ex-acidity was analyzed by titration method with relatively simple procedures. It may be suggested that some of analysts have been skilled in the procedures in recent years.

As discussed also in the report of the 1<sup>st</sup> project, soil analyses have some steps in the procedures; e.g. extraction, instrumental analysis and/or titration. Therefore, in order to improve the analytical quality, at the first, it should be clarified which steps were most effective. In the future program of the inter-laboratory comparison for soil analysis, effect of each analytical step on the variation among laboratories should be evaluated.

### 3.3. Calculation of permissible tolerance

Permissible tolerances were also shown in Table 6.1 and 6.2.

In pH (H<sub>2</sub>O) and pH (KCl), within-laboratory-reproducibility limits were less than 0.1, and most were zero. It could be a reference value in the repeat analysis of same sample, as discussed in the 1<sup>st</sup> report. For other parameters, the limits also might be available.

Concerning the reproducibility limit, inter-laboratories-precision should be improved for all the parameters, and then the discussion should be carried out.

**Table 6.1. Estimation of precision and determination of permissible tolerance: The verified data of No.001**

		pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
		cmol (+)/kg								
Statistics	Number of data	24	30	24	24	20	16	26	24	22
	Number of laboratory	12	15	11	12	10	8	13	12	11
	Total sum	107.8	124.5	1.6	2.4	1.4	1.0	46.1	37.3	5.7
	Total average	4.5	4.2	0.1	0.1	0.1	0.1	1.8	1.6	0.3
Estimated precision	Within-laboratory standard deviation ( $s_{RW}$ )	0.00	0.03	0.00	0.00	0.00	0.01	0.03	0.06	0.01
	Inter-laboratories standard deviation ( $s_R$ )	0.14	0.14	0.06	0.05	0.06	0.05	0.46	0.54	0.19
	Within-laboratory precision CV (%)	0.00	0.76	6.24	4.15	0.00	11.31	1.83	3.73	5.77
	Inter-laboratories precision CV (%)	3.21	3.47	83.13	51.73	83.57	81.02	25.67	34.72	72.15
Permissible tolerance	Within-laboratory-reproducibility limit ( $R_w$ )	0.00	0.09	0.01	0.01	0.00	0.02	0.09	0.16	0.04
	Reproducibility limit (R)	0.40	0.40	0.16	0.14	0.16	0.14	1.28	1.51	0.52

**Table 6.2. Estimation of precision and determination of permissible tolerance: The verified data of No.002**

		pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
		cmol (+)/kg								
Statistics	Number of data	26	30	22	26	22	26	24	24	20
	Number of laboratory	13	15	11	13	11	13	12	12	10
	Total sum	126.4	130.0	2.6	3.4	3.2	22.7	51.3	61.8	5.9
	Total average	4.9	4.3	0.1	0.1	0.1	0.9	2.1	2.6	0.3
Estimated precision	Within-laboratory standard deviation ( $s_{RW}$ )	0.00	0.00	0.01	0.01	0.01	0.04	0.10	0.06	0.02
	Inter-laboratories standard deviation ( $s_R$ )	0.17	0.12	0.06	0.07	0.08	0.40	0.67	1.61	0.22
	Within-laboratory precision CV (%)	0.00	0.00	5.10	5.02	5.55	4.91	4.75	2.50	7.19
	Inter-laboratories precision CV (%)	3.52	2.85	51.10	51.89	52.75	45.72	31.45	62.67	75.07
Permissible tolerance	Within-laboratory-reproducibility limit ( $R_w$ )	0.00	0.00	0.02	0.02	0.02	0.12	0.28	0.18	0.06
	Reproducibility limit (R)	0.48	0.35	0.17	0.19	0.21	1.12	1.88	4.52	0.62

#### 4. ACKNOWLEDGMENT

ADORC wishes to thank Dr. Tomoyuki Hakamata for support on the preparation of the soil sample and useful advice on the statistical analysis of the data. ADORC thanks also “Tochigi Prefectural Forest Research Center” and “University Forest in Aichi, The University of Tokyo” for their cooperation on the soil sampling.

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- 3) Japanese Standard Association (1991): General rules for permissible tolerance of chemical analyses and physical tests (JIS Z-8402-1991), Japanese Industrial Standard.

#### 6. CONTACT INFORMATION

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## **APPENDIX 1: Participating laboratories**

### **1. CHINA**

- 1) Chong qing Institute of Environmental Science
- 2) Xi'an Environmental Monitoring Station
- 3) Xiamen Environmental Monitoring Central Station
- 4) Zhuhai Environmental Monitoring Station

### **2. INDONESIA**

Soil and Agro-Climate Research Development Centre

### **3. JAPAN**

- 1) Agricultural Experimental Station, Shimane Prefecture
- 2) Gifu Prefectural Research Institute of Health and Environment
- 3) Ecological Impact Research Department, Acid Deposition and Oxidant Research Center (ADORC)

### **4. Republic of KOREA**

Soil Environmental Laboratory, National Institute of Environmental Research

### **5. MALAYSIA**

Department of Environmental Sciences, Universiti Putra Malaysia

### **6. MONGOLIA**

Central Laboratory of Environmental Monitoring

### **7. PHILIPPINES**

Department of Soil Science, University of the Philippines, Los Banos

### **8. RUSSIA**

Limnological Institute Russian Academy of Science/Siberian Branch

### **9. THAILAND**

King Mongkut's University of Technology Thonburi

### **10. VIET NAM**

Water and Atmospheric Environmental Research Center, Institute of Meteorology and Hydrology

**APPENDIX 2.1. Original data: Soil Sample No.001**

ID	Moisture content %	pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H	ECEC	T-C	T-N	Available phosphate	Sulphate	
														P-mg/kg	S-mg/kg	
cmol (+)/kg												g/kg	g/kg	P-mg/kg	S-mg/kg	
1619	1st	1.9	4.5	3.9	0.04	0.10	0.13	0.13	2.08	1.53	0.55	2.48	0.8	0.5	0.6	154.7
	2nd		4.5	3.9	0.04	0.11	0.15	0.15	1.98	1.41	0.57	2.43	0.7	0.5	0.7	149.6
1B20	1st	2.3	4.6	4.2	0.04	0.14	0.07	0.13	2.72	2.24	0.47	3.09	0.9	0.1	1.1	80.3
	2nd		4.7	4.2	0.04	0.14	0.07	0.13	2.72	2.24	0.48	3.10	0.9	0.1	1.2	81.0
1F21	1st	2.7	4.4	4.2	0.04	0.13	0.11	0.02	4.30	3.88	0.43	4.60	1.0	0.5	0.4	13.2
	2nd		4.4	4.3	0.03	0.13	0.11	0.03	4.28	3.84	0.44	4.58	1.0	0.5	0.5	13.2
1E22	1st	2	4.5	4.0	0.16	0.16	0.07	0.25	2.27	2.23	0.05	2.91	14.0	0.4	0.6	108.6
	2nd		4.5	4.0	0.16	0.16	0.07	0.25	2.27	2.23	0.05	2.92	14.0	0.4	0.6	110.3
1D23	1st	1.5	4.0	4.0	0.02	0.07	0.17	0.66	1.12	1.08	0.05	2.04	0.78	0.05	150	153000
	2nd		4.0	4.0	0.02	0.04	0.12	0.51	1.08	1.04	0.05	1.77	0.7	0.04	160	150000
1D15	1st	2.2	4.6	4.2	0.07	0.06	0.03	0.01	2.04	1.64	0.41	2.21				
	2nd		4.6	4.2	0.06	0.06	0.03	0.01	2.04	1.64	0.41	2.21				
1718	1st	1.7	4.4	4.0					1.60	2.30	-0.44					
	2nd		4.4	4.0					1.60	2.40	-0.54					
1810	1st	2.7	4.6	4.4					1.47	0.63	0.18					
	2nd		4.6	4.4					1.55	0.53	0.17					
1714	1st	1.6	4.3	4.2	0.92	0.14	0.18	0.31	1.83	1.60	0.23	3.38	1.9	0.57	0.52	
	2nd		4.3	4.2	1.03	0.13	0.18	0.20	1.75	1.56	0.19	3.29	1.9	0.54	0.59	
1806	1st	2.1	4.6	4.3	0.11	0.07	0.15	0.36	1.06	1.04	0.02	1.75	6.99	4.58		
	2nd		4.6	4.2	0.12	0.07	0.15	0.37	1.05	1.02	0.03	1.76	7.68	3.23		
1412	1st	2.0	4.2	4.0	0.03	0.01	0.02	0.09	1.59			1.74	0.1	0.1		
	2nd		4.2	4.0	0.03	0.01	0.02	0.08	1.64			1.78	0.1	0.1		
1711	1st	1.5	4.5	4.1	0.18	0.18	0.30	0.68	1.80			3.14				
	2nd		4.5	4.1	0.19	0.18	0.30	0.76	1.82			3.25				
1F02	1st	1.6	4.6	4.3	0.03	0.05	0.02	0.05	1.53	1.27	0.27	1.68				163
	2nd		4.7	4.3	0.05	0.06	0.02	0.04	1.52	1.28	0.27	1.69				163
1804	1st	2.2	4.7	4.3	0.07	0.07	0.03	0.05		1.77	0.16	2.15	8.13	1.09	4.16	299.5
	2nd		4.7	4.3	0.07	0.07	0.03	0.05		1.82	0.21	2.25	8.31	1.06	4.1	315
1427	1st	2.4	4.6	4.2	0.02	0.06	0.02	0.01	2.00	1.30	0.70	2.11				
	2nd		4.6	4.1	0.02	0.07	0.02	0.02	2.00	1.50	0.52	2.12				

**APPENDIX 2.2. Original data: Soil Sample No.002**

ID	Moisture content %	pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H	ECEC	T-C	T-N	Available phosphate	Sulphate	
														P-mg/kg	S-mg/kg	
cmol (+)/kg												g/kg	g/kg	P-mg/kg	S-mg/kg	
1619	1st	20.5	4.8	4.1	0.14	0.08	1.10	1.10	2.12	1.78	0.34	4.54	120.7	7.7	11.1	299.4
	2nd		4.8	4.1	0.14	0.09	1.08	1.08	2.26	1.88	0.38	4.65	120.3	7.8	10.9	294.6
1B20	1st	27.8	4.9	4.3	0.11	0.20	0.08	0.80	6.23	5.08	1.15	7.42	12.3	5.8	3.0	90.8
	2nd		4.9	4.3	0.11	0.19	0.08	0.81	6.23	5.06	1.17	7.42	12.0	5.7	2.9	88.6
1F21	1st	28.8	4.7	4.4	0.06	0.08	0.10	0.57	4.93	4.66	0.27	5.74	13.1	7.6	38.6	15.4
	2nd		4.7	4.4	0.06	0.08	0.10	0.58	4.84	4.53	0.31	5.66	14.0	7.7	36.5	15.7
1E22	1st	2.1	4.9	4.2	0.23	0.14	0.14	1.25	3.31	3.16	0.15	5.07	212.2	6.7	3.4	46.6
	2nd		4.9	4.2	0.22	0.14	0.14	1.27	3.31	3.16	0.15	5.08	212.2	6.9	3.4	46.6
1D23	1st	16.6	4.5	4.2	0.06	0.10	0.22	1.38	1.31	1.22	0.05	3.07	13.92	0.71	80	40000
	2nd		4.5	4.2	0.06	0.08	0.20	1.50	1.14	1.20	0.05	2.98	13.64	0.71	100	37000
1D15	1st	26.8	5.0	4.4	0.17	0.10	0.12	0.75	2.92	2.54	0.38	4.05				
	2nd		5.0	4.4	0.16	0.10	0.12	0.75	2.79	2.41	0.38	3.91				
1718	1st	22.2	4.6	4.2					2.20	3.10	-0.75					
	2nd		4.6	4.2					2.50	2.30	-0.60					
1810	1st	28.7	4.9	4.4					2.04	0.79	0.78					
	2nd		4.9	4.4					2.04	0.79	0.78					
1714	1st	23.4	4.7	4.5	1.25	0.21	0.31	0.93	2.13	1.99	0.14	4.83	25.7	7.84	0.84	
	2nd		4.6	4.5	1.01	0.22	0.30	0.82	2.15	2.01	0.14	4.50	30.5	7.72	1.06	
1806	1st	21.3	5.0	4.4	0.18	0.11	0.21	1.25	0.68	0.63	0.05	2.43	123.35	24.83		
	2nd		5.0	4.4	0.18	0.12	0.23	1.37	0.70	0.64	0.06	2.60	124.71	20.94		
1412	1st	23.8	4.6	4.3	0.01	0.02	0.03	0.09	2.07			2.22	2.2	0.7		
	2nd		4.5	4.3	0.02	0.03	0.03	0.09	2.07			2.24	2.2	0.7		
1711	1st	11.2	4.9	4.3	0.37	0.28	0.58	1.08	2.15			4.46				
	2nd		4.9	4.3	0.39	0.29	0.66	1.08	2.18			4.60				
1F02	1st	18.7	5.0	4.5	0.11	0.11	0.11	1.04	2.20	1.93	0.29	3.57				400
	2nd		5.0	4.5	0.13	0.12	0.13	1.05	2.17	1.94	0.26	3.60				390
1804	1st	21.3	5.1	4.5	0.14	0.12	0.11	0.22		5.36	0.45	6.40	72.2	4.85	9.43	717.3
	2nd		5.1	4.5	0.13	0.12	0.11	0.25		5.24	0.31	6.16	71.3	4.79	9.32	724.2
1427	1st	27.2	4.9	4.3	0.09	0.12	0.14	0.77	2.60	2.00	0.52	3.72				
	2nd		4.9	4.3	0.09	0.12	0.15	0.84	2.30	1.80	0.45	3.50				

**APPENDIX 3.1. ANOVA , estimation of precision and determination of permissible tolerance: The verified data of No.001**

		pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
				cmol (+)/kg						
Statistics	Number of data	24	30	24	24	20	16	26	24	22
	Number of laboratory	12	15	11	12	10	8	13	12	11
	Total sum	107.8	124.5	1.6	2.4	1.4	1.0	46.1	37.3	5.7
	Total average	4.5	4.2	0.1	0.1	0.1	0.1	1.8	1.6	0.3
ANOVA	Total sum of square (S <sub>T</sub> )	0.46	0.60	0.06	0.06	0.06	0.04	4.99	6.45	0.70
	Sum of square inter-labotatories (S <sub>R</sub> )	0.46	0.58	0.06	0.06	0.06	0.04	4.98	6.41	0.70
	Sum of square within-labotatory (S <sub>RW</sub> = S <sub>T</sub> - S <sub>R</sub> )	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.04	0.00
	Total degree of freedom (Φ <sub>T</sub> )	23	29	23	23	19	15	25	23	21
	Inter-laboratories degree of freedom (Φ <sub>R</sub> )	11	14	10	11	9	7	12	11	10
	Within-laboratory-reproducibility degree of freedom (Φ <sub>RW</sub> )	12	15	11	12	10	8	13	12	11
	Inter-laboratories variance (V <sub>R</sub> = S <sub>R</sub> /Φ <sub>R</sub> )	0.04	0.04	0.01	0.01	0.01	0.01	0.41	0.58	0.07
Within-laboratory-reproducibility Variance (V <sub>RW</sub> = S <sub>RW</sub> /Φ <sub>RW</sub> )	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Estimated precision	Laboratory component of variance (s <sub>b</sub> <sup>2</sup> = (V <sub>R</sub> - V <sub>RW</sub> )/2)	0.02	0.02	0.00	0.00	0.00	0.00	0.21	0.29	0.03
	Within-laboratory standard deviation (s <sub>RW</sub> = SQRT(V <sub>RW</sub> ))	0.00	0.03	0.00	0.00	0.00	0.01	0.03	0.06	0.01
	Inter-laboratories standard deviation (s <sub>R</sub> = SQRT(s <sub>b</sub> <sup>2</sup> + s <sub>RW</sub> <sup>2</sup> /2)	0.14	0.14	0.06	0.05	0.06	0.05	0.46	0.54	0.19
	Within-laboratory precision CV (%)	0.00	0.76	6.24	4.15	0.00	11.31	1.83	3.73	5.77
	Inter-laboratories precision CV (%)	3.21	3.47	83.13	51.73	83.57	81.02	25.67	34.72	72.15
Permissible tolerance	Within-laboratory-reproducibility limit (R <sub>W</sub> = D (2, 0.95) s <sub>RW</sub> )	0.00	0.09	0.01	0.01	0.00	0.02	0.09	0.16	0.04
	Reproducibility limit (R = D (2, 0.95) s <sub>R</sub> )	0.40	0.40	0.16	0.14	0.16	0.14	1.28	1.51	0.52

Note: ANOVA was carried out according to the Annex II of the Technical Manual for Soil and Vegetation Monitoring in East Asia (2000).

**APPENDIX 3.2. ANOVA , estimation of precision and determination of permissible tolerance: The verified data of No.002**

		pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
				cmol (+)/kg						
Statistics	Number of data	26	30	22	26	22	26	24	24	20
	Number of laboratory	13	15	11	13	11	13	12	12	10
	Total sum	126.4	130.0	2.6	3.4	3.2	22.7	51.3	61.8	5.9
	Total average	4.9	4.3	0.1	0.1	0.1	0.9	2.1	2.6	0.3
ANOVA	Total sum of square (S <sub>T</sub> )	0.70	0.43	0.07	0.11	0.12	3.85	10.08	57.34	0.90
	Sum of square inter-labotatories (S <sub>R</sub> )	0.70	0.43	0.07	0.11	0.11	3.83	9.96	57.29	0.89
	Sum of square within-labotatory (S <sub>RW</sub> = S <sub>T</sub> - S <sub>R</sub> )	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.05	0.00
	Total degree of freedom (Φ <sub>T</sub> )	25	29	21	25	21	25	23	23	19
	Inter-laboratories degree of freedom (Φ <sub>R</sub> )	12	14	10	12	10	12	11	11	9
	Within-laboratory-reproducibility degree of freedom (Φ <sub>RW</sub> )	13	15	11	13	11	13	12	12	10
	Inter-laboratories variance (V <sub>R</sub> = S <sub>R</sub> /Φ <sub>R</sub> )	0.06	0.03	0.01	0.01	0.01	0.32	0.91	5.21	0.10
Within-laboratory-reproducibility Variance (V <sub>RW</sub> = S <sub>RW</sub> /Φ <sub>RW</sub> )	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	
Estimated precision	Laboratory component of variance (s <sub>b</sub> <sup>2</sup> = (V <sub>R</sub> - V <sub>RW</sub> )/2)	0.03	0.02	0.00	0.00	0.01	0.16	0.45	2.60	0.05
	Within-laboratory standard deviation (s <sub>RW</sub> = SQRT(V <sub>RW</sub> ))	0.00	0.00	0.01	0.01	0.01	0.04	0.10	0.06	0.02
	Inter-laboratories standard deviation (s <sub>R</sub> = SQRT(s <sub>b</sub> <sup>2</sup> + s <sub>RW</sub> <sup>2</sup> /2)	0.17	0.12	0.06	0.07	0.08	0.40	0.67	1.61	0.22
	Within-laboratory precision CV (%)	0.00	0.00	5.10	5.02	5.55	4.91	4.75	2.50	7.19
	Inter-laboratories precision CV (%)	3.52	2.85	51.10	51.89	52.75	45.72	31.45	62.67	75.07
Permissible tolerance	Within-laboratory-reproducibility limit (R <sub>W</sub> = D (2, 0.95) s <sub>RW</sub> )	0.00	0.00	0.02	0.02	0.02	0.12	0.28	0.18	0.06
	Reproducibility limit (R = D (2, 0.95) s <sub>R</sub> )	0.48	0.35	0.17	0.19	0.21	1.12	1.88	4.52	0.62

Note: ANOVA was carried out according to the Annex II of the Technical Manual for Soil and Vegetation Monitoring in East Asia (2000).

**APPENDIX 4.1. ANOVA , estimation of precision and determination of permissible tolerance: All the data of No.001**

		pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
				cmol (+)/kg						
Statistics	Number of data	30	30	26	26	26	26	28	26	24
	Number of laboratory	15	15	13	13	13	13	14	13	12
	Total sum	134.4	124.5	3.6	2.5	2.6	5.4	54.7	45.0	6.9
	Total average	4.5	4.2	0.1	0.1	0.1	0.2	2.0	1.7	0.3
ANOVA	Total sum of square (S <sub>T</sub> )	1.05	0.60	1.59	0.06	0.17	1.26	16.74	16.26	0.94
	Sum of square inter-labotatories (S <sub>R</sub> )	1.04	0.58	1.59	0.06	0.17	1.24	16.73	16.22	0.92
	Sum of square within-labotatory (S <sub>RW</sub> = S <sub>T</sub> - S <sub>R</sub> )	0.01	0.01	0.01	0.00	0.00	0.02	0.01	0.04	0.02
	Total degree of freedom (Φ <sub>T</sub> )	29	29	25	25	25	25	27	25	23
	Inter-laboratories degree of freedom (Φ <sub>R</sub> )	14	14	12	12	12	12	13	12	11
	Within-laboratory-reproducibility degree of freedom (Φ <sub>RW</sub> )	15	15	13	13	13	13	14	13	12
	Inter-laboratories variance (V <sub>R</sub> = S <sub>R</sub> /Φ <sub>R</sub> )	0.07	0.04	0.13	0.01	0.01	0.10	1.29	1.35	0.08
Within-laboratory-reproducibility Variance (V <sub>RW</sub> = S <sub>RW</sub> /Φ <sub>RW</sub> )	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Estimated precision	Laboratory component of variance (s <sub>b</sub> <sup>2</sup> = (V <sub>R</sub> - V <sub>RW</sub> )/2)	0.04	0.02	0.07	0.00	0.01	0.05	0.64	0.67	0.04
	Within-laboratory standard deviation (s <sub>RW</sub> = SQRT(V <sub>RW</sub> ))	0.03	0.03	0.02	0.01	0.01	0.04	0.03	0.06	0.04
	Inter-laboratories standard deviation (s <sub>R</sub> = SQRT(s <sub>b</sub> <sup>2</sup> + s <sub>RW</sub> <sup>2</sup> /2)	0.19	0.14	0.26	0.05	0.08	0.23	0.80	0.82	0.20
	Within-laboratory precision CV (%)	0.58	0.76	16.13	7.44	10.68	19.51	1.62	3.25	13.69
	Inter-laboratories precision CV (%)	4.30	3.47	186.14	52.81	84.34	110.48	41.05	47.48	71.13
Permissible tolerance	Within-laboratory-reproducibility limit (R <sub>W</sub> = D (2, 0.95) s <sub>RW</sub> )	0.07	0.09	0.06	0.02	0.03	0.11	0.09	0.16	0.11
	Reproducibility limit (R = D (2, 0.95) s <sub>R</sub> )	0.54	0.40	0.72	0.14	0.23	0.64	2.25	2.30	0.57

Note: ANOVA was carried out according to the Annex II of the Technical Manual for Soil and Vegetation Monitoring in East Asia (2000).

**APPENDIX 4.2. ANOVA , estimation of precision and determination of permissible tolerance: All the data of No.002**

		pH(H <sub>2</sub> O)	pH(KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-acidity	Ex-Al	Ex-H
				cmol (+)/kg						
Statistics	Number of data	30	30	26	26	26	26	28	26	24
	Number of laboratory	15	15	13	13	13	13	14	13	12
	Total sum	144.8	130.0	5.6	3.4	6.6	22.7	73.6	67.2	9.0
	Total average	4.8	4.3	0.2	0.1	0.3	0.9	2.6	2.6	0.4
ANOVA	Total sum of square (S <sub>T</sub> )	0.96	0.43	2.04	0.11	2.05	3.85	51.96	57.69	2.26
	Sum of square inter-labotatories (S <sub>R</sub> )	0.95	0.43	2.01	0.11	2.05	3.83	51.83	57.32	2.25
	Sum of square within-labotatory (S <sub>RW</sub> = S <sub>T</sub> - S <sub>R</sub> )	0.01	0.00	0.03	0.00	0.00	0.02	0.13	0.37	0.01
	Total degree of freedom (Φ <sub>T</sub> )	29	29	25	25	25	25	27	25	23
	Inter-laboratories degree of freedom (Φ <sub>R</sub> )	14	14	12	12	12	12	13	12	11
	Within-laboratory-reproducibility degree of freedom (Φ <sub>RW</sub> )	15	15	13	13	13	13	14	13	12
	Inter-laboratories variance (V <sub>R</sub> = S <sub>R</sub> /Φ <sub>R</sub> )	0.07	0.03	0.17	0.01	0.17	0.32	3.99	4.78	0.20
Within-laboratory-reproducibility Variance (V <sub>RW</sub> = S <sub>RW</sub> /Φ <sub>RW</sub> )	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	
Estimated precision	Laboratory component of variance (s <sub>b</sub> <sup>2</sup> = (V <sub>R</sub> - V <sub>RW</sub> )/2)	0.03	0.02	0.08	0.00	0.09	0.16	1.99	2.37	0.10
	Within-laboratory standard deviation (s <sub>RW</sub> = SQRT(V <sub>RW</sub> ))	0.03	0.00	0.05	0.01	0.02	0.04	0.10	0.17	0.03
	Inter-laboratories standard deviation (s <sub>R</sub> = SQRT(s <sub>b</sub> <sup>2</sup> + s <sub>RW</sub> <sup>2</sup> /2)	0.18	0.12	0.29	0.07	0.29	0.40	1.41	1.55	0.32
	Within-laboratory precision CV (%)	0.53	0.00	22.00	5.02	7.02	4.91	3.64	6.53	9.28
	Inter-laboratories precision CV (%)	3.81	2.85	133.82	51.89	115.44	45.72	53.74	59.79	85.14
Permissible tolerance	Within-laboratory-reproducibility limit (R <sub>w</sub> = D (2, 0.95) s <sub>RW</sub> )	0.07	0.00	0.13	0.02	0.05	0.12	0.27	0.47	0.10
	Reproducibility limit (R = D (2, 0.95) s <sub>R</sub> )	0.52	0.35	0.81	0.19	0.82	1.12	3.95	4.33	0.89

Note: ANOVA was carried out according to the Annex II of the Technical Manual for Soil and Vegetation Monitoring in East Asia (2000).

**APPENDIX 5. Variation of chemical properties among bottles**

Sample No	Serial NO.	Moisture content (%)	pH (H <sub>2</sub> O)	pH (KCl)	Ex-Na	Ex-K	Ex-Mg	Ex-Ca	Ex-Al	Ex-H
					cmol(+)/kg					
No.001	001-015	2.7	4.7	4.1	0.05	0.08	0.03	0.08	1.59	0.31
	001-035	2.6	4.7	4.2	0.05	0.07	0.03	0.11	1.56	0.34
	001-055	2.4	4.7	4.2	0.05	0.06	0.03	0.09	1.57	0.33
	001-075	2.4	4.7	4.2	0.05	0.06	0.03	0.15	1.54	0.31
	001-095	2.5	4.7	4.2	0.05	0.06	0.03	0.09	1.57	0.28
	Mean	2.5	4.7	4.2	0.05	0.07	0.03	0.11	1.57	0.31
	Standard deviation	0.1	0.0	0.0	0.00	0.01	0.00	0.03	0.02	0.02
	CV (%)	3.9	0.3	0.8	2.50	8.42	1.43	27.06	1.16	7.33
No.002	002-015	27.0	5.0	4.4	0.15	0.11	0.14	1.02	2.15	0.39
	002-035	27.3	5.0	4.4	0.16	0.11	0.14	0.93	2.15	0.40
	002-055	27.6	5.0	4.3	0.15	0.12	0.14	1.02	2.16	0.40
	002-075	27.2	5.0	4.3	0.16	0.12	0.14	1.05	2.14	0.41
	002-095	27.3	5.0	4.4	0.16	0.12	0.13	1.09	2.14	0.41
	Mean	27.3	5.0	4.4	0.15	0.12	0.14	1.02	2.15	0.40
	Standard deviation	0.2	0.0	0.0	0.00	0.01	0.00	0.06	0.01	0.01
	CV (%)	0.8	0.1	0.5	2.61	4.73	1.44	5.79	0.39	2.08