A PRELIMINARY STUDY OF RISK ASSESSMENT FOR POTENTIAL PCBs CONTAMINATED SITE IN KOREA

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Introduction

Polychlorinated biphenyls(PCBs) is generally environmentally persistent and can heavily contaminate soil. In this study, we suggested a preliminary risk assessment procedure for potential PCBs-contaminated sites in Korea.

Materials and methods

Site selection and soil sampling

One site (a site within insulating oil recycling facility) was selected for this study from several potential PCBs-contaminated sites in South Korea (Figure 1)[1]. Six points were sampled with eight depth intervals (48 sampling in total). Sampling depths were 0~15 cm for topsoil, and, for subsurface soil, 15~30 cm,30~50 cm,50~70 cm,70~100 cm,100~130 cm,130~160 cm,and 160~200 cm.

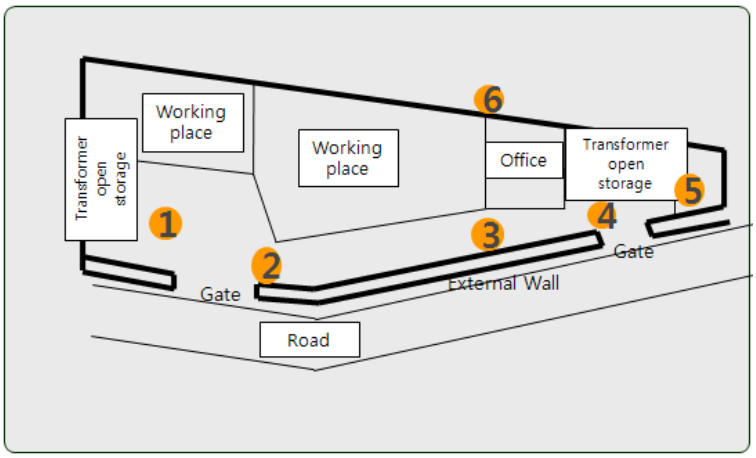

Figure 1. The site map and location of sampling points

Soil characteristics

Soil pH was analyzed using Korean Soil Contamination Public Testing Protocol [2] and organic matter content was measured through Walkley-Black method[3]. Texture was analyzed using pipette method[3] and determined using USDA texture triangle.

PCBs contamination characteristics

Three analyses (i.e., total PCBs, homologue, and congener) were conducted to identify the PCBs contamination characteristics in the site. Total PCBs were analyzed using Korean Persistent Organic Pollutant Public Testing Protocol[4] and Endocrine DisruptingChemical Analysis Protocol[5]. Homologue and congener analyses were conducted using EPA 8082a method.

Preliminary risk assessment

A couple of preliminary risk assessments were conducted using total PCBs and congener analysis, respectively. Using total PCBs data, a preliminary risk assessment was conducted via Japanese GERAS risk assessment tool[6]. Another preliminary risk assessment was conducted via CSOIL model[7]using congener analysis data.

Results and discussion

Soil characteristics

The range of soil pH in the site was 4.5 to 6.4 and that of soil organic content was 0.2 to 3.4 percentages (Table 1). Soil texture was mostly sandy loam and its clay content was 8 to 13 percentages.

Table 1. Soil characteristics of the site

Sampling points	Soil pH	Organic matter content (%)	Soil Texture			
			Sand(%)	Silt(%)	Clay(%)	Texture
1	5.62	3.42	65	25	10	Sandy loam
2	5.43	0.20	61	31	8	Sandy loam
3	6.44	1.05	62	28	11	Sandy loam
4	5.00	1.08	61	27	13	Sandy loam
5	6.08	0.80	60	28	12	Sandy loam
6	4.50	0.90	45	32	23	Loam

PCBs contamination characteristics

The PCBs were detected in three sampling points among six sampling points and the concentration of total PCBs ranged from N.D. to 0.744 mg/kg (Table 2). Furthermore, PCBs were detected down to 50 cm depth,probably suggesting that concrete pavement within the site might limit PCBs spreading into deeper subsoil.

Table 2. Total PCBs concentrations of the site

Sampling points	Soil depth	Conc. of total PCBs (mg/kg)	Sampling points	Soil depth	Conc. of total PCBs (mg/kg)
1	0~15cm	0.241	4	0~15cm	N.D.
	15~30cm	N.D.		15~30cm	N.D.
	30~50cm	N.D.		30~50cm	N.D.
	50~70cm	N.D.		50~70cm	N.D.
	70~100cm	N.D.		70~100cm	N.D.
	100~130cm	N.D.		100~130cm	N.D.
	130~160cm	N.D.		130~160cm	N.D.
	160~200cm	N.D.		160~200cm	N.D.
2	0~15cm	N.D.	5	0~15cm	0.097
	15~30cm	N.D.		15~30cm	0.022
	30~50cm	N.D.		30~50cm	N.D.
	50~70cm	N.D.		50~70cm	N.D.
	70~100cm	N.D.		70~100cm	N.D.
	100~130cm	N.D.		100~130cm	N.D.
	130~160cm	N.D.		130~160cm	N.D.
	160~200cm	N.D.		160~200cm	N.D.
3	0~15cm	0.744	6	0~15cm	N.D.
	15~30cm	0.277		15~30cm	N.D.
	30~50cm	0.001		30~50cm	N.D.
	50~70cm	N.D.		50~70cm	N.D.
	70~100cm	N.D.		70~100cm	N.D.
	100~130cm	N.D.		100~130cm	N.D.

	130~160cm	N.D.	130~160cm	N.D.
	160~200cm	N.D.	160~200cm	N.D.

Concentrations of each PCB homologue group for three sampling points are listed in Table 3. Since penta-, hexa-, hepta-, and octa- PCB homologues were detected, dioxin-like PCB congeners appears to be present in the site. Furthermore, the PCB congener analysis shows that congener distribution patterns of three sampling points were very similar to those of Aroclor 1254 and 1260 (Figure 2). Both homologue and congener analyses indicates that dioxin-like congeners can be present in the site.

Table 3. Concentration of each PCB homologue group for three sampling points

Homologue Groups	SA-1 (0-15cm) (μg/kg)	SA-3 (0-15cm) (μg/kg)	SA-5 (0-15cm) (μg/kg)
1 chlorine	0	0	0
2 chlorines	0	0	0
3 chlorines	0	0	0
4 chlorines	0	0	0
5 chlorines	58	80	6
6 chlorines	94	256	45
7 chlorines	85	333	48
8 chlorines	4	75	1
9 chlorines	0	0	0
10 chlorines	0	0	0

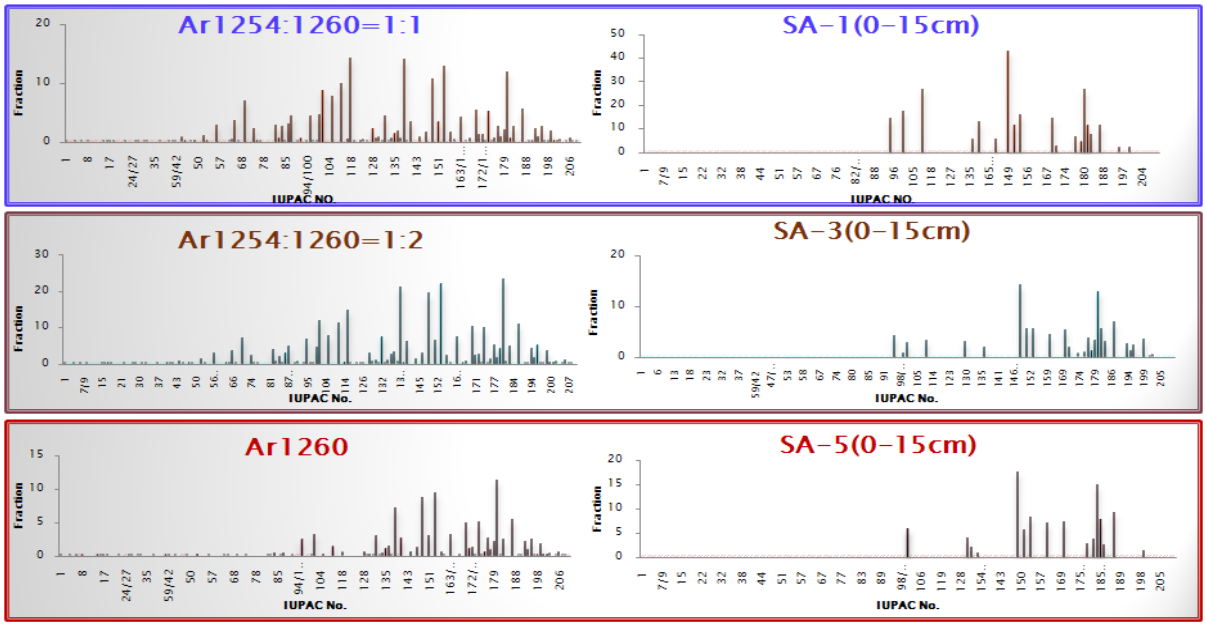

Figure 2. Distribution patterns of PCB congeners for three sampling points

Preliminary risk assessment

(Exposure route analysis) Maximum concentration (0.744 mg/kg) among total PCBs concentration values in the site was selected for the PCBs concentration in the site for GERAS model. Also, for CSOIL model, concentrations of seven PCB congeners were used for the PCBs concentration in the site. Since groundwater in the site was not used for drinking, exposure routes were determined to dermal contact, inhalation, and ingestion, with taking into account of site characteristics and receptors together. Data for soil characteristics were from measured data in the site, while values of other exposure factors were chosen from values of the Korean Guideline for Soil Risk Assessment and default values of the models used.
(Toxicity assessment and risk characterization) Preliminary risk assessment was reviewed mostly with regard to carcinogenic risk. Acceptable risk was 10^{-5} in GERAS model and 10^{-4} in CSOIL model. Its value can be chosen from the range from 10^{-4} to 10^{-6}in the Korean Guideline for Soil Risk Assessment. Using the GERAS model, we conducted the risk assessment for total PCBs analysis. We found that carcinogenic risk in the site ranged from $3.9x10^{-6}$ to $2.0x10^{-7}$, much smaller than acceptable risk ($1.0x10^{-5}$). Furthermore, using the CSOIL model, we conducted the risk assessment for PCB congener analysis. We found that risk index was 0.03, much lower than acceptable risk index (1.0).

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