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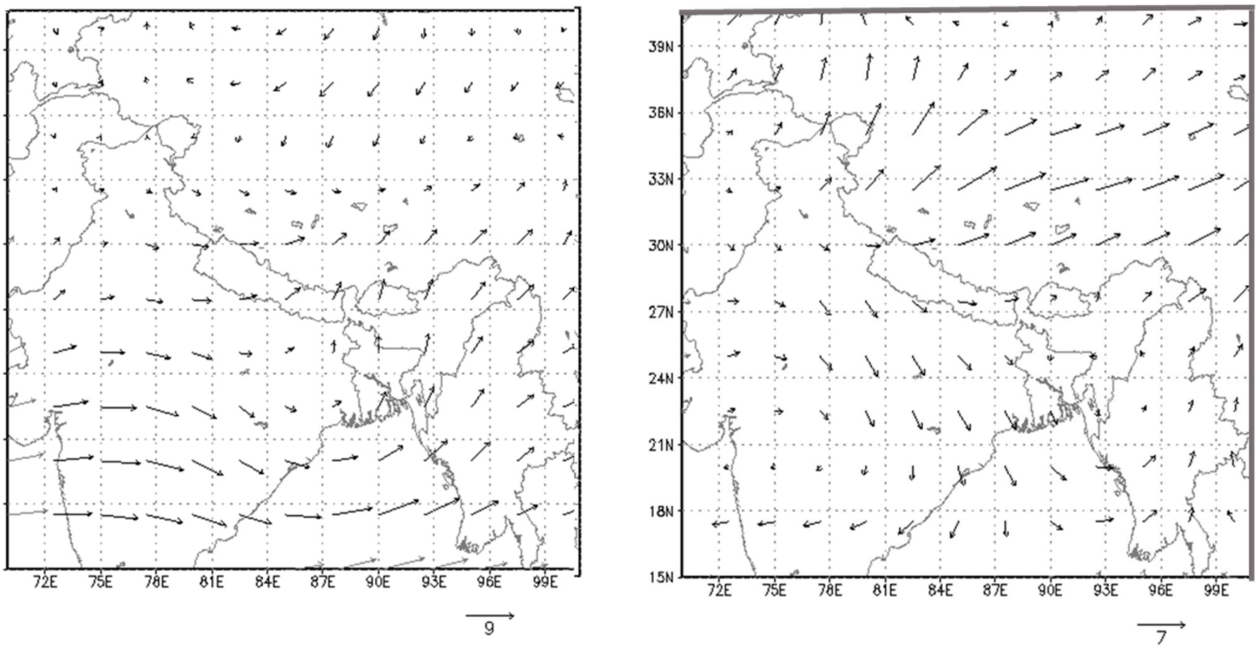
Atmospheric organochlorine pesticides and polychlorinated biphenyls in urban areas of Nepal: spatial variation, sources, temporal trends, and long-range transport potential

Balram Pokhrel et al.

Correspondence to: Xiaoping Wang (wangxp@itpcas.ac.cn)

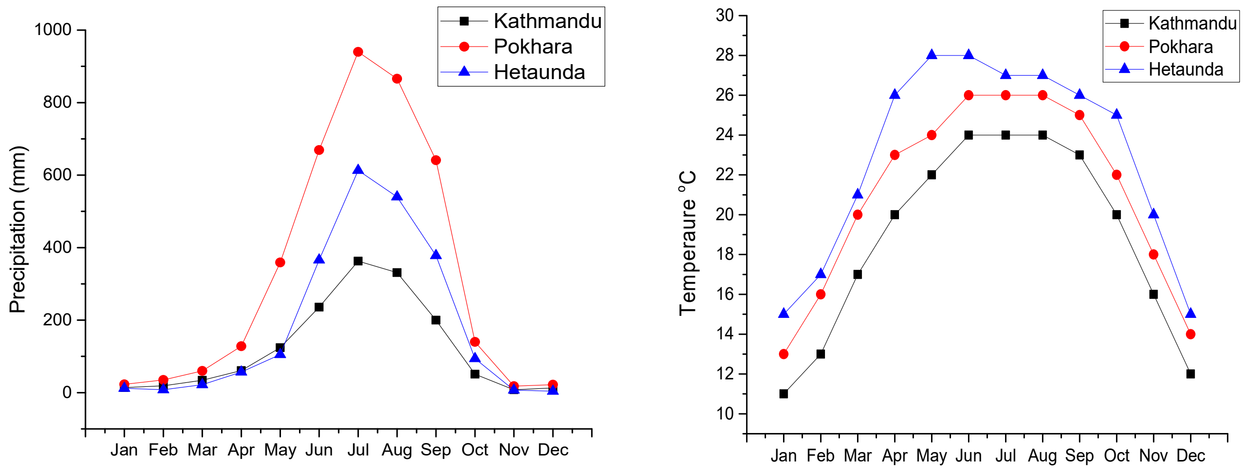
Text SI-1. Description about the Study area

Kathmandu (1350m asl) located in mountain valley is the capital city of Nepal, with very dense population (an area of 642 sq. km, population =2.5 million,). Agriculture, industry (instant food, clothes, bricks), and tourism are the major economy of Kathmandu. Pokhara (750-1050m asl) is second largest city after Kathmandu, covering an area of 225 sq. km with a population of 0.3 million. Hetauda (100m) is relatively small with 135,475 populations. Different from Kathmandu, Pokhara and Hetauda are agricultural cities, with large area of crop and vegetable production place and market. Climate of these 3 cities are commonly influenced by the Indian monsoon in summer and westerlies (south branch) in winter. Summer is warm and wet particularly in July-August but winter is dry and cold. Among the cities, Hetauda is warmest followed by Pokhara and Kathmandu, whereas annual rainfall follows the order Pokhara (~3900mm) >Hetauda (~2250mm) > Kathmandu (1450mm).



(a) **(b)**

Figure SI-1. Wind field of over Nepal; a. Indian monsoon (June to September) b. Winter (October to January)



(a) **(b)**

Figure SI-2. Monthly average of (a) precipitation and (b) temperature variation in 3 cities of Nepal (Data source: Department of Hydrology and Meteorology, Nepal)

Table SI-1. Details of PUF-PAS sampling sites in the three major cities of Nepal

PAS	Land type	Latitude N	Longitude E	Altitude	Site description
Kathmandu (27° 42'N; 85° 18'E)					
K1	Cropland	27° 36' 38.92"	85° 21' 30.79"	1433	Sub-urban site, south of the Kathmandu valley, produce maize, rice
K2	Market area	27° 42' 12.42"	85° 18' 38.34"	1311	Major vegetable market of the capital city
K3	Industrial area	27° 43' 53.69"	85° 17' 54.28"	1315	Industrial area in the north of Kathmandu city
K4	Tourist	27° 42' 35.68"	85° 20' 43.87"	1318	A famous religious place for Hindu people, one of UNESCO-world heritage site
K5	Residential	27° 41' 13.45"	85° 18' 8.71"	1293	Residential area in Kathmandu
K6	Farm/Industrial	27° 40' 12.11"	85° 25' 31.73"	1348	Eastern part of Kathmandu valley, mix of farm land and industrial plants
Pokhara (28°15'N; 83°58'E)					
P1	Cropland	28°16'52.51"	83°55'44.17''	1065	Suburban region, famous for maize, paddy production
P2	Vegetable production area (market)	28°13'39.01"	83°58'56.18''	871	Major market area on one side, vegetable production area on the other side
P3	Industrial area	28°12'51.39"	84°00'37.58''	813	Industrial area for making chocolate and noodles
P4	Tourist place	28°12'47.35"	83°57'41.88''	781	East bank of Phewa lake, a famous tourist destination
Hetauda (27°25'N; 85°02'E)					
H1	Cropland	27°23'26.88"	85°02'38.64"	512	A rural village with seasonal farming mostly rice, wheat and mustard
H2	Vegetable production area	27°25'8.40"	85°02'28.20"	459	Vegetable production area and market, mainly for commercial purpose
H3	Industrial area	27°24'6.78"	85°01'32.34"	436	Industrial area for instant food

Table SI-2. PUF-PAS sampling time

Kathmandu and Pokhara (2014-08 to 2015-08)			Hetaunda (2015-11 to 2016-11)		
SN	Period	total days	SN	Period	total days
1	2014-08-19 to 2014-10-12	55	1	2015-11-06 to 2016-01-06	62
2	2014-10-12 to 2014-12-11	61	2	2016-01-06 to 2016-03-05	59
3	2014-12-11 to 2015-02-03	65	3	2016-03-05 to 2016-05-07	64
4	2015-02-03 to 2015- 04-18	65	4	2016-05-07 to 2016-07-09	63
5	2015-04-18 to 2015-06-16	57	5	2016-07-09 to 2016-09-10	63
6	2015-06-13 to 2015-08-15	64	6	2016-09-10 to 2016-11-10	62

Text SI-2. Chemical cleanup procedure

Each extract was concentrated using rotary evaporator and solvent exchanged to hexane. The concentrated extract was loaded on the top of a chromatography column (from the top to bottom: 1 cm of anhydrous Na_2SO_4, 2g activated alumina, and 3g activated silica gel), and eluted with 30 mL mixture of DCM and hexane (1:1). The volume of eluate was reduced under gentle stream of high purity nitrogen to about 1ml and added 20µl internal standard containing a known quantity of pentachloronitrobenzene (PCNB) and decachlorobiphenyl (PCB-209). Finally, the volume was reduced to 100 µl under gentle stream of nitrogen before analysis.

Text SI-3. Details about the gas chromatography temperature program

Helium was used as the carrier gas at 1 mL min^{-1} under constant-flow mode. The oven temperature began at 100 °C for 2 min, ramped up at a rate of 20°C min^{-1} to 140°C, at 4°C min^{-1} to 200°C (10 min hold time), then at 4°C min^{-1} to 310°C and held for 5 min.

Table SI-3. Data of Field blanks and Method detection limits (MDL) ng/PAS

	Kathmandu					Pokhara			Hetauda			MDL*		
	Kfb-1	Kfb-2	Kfb-3	Kfb-4	Kfb-5	Pfb-1	Pfb-2	Pfb-3	Hfb-1	Hfb-2	Hfb-3	Ktm	Pkr	Het
o,p'-DDT	0.14	ND	ND	ND	ND	ND	ND	0.01	ND	ND	ND	0.11	0.01	0.01
p,p'-DDT	0.02	ND	ND	ND	ND	ND	ND	0.06	0.02	0.01	0.01	0.02	0.06	0.02
o,p'-DDE	0.17	ND	ND	ND	ND	ND	ND	ND	0.02	0.01	0.02	0.14	0.18	0.03
p,p'-DDE	1.53	ND	ND	0.01	0.03	0.02	0.04	0.06	0.02	0.01	0.01	1.27	0.06	0.03
o,p'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.22	0.22	0.01
p,p'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.03	0.03	0.01
α-HCH	0.05	ND	ND	0.01	0.02	0.02	0.01	ND	0.02	0.07	ND	0.04	0.02	0.13
β-HCH	0.31	0.11	ND	0.06	0.02	0.06	0.04	0.04	ND	ND	ND	0.27	0.07	0.22
γ-HCH	0.19	ND	ND	0.01	0.06	0.03	0.01	0.01	ND	0.01	0.02	0.16	0.03	0.01
δ-HCH	0.02	ND	0	ND	ND	ND	ND	ND	ND	ND	ND	0.02	0.01	0.03
HCB	0.3	0.08	0.04	0.1	0.18	0.3	0.06	0.08	0.06	0.13	0.04	0.48	0.51	0.51
α-endo	0.09	0.02	ND	ND	0.03	ND	ND	ND	ND	ND	0.02	0.08	0.06	0.06
β-endo	1.61	ND	ND	ND	ND	0.08	ND	ND	0.05	ND	0.19	1.34	0.07	0.07
Hept	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.12	0.12	0.12
Hepx	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.11	0.11	0.11
PCB-28	0.05	ND	ND	0.01	0.01	0.01	ND	0.01	ND	ND	ND	0.04	0.02	0.02
PCB-52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.08	0.08	0.08
PCB-101	0.07	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.35	0.11	0.11	0.11
PCB-153	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	0.11	0.11	0.11
PCB-138	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.08	0.08	0.08
PCB-180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.01	0.13	0.13	0.13

*MDL *Method detection limit*

Text SI-4. Details about PUF-disk and Sampling rate

a. Sample holder and sampler

__**Dimensions of PUF-Disks:**__

Polyurethane foam disk used for air sampling had the following dimensions: Diameter (d) = 135.5 cm, thickness (h) = 1.3 cm; mass (m) = 3.78 g; area (A) = 341.4 cm^2 (ND34 m^2); Volume (V) = 186.1 cm^3 (ND00186 m^3); Density (δ) = 20305.6 g/m^3.

A chamber to house the PUF-disk was prepared connecting two stainless steel bowls by means of hinges and a lock. It was so designed that it would protect the PUF-disk from direct precipitation, sunlight and course particle deposition and allow ambient air to pass the through chamber from the gap between bowls and small holes at the base of bottom bowl. This design of chamber has been successfully calibrated and used in numerous previous studies (Shoeib & Harner, 2002a; Harner et al., 2004; Pozo et al., 2006; Harner et al., 2006). PUF disks samplers were pre-cleaned by Soxhlet extraction using dichloromethane (DCM) for 24 h and dried for 24h in a clean desiccator under reduced pressure. Before sending for field deployment, the PUF-disks were spiked with four performance reference compounds (PRCs, PCB-30, -54, -104, -188), that were used to determine the site-specific sampling rates (Pozo et al., 2009). After applying DCs, each PUF-disks was wrapped with clean aluminum foil packed into a plastic bag and stored in a tin container. Five field blanks for Kathmandu, 3 for Pokhara and 3 for Hetauda were prepared to inspect the possible contamination during handling, storage, and transport.

b. Calculation of Sampling Rate "R"

To assess the site specific sampling rates, PRCs were added to each PUF disks prior to their deployment. Loss of DCs during sampling period was quantified based on individual recoveries. Ideally, recoveries between 20 and 80% of their initial amount would indicate the linear sampling of individual PAS. This requires DCs with a wide range of octanol-air partition coefficients (K_{OA}). By measuring the loss of DCs during sampling period site-specific air sampling rate 'R' can be estimated using the following relationship given by Moeckel et al., (2009)

$$R = \frac{-ln\left(\frac{C_{DC}^{corr}}{C_{DC,0}}\right).K_{PAS-A}\,.\rho_{PAS}.V}{t} \qquad (1)$$

$$\text{With } C_{DC}^{corr} = \frac{C_{DC}}{\frac{C_{DC-stable}}{C_{DC-stable,0}}}$$

$$K_{PAS\text{-}A} = 10^{0.6366\log K_{OA}-3.1774} \qquad (2)$$

Where C_{DC} and $C_{DC\text{-}stable}$ are the concentrations of DC and DC-stable at the end of the deployment period, respectively (ng $sample^{-1}$). $K_{PAS\text{-}A}$ is the chemical's PAS-air partition coefficient with units of m^3 g^{-1} and it can be calculated according to the regression (eq 2) given by Shoeib and Harner, (2002), ρ_{PAS} is the PAS bulk density (g m^{-3}), V is the volume of the PAS (m^3), and t is the deployment period in days. PCB-188 is used as DC-stable for correcting the losses of DCs. Only DCs that have recoveries within the desired range of between 20% and 80% should be used to estimate uptake rates.

Table SI-4. Site specific sampling rate

Sampling period	Aug-Oct 55 days		Oct-Dec 61 days		Dec-Feb 65 days		Feb-Apr 65 days		Apr-Jun 57 days		Jun-Aug 64 days	
KATHMANDU	I	II	I	II	I	II	I	II	I	II	I	I
K1	4.4	3.9	4.6	5.2	5.2	5.3	4.5	4.7	4.3	4.4	3.3	3.4
K2	4.3	4.4	4.9	4.6	5.2	4.6	4.7	4.3	5.5	NA	3.4	4.1
K3	3	4.2	5.2	3.2	4	3.5	3.4	3.8	4	4.1	3.1	2.3
K4	3.9	3.7	3.4	4.2	4.2	NA	2.9	4.4	3	NA	2.8	2.8
K5	4.4	4.6	5	3.9	5.7	6.1	3.9	4.7	4.7	4.8	3.1	3.4
K6	4.8	4	4.3	4.3	5.9	5.4	5.4	5	4.7	4.6	3.8	4.3
Average	**4.1**	**4.1**	**4.6**	**4.2**	**5**	**4.9**	**4.1**	**4.5**	**4.4**	**4.5**	**3.3**	**3.4**
Std. Dev	**0.6**	**0.3**	**0.7**	**0.7**	**0.8**	**1**	**0.9**	**0.4**	**0.8**	**0.3**	**0.3**	**0.8**
POKHARA												
P1	4.7	3.7	3.6	4.1	3.9	4	3.2	3.6	4.7	2.6	2.3	4.8
P3	5.7	5.9	6.3	NA	3.2	3.3	4.6	3.8	4.7	4.3	4	4.5
P2	6.8	5.9	3.3	3.1	2.3	2.2	2.8	2.1	5.6	5	6.1	4.9
P4	4.8	6.4	4.9	4.8	4.4	3.7	4.2	3.5	4.9	3.7	3.9	5.7
Average	**5.5**	**5.5**	**4.5**	**4**	**3.4**	**3.3**	**3.7**	**3.2**	**5**	**3.9**	**4.1**	**5**
Std. Dev	**1**	**1.2**	**1.4**	**0.8**	**0.9**	**0.8**	**0.8**	**0.8**	**0.4**	**1**	**1.6**	**0.5**
HETAUDA	62 days		62 days		59 days		64 days		64 days		63 days	
H1	NA	NA	2.1	3.9	2.7	3.2	4.7	3.7	4.8	4.9	3.2	2.8
H2	NA	NA	3	2.7	2.8	3.1	2.2	3	3.8	3.7	3.6	4.1
H3	NA	NA	2.5	2.4	3.6	4.8	2.8	2.7	3.4	2.5	2.4	4.9
Average	**NA**	**NA**	**2.5**	**3**	**3**	**3.7**	**3.2**	**3.1**	**4**	**3.7**	**3.1**	**3.9**
Std. Dev	**NA**	**NA**	**0.5**	**0.8**	**0.5**	**0.9**	**1.3**	**0.5**	**0.7**	**1.2**	**0.6**	**1**

Table SI-5a. Site specific concentrations (pg/m^3) of OCPs in different urban sites of Kathmandu

Land type	Seasons	Sampling		*o,p'-DDT*	*p,p'-DDT*	*o,p'-DDE*	*p,p'-DDE*	*o,p'-DDD*	*p,p'-DDD*	*α-HCH*	*β-HCH*	*γ-HCH*	*δ-HCH*	*HCB*	*α-endo*	*β-endo*	*Hept*	*Hepx*
Crop Land	Winter	1	I	8.1	4.9	2	8.4	0.6	0.7	6.8	2.5	7.6	1.1	20.2	3.3	3.4	BDL	BDL
			II	7.9	5.3	1.7	5.8	0.4	0.8	6	2.4	6.7	2.7	25.8	1.7	10	0.1	BDL
		2	I	5.5	3.1	0.9	4.6	BDL	0.9	5.3	0.3	6.7	2.1	23.9	BDL	2.5	BDL	BDL
			II	4.4	2.8	0.6	3.9	BDL	0.3	3.1	0.8	3.7	1	23	BDL	2.5	BDL	BDL
	Pre-monsoon	3	I	26.1	25.9	3.4	13.8	BDL	1.1	7.4	2	17.8	BDL	15.4	1	6.9	BDL	BDL
			II	23.4	16.9	2.9	8.9	BDL	0.8	4.5	1.2	12.8	BDL	15.8	BDL	1.3	BDL	BDL
		4	I	61.9	72.2	3.1	25.6	1.1	2.4	10.9	2.7	17.3	2.8	21.2	3.2	8.6	BDL	BDL
			II	56	66.4	4.3	21.1	1.1	2.3	9.1	1.4	14.1	1.3	22.7	BDL	BDL	BDL	BDL
	Monsoon	5	I	40.3	40.8	2.3	13.3	0.8	1.2	12.3	1.6	12.3	1	16.1	1.5	7.2	BDL	BDL
			II	48	49.3	3	24.1	1.3	1.9	18.2	1.7	14.9	0.9	28.3	BDL	BDL	BDL	BDL
		6	I	24.4	19.5	2.9	15.2	0.5	1.3	12.3	2	12.8	3	31.3	2.4	5.1	BDL	BDL
			II	28.3	24	2.2	15.4	BDL	0.8	10.1	2.7	7.1	1.5	23.1	BDL	10.5	BDL	BDL
Vegetable Market	Winter	1	I	11.9	20.1	1.8	26.8	0.7	3.2	14.2	2.4	26.6	2.4	20.5	BDL	7.7	BDL	BDL
			II	13.4	22	1.4	29.4	0.7	3.5	10.5	2.4	27.1	0.6	31.7	BDL	8.3	0.4	BDL
		2	I	6.5	14.9	1.4	25.5	2.1	4.2	6.1	2.9	18.8	0.4	45.5	2	13.2	0.9	BDL
			II	6.4	11.6	1.7	26	1.7	4.1	7.6	1.6	19.3	BDL	38.7	BDL	4.3	0.8	BDL
	Pre-monsoon	3	I	48.4	102.9	9.6	112.1	3.7	10.5	15.6	4	63.4	1.4	27.9	BDL	12.6	0.5	BDL
			II	52.6	130.7	8	125	4.5	13.4	18.1	7.6	62.2	2.6	25.9	7.3	21.7	0.9	BDL
		4	I	50.1	96.9	6.5	65.8	2.6	6.1	9.3	3.4	44.5	2.6	16.3	7.1	3.8	0.9	BDL
	Monsoon	5	I	89.5	144.8	11.2	186.7	4.9	9.8	28.2	6.6	229.2	5	28.3	15.7	35.3	0.7	BDL
			II	75.5	111.1	12.3	145.7	3.9	7.3	21.4	7.7	182.2	6.4	28.2	8	4.9	1	BDL
		6	I	48.9	104.6	3.9	92.6	2.7	6.2	19.1	4.3	30.8	7.4	31.3	4.3	18.2	0.2	BDL
			II	49.9	104.9	5.6	97.6	3.1	6.7	22.9	4.8	37.9	9.6	25.5	BDL	17.8	0.4	BDL
Industrial	Winter	1	I	5.4	5.9	1.7	11.6	0.3	1.9	6.3	1.4	9.7	BDL	135.1	BDL	2.4	0.7	BDL
			II	3.6	3.8	0.7	6.5	0.2	0.8	4.2	1.2	6	BDL	73.7	BDL	1.1	0.4	BDL
		2	I	6.3	22.9	1.6	14.6	0.5	3.7	7.1	3.1	15	2.9	242.5	1.7	3.3	0.2	BDL
			II	6.2	23.1	1.9	16.6	0.5	4.2	7.7	1.3	20.9	BDL	347	3.8	2.9	0.3	BDL
	Pre-monsoon	3	I	18	19.9	2	18.7	0.7	2.7	8.5	2.3	16.8	1.4	113.1	2.4	4.3	0.3	BDL
			II	15	15	2.6	16.8	0.5	2.3	8	1.6	20.7	1.5	104.9	2.4	6.3	BDL	BDL

	Monsoon	4	I	48.4	57.7	7.4	40.2	1.5	3.3	12.2	2.9	22.4	3.9	37.1	5.1	3.1	0.6	BDL
			II	39.3	50.6	4.7	29.2	1.2	2.9	9.4	2.7	15.7	4.1	25.8	BDL	5.3	BDL	BDL
		5	I	38.6	45.8	4.9	46.3	1.6	3	15.1	4.1	27.1	3.9	73.6	2.3	9.2	BDL	BDL
			II	59	70.5	7.6	73.5	2.5	7.9	25	7.5	45.4	4	164.9	3	10.9	1.3	BDL
		6	I	15.7	19	5.1	28.8	1.1	2.6	26.7	6	28.6	4.6	175.3	3.8	9.6	BDL	BDL
			II	12.3	12.1	8.9	44.6	2.3	3.6	47.7	12.4	36.4	3.4	97.1	4.2	8.2	BDL	BDL
Tourist	Winter	1	I	6.6	8.8	1.6	34.7	1	6.1	13.8	4.8	24.2	2.8	68.4	BDL	2.1	BDL	BDL
			II	3.2	12.5	0.6	12.7	0.3	2.6	4.8	2.3	11.5	BDL	25.8	BDL	1.2	BDL	BDL
		2	I	4.8	4.2	1.1	13.4	0.6	1.8	10.7	1.8	20.7	BDL	30.4	BDL	2.5	0.4	BDL
	Pre-monsoon	3	I	4.8	4.7	1	10.8	0.5	1.8	9	2.4	20.3	BDL	38	BDL	BDL	0.7	BDL
			II	31.1	43	4	33.8	2.2	4.7	27	8.1	28.6	3.9	22.1	2.2	5.8	0.6	BDL
		4	I	25.2	25.9	2.7	34.3	1.5	4.2	18.2	6.3	61.6	BDL	39.9	5.1	15.9	0.5	BDL
	Monsoon	5	I	42.8	48.8	4.4	62.7	4.5	7.9	69.8	15	61.3	4.2	26.9	BDL	14.4	1	BDL
			II	44.7	52.3	4.2	64.4	4.2	6.6	72.3	13.6	66.3	5	32.2	3.2	15	1.2	BDL
		6	I	16.4	22.2	3.2	37.2	2.4	4.9	28.5	8.5	41.5	7.1	35.7	6.5	25.3	BDL	BDL
			II	17.8	17.6	2.7	37.7	2.6	4.9	31.1	9.1	46.3	BDL	34.5	4.7	4.7	BDL	BDL
Residential	Winter	1	I	7.1	13.2	1.8	25.4	0.4	2.5	5.8	0.8	10.9	BDL	23.8	BDL	4.8	0.5	BDL
			II	10.7	17	1.7	13.5	0.9	5.7	8.7	2	19.9	0.8	32.2	BDL	5.2	0.2	BDL
		2	I	5.8	17.8	1.6	13.7	1	6.7	5.6	1.4	19.2	1	37	BDL	5	0.6	BDL
			II	3.7	6.8	0.9	6.8	0.3	3.5	2.6	0	7.9	BDL	18.2	BDL	BDL	0.4	BDL
	Pre-monsoon	3	I	18.9	23.7	6.4	33.3	1.5	6.4	9.3	3.5	20.2	0.8	30.6	2.2	8	0.1	BDL
			II	15.5	20.4	5.1	26.6	1.8	7	12.3	1.6	28.3	1	34	1.7	4.7	0.1	BDL
		4	I	37.1	45.9	3.6	33.2	2.2	5.8	9.4	1.7	20.3	1.3	19.1	3	5.6	BDL	BDL
			II	36.6	49.1	3.7	34.4	2.6	7.2	10.7	2.8	22.1	3.4	17.1	4.6	4.9	BDL	BDL
	Monsoon	5	I	46.4	58.4	5.5	58.8	3	7.6	18.4	5.2	46.6	3.4	56.8	BDL	17.8	BDL	BDL
			II	33.6	44.6	4.1	41.4	2.3	5.5	12.6	3.6	32.1	1.6	25.3	BDL	17.3	0.5	BDL
		6	I	21.5	40.5	3.4	23	1.8	5.8	15.1	4.4	2.5	3.5	30	7.3	8.6	BDL	BDL
			II	24.6	34.3	4.6	27.5	2	5.3	18	3.5	27.8	1.5	27.3	3.5	16.6	BDL	BDL
Industrial + farmland	Winter	1	I	8.7	7.7	1.1	12	0.5	3.2	11.9	2.8	12.1	BDL	31	1.2	2	0.2	BDL
			II	9.6	8.3	1.3	12.2	0.5	3.5	15.5	2.7	16.4	BDL	39.1	BDL	2.4	0.2	BDL
		2	I	5	6	1.1	10.9	1.4	4.5	10	1.6	12.8	0.4	18.2	BDL	2.5	BDL	BDL
			II	4.4	5.7	1	10	0.9	4.2	9.4	2.4	11.6	BDL	37.9	BDL	3	0.4	BDL
		3	I	24.3	25.5	3.1	24.1	1.2	5.7	20.1	4.1	21	2.5	24.6	BDL	4.3	BDL	BDL

		II	25.7	25.4	3.6	26.2	1.2	6.3	13.4	4.2	20	BDL	23.1	2.3	6.2	BDL	BDL
Pre-monsoon	4	I	32.5	43.3	2.1	27.2	1.5	4	26.5	8.1	21.8	4.8	29.4	7.4	18.7	BDL	BDL
		II	45.7	61.3	3.3	32.6	2	5.5	25.8	7.1	17.4	3.6	36.9	1.7	14.4	BDL	BDL
Monsoon	5	I	46.2	58.5	5	48.9	3.7	10.4	62.4	14.1	38.3	4.4	87.3	BDL	25	0.5	BDL
		II	52.7	71.1	5.7	54.7	3.6	10.8	72.9	16	43.9	4.5	58	7.1	7.5	0.8	BDL
	6	I	16.1	15.8	2.3	21.4	1.3	4.4	20.5	6.5	16.6	4.4	34.8	3.4	17	0.2	BDL
		II	22.2	20.4	2.7	28	2	6	35.9	10.1	19.2	5.6	48	BDL	12.3	0.3	BDL

Table SI-5b. Site specific concentrations (pg/m^3) of OCPs in different urban sites of Pokhara

Site type	Seasons	Sampling		*o,p'-DDT*	*p,p'-DDT*	*o,p'-DDE*	*p,p'-DDE*	*o,p'-DDD*	*p,p'-DDD*	*α-HCH*	*β-HCH*	*γ-HCH*	*δ-HCH*	*HCB*	*α-endo*	*β-endo*	*Hept*	*Hepx*
Cropland	Winter	1	I	9.5	25.6	2.8	37.9	BDL	1.6	5.4	BDL	8	BDL	15.1	BDL	4.7	0.5	BDL
			II	6.5	17.1	1.7	24.6	BDL	1.1	3.3	0.4	7.2	0.3	14.2	1.2	1.4	BDL	BDL
		2	I	3.4	9.6	1	14.5	BDL	0.9	3.7	2.5	15.5	0.5	19.5	1.5	1.7	0.4	BDL
	Pre-monsoon	3	I	18.6	114.3	5.2	207.4	0.8	5.6	3.9	0.9	15.9	1.6	23.9	BDL	5	0.7	BDL
			II	13.5	95.7	4.3	182.3	0.6	5	3.9	0.7	17.7	BDL	21.9	0.7	2	0.2	BDL
		4	I	50.1	132.6	4.7	136.8	0.9	4.5	6	0.8	23.6	0.8	19.9	6.8	4.6	BDL	BDL
			II	58.4	142.7	3.4	121.7	0.8	3.6	6.6	0.5	18.8	1.7	12.9	2.6	1.3	0.3	BDL
	Monsoon	5	I	61.8	147.8	5.5	140.3	1.2	4.5	7.5	3.8	15.5	8.8	46.3	5.5	10.7	0.2	BDL
			II	43.1	100.9	4.4	106.6	BDL	3.6	9	3.5	15.3	3.3	34.2	1.2	3.1	0.2	BDL
		6	I	18.5	35.4	1.9	38.3	BDL	1.5	6.7	1.2	6.4	1	15.4	0.7	1.2	BDL	BDL
			II	14.6	26.2	1.4	19.8	BDL	0.8	5.7	0.5	5.1	BDL	13.8	BDL	1.1	0.2	BDL
Veg- production area/Market	Winter	1	I	13.9	30.3	2.2	45.3	0.6	4.4	6.3	1.5	36	1.3	14.9	BDL	3.8	BDL	BDL
			II	13	25.9	1.7	34	0.7	5.1	4.9	BDL	28.6	BDL	22.3	BDL	6.2	0.2	BDL
		2	I	10.4	33.3	2.1	34.3	0.5	4.8	4.5	BDL	21.8	BDL	12.7	BDL	11	BDL	BDL
			II	13.7	37	2.4	40.5	0.6	6.4	5.9	BDL	27.2	BDL	16.1	BDL	4.7	BDL	BDL
	Pre-monsoon	3	I	27.8	47.8	3.1	51.3	0.9	4.7	4.3	1.3	26.4	BDL	20.7	BDL	6.7	BDL	BDL
			II	13.8	22	2.3	31	0.6	3.1	5.1	0.6	14.7	1.1	21.3	2.1	4.2	BDL	BDL
		4	I	69.1	129.2	5.5	77.1	1.4	5.7	7.2	2.1	32.7	2.5	41.6	BDL	8.3	BDL	BDL
	Monsoon	5	I	21.7	620.7	11.6	364.1	2.2	BDL	5.8	2.3	30.5	2.7	21.8	BDL	4.4	BDL	BDL
			II	20.3	530.4	9.2	291.9	1.9	19.7	5.5	1.4	20.8	3.6	17.5	BDL	3.1	0.1	BDL
		6	I	43.3	79	4	69.1	1.2	3.4	10.6	1.7	25.6	BDL	14.2	2.8	2.2	BDL	BDL

			II	27.4	48.6	2.4	43.2	0.8	2.9	6.4	1.4	15.8	0.7	7.3	3.5	5.9	BDL	BDL
Industrial	Winter	1	I	15.4	24	3	34.3	0.8	2.8	5.6	1.6	10.6	1.2	25.6	0.4	3.9	BDL	BDL
			II	15.2	17.8	1.9	24.1	0.5	2.6	6.6	BDL	11	BDL	20.2	3.3	2.4	0.4	BDL
		2	I	12.9	25.9	3.8	45.3	1.2	5.6	5.4	1.9	17.4	1.5	42.9	6.7	3.9	BDL	BDL
			II	18.9	20.9	3	26.6	2.4	9.7	11.5	5.5	38.8	1.8	35.1	BDL	6.5	BDL	BDL
	Pre-monsoon	3	I	9.1	46.9	2.1	21	0	1.7	6.4	1	21	1.5	18.8	8	3.9	BDL	BDL
			II	14.5	6.2	3.3	31.7	0.1	2.7	7.8	1.4	24.8	2	22.2	12.6	6.2	BDL	BDL
		4	I	51.9	77.5	3.4	40.7	1.5	3.8	7.4	0.7	13	1.8	23.2	BDL	4.3	BDL	BDL
			II	44.8	65.7	3	33.9	1	2.7	5.4	0.3	9.1	2.1	18.6	1.8	11.5	BDL	BDL
	Monsoon	5	I	27.2	37.2	2.7	28.7	1	2.6	3.5	0.7	6.8	0.5	17.3	BDL	4.1	BDL	BDL
			II	33.7	43.6	2.2	29.4	1	2.7	3.3	0.4	5	0.4	11.5	BDL	4.6	BDL	BDL
		6	I	21.9	27.2	2	24.7	1.3	3.2	11.5	1.1	14.5	2.9	23.7	2.8	3.4	BDL	BDL
			II	24.2	35.4	3.2	35.2	0.9	2	9.5	2.6	12.6	2.8	24.5	6.9	4.2	BDL	BDL
Tourist	Winter	1	I	4.7	6.3	0.7	8.8	0.4	1.7	3.1	BDL	6.9	1.6	12.8	2.4	6.5	BDL	BDL
		2	I	7.1	22.6	1.5	29.1	BDL	2.2	2.8	BDL	18.9	BDL	11.6	BDL	6	BDL	BDL
			II	7.7	23.1	1.4	21.3	0.3	1.9	3.2	0.4	17.7	BDL	15.4	BDL	10.9	BDL	BDL
	Pre-monsoon	3	I	19.7	27.4	2.9	28.4	0.8	2.1	3.4	0.9	13	1.2	31.7	BDL	7.5	BDL	BDL
			II	15.8	17.9	1.7	18.8	1.2	3	3.7	2	11.3	0.8	13.5	BDL	2.5	BDL	BDL
		4	I	49.1	71.4	4.4	39.7	1.9	4.1	4.5	1	14.6	1.5	21.4	BDL	6	BDL	BDL
			II	29.5	39.9	4.1	25.6	1.7	3	2.6	0.6	7.4	1.4	6.9	2.2	3.1	BDL	BDL
	Monsoon	5	I	7.6	23	1.3	17.8	0.5	1.2	3.3	1.7	32.3	3.3	18.5	2.3	4	BDL	BDL
			II	5.3	18.3	1.1	13.6	0.4	0.8	3.2	1.9	34.8	4.1	14.6	2	1.9	0.3	BDL
		6	I	16.6	24.1	2.1	26.5	0.9	2.1	7.3	1.4	10.8	0.8	18.9	BDL	2.7	BDL	BDL
			II	20	31.8	5	52	1.8	3.6	14.1	2.7	23.2	5.2	15.6	3.2	7.3	BDL	BDL

Table SI-5c. Site specific concentrations (pg/m^3) of OCPs in different urban sites of Hetauda

Site type	Seasons	Sampling		*o,p'-DDT*	*p,p'-DDT*	*o,p'-DDE*	*p,p'-DDE*	*o,p'-DDD*	*p,p'-DDD*	*α-HCH*	*β-HCH*	*γ-HCH*	*δ-HCH*	*HCB*	*α-endo*	*β-endo*	*Hept*	*Hepx*
Cropland	Winter	1	I	1.3	8.9	0.3	3.4	BDL	0.6	6.2	1.2	10.5	0.9	23.2	1.4	7.7	BDL	BDL
			II	1.0	5.0	0.3	2.2	BDL	0.1	6.0	0.9	6.0	0.8	27.6	1.1	4.8	BDL	BDL
		2	I	1.7	8.1	0.3	3.3	0.1	0.2	6.5	1.5	12.5	2.9	17.0	1.5	10.1	BDL	BDL
			II	2.4	9.9	0.3	3.1	0.1	0.2	8.8	1.3	13.5	4.3	16.8	1.2	6.9	BDL	BDL
	Pre-monsoon	3	I	2.6	12.1	0.3	2.3	0.1	0.2	5.9	0.9	9.0	1.9	13.8	0.9	6.1	BDL	BDL
			II	4.6	22.4	0.4	3.3	0.1	0.3	4.7	1.3	8.4	1.2	12.8	1.2	9.7	BDL	BDL
		4	I	3.0	11.9	0.7	10.2	0.1	0.2	3.2	2.4	4.4	1.8	7.9	3.4	27.5	BDL	BDL
			II	4.0	11.8	0.4	3.0	0.1	0.2	2.8	0.9	4.2	0.7	8.8	0.7	3.4	BDL	BDL
	Monsoon	5	I	4.5	12.8	0.3	3.6	0.1	0.2	3.4	1.2	5.7	0.6	11.5	1.3	8.8	BDL	BDL
			II	4.5	12.1	0.5	3.9	0.1	0.2	2.7	1.5	5.4	1.0	10.9	1.0	7.4	BDL	BDL
Veg- production area	Winter	1	I	3.1	27.4	0.6	7.4	0.2	0.4	10.2	BDL	2960.3	4.7	16.0	1.7	14.1	1	BDL
			II	1.3	5.7	0.3	4.4	BDL	0.2	5.3	BDL	40.6	2.4	28.1	1.0	5.1	0.8	BDL
		2	I	1.0	7.8	0.6	10.2	0.3	0.2	6.8	2.0	3192.6	BDL	22.3	1.9	5.6	BDL	BDL
			II	1.2	7.8	0.5	6.7	0.1	0.3	6.6	BDL	3326.3	1.7	20.5	0.8	3.9	BDL	BDL
	Pre-monsoon	3	I	3.1	29.2	0.6	10.8	0.2	0.6	9.3	BDL	3097.6	BDL	20.8	3.5	15.8	BDL	BDL
			II	2.3	12.1	0.3	7.9	0.3	0.9	6.7	BDL	1662.0	BDL	16.5	2.6	11.4	BDL	BDL
		4	I	1.8	2.4	0.1	6.5	0.5	1.1	6.1	BDL	867.7	BDL	16.8	2.2	9.3	BDL	BDL
			II	0.9	7.1	0.3	3.8	0.0	0.3	1.2	BDL	227.0	0.6	7.9	0.9	3.0	BDL	BDL
	Monsoon	5	I	2.8	16.3	0.6	7.1	0.2	0.4	4.3	BDL	543.6	4.5	12.5	2.4	12.3	0.8	BDL
			II	1.7	13.3	0.5	6.7	0.1	0.3	3.9	1.4	427.0	1.5	13.9	1.4	7.4	BDL	BDL
Industrial	Winter	1	I	3.1	28.1	1.1	21.8	0.3	0.1	10.8	6.8	21.2	8.4	46.8	5.5	35.6	BDL	BDL
			II	4.1	21.5	1.1	15.7	0.2	0.6	4.8	2.4	13.9	3.5	27.2	4.6	28.6	BDL	BDL
		2	I	1.3	6.3	0.4	4.7	BDL	0.1	1.5	BDL	3.1	0.6	12.6	0.8	5.6	BDL	BDL
			II	1.0	5.5	0.3	4.0	BDL	0.1	1.3	0.7	2.7	0.5	11.2	0.8	3.8	BDL	BDL
	Pre-monsoon	3	I	4.7	26.0	0.9	14.6	0.2	0.4	6.5	4.4	10.9	2.7	24.7	3.4	25.1	BDL	BDL
			II	4.7	17.0	0.8	10.3	0.1	0.3	3.0	1.9	5.4	1.8	13.0	1.8	10.9	BDL	BDL
		4	I	3.4	12.5	0.7	10.4	0.1	0.2	2.6	1.5	4.7	2.5	6.8	2.8	26.6	BDL	BDL
			II	3.3	18.1	0.8	9.7	0.2	0.1	5.8	1.8	4.0	2.2	26.5	2.5	10.5	BDL	BDL
	Monsoon	5	I	7.1	48.9	0.9	11.6	0.4	0.1	7.2	1.3	4.1	1.6	6.2	2.4	13.5	BDL	BDL
			II	4.4	29.8	0.6	7.1	0.2	BDL	6.2	0.8	6.0	1.0	5.8	1.6	8.4	BDL	BDL

Table SI-6a. Site specific concentrations (pg/m^3) of PCBs in different urban sites of Kathmandu

Land type	Seasons	Sampling		*PCB-28*	*PCB-52*	*PCB-101*	*PCB-153*	*PCB-138*	*PCB-180*
Crop land	Winter	1	I	3.1	1.4	0.7	0.1	0.2	0.1
			II	2.7	1.1	0.6	0.2	0.6	0.0
		2	I	1.8	0.5	0.4	0.1	0.1	0.2
			II	1.2	0.3	0.2	0.0	0.1	0.0
	Pre-monsoon	3	I	2.4	1.0	0.6	0.2	0.2	0.1
			II	2.4	0.4	0.3	0.0	0.0	0.0
		4	I	3.1	1.3	0.8	1.7	0.3	0.1
			II	1.5	0.7	0.5	0.7	0.2	0.0
	Monsoon	5	I	1.9	1.0	0.4	1.4	0.1	0.0
			II	2.1	1.2	0.6	1.3	0.2	0.0
		6	I	2.5	1.0	0.6	0.2	0.3	0.0
			II	3.3	0.7	0.4	0.2	0.0	0.0
Veg- production area/Market	Winter	1	I	3.5	1.8	0.9	0.4	0.8	0.0
			II	4.1	1.5	0.9	0.3	0.7	0.0
		2	I	6.4	2.1	1.1	0.5	0.5	0.1
			II	6.5	1.7	1.0	0.4	0.6	0.1
	Pre-monsoon	3	I	4.8	3.4	1.6	0.7	0.9	0.2
			II	5.7	3.5	1.5	0.6	1.1	0.3
		4	I	4.2	2.0	1.2	1.8	0.7	0.2
	Monsoon	5	I	8.4	6.4	3.6	3.1	1.5	0.3
			II	6.4	5.6	3.3	2.0	1.2	0.3
		6	I	5.9	2.9	1.8	0.7	0.7	0.2
			II	7.1	4.2	2.2	1.2	0.3	0.3
Industrial	Winter	1	I	2.1	0.9	0.3	1.8	3.3	0.1
			II	3.2	0.7	0.4	0.1	0.2	0.0
		2	I	3.8	2.2	0.7	0.4	0.4	0.1
			II	4.5	2.2	0.8	0.3	0.3	0.1
	Pre-monsoon	3	I	5.3	4.4	4.0	1.7	2.1	0.3
			II	5.6	3.8	3.5	1.5	1.7	0.2
		4	I	5.3	2.6	1.2	2.1	0.6	0.2
			II	4.6	1.5	0.9	2.0	0.4	0.1
	Monsoon	5	I	4.4	2.8	2.0	1.5	0.9	0.2
			II	9.6	4.5	3.5	2.2	1.6	0.2
		6	I	19.4	3.8	1.2	0.7	0.5	0.1
			II	19.6	21.7	2.4	1.9	1.5	0.3

Tourist	Winter	1	I	9.7	1.7	0.8	0.7	0.4	0.1
			II	5.4	0.9	0.4	1.5	0.2	0.0
		2	I	3.8	0.6	0.5	0.4	0.1	0.0
	Pre-monsoon	3	I	4.5	0.7	0.4	0.6	0.0	0.0
			II	4.3	2.0	0.9	0.7	0.4	0.1
		4	I	5.1	1.9	1.2	1.9	0.5	0.2
	Monsoon	5	I	6.7	1.9	1.2	1.8	0.5	0.0
			II	4.6	1.9	1.2	1.7	0.4	0.1
		6	I	6.0	2.6	1.3	0.7	0.6	0.2
			II	5.2	2.0	1.1	0.3	0.4	0.0
Residential	Winter	1	I	1.8	0.7	0.5	0.2	0.4	0.0
			II	7.4	3.0	1.7	0.7	0.8	0.1
		2	I	6.0	2.9	1.4	0.6	0.8	0.2
			II	5.0	1.4	0.7	0.3	0.5	0.1
	Pre-monsoon	3	I	13.3	6.4	2.5	1.8	1.4	0.5
			II	12.8	6.6	2.5	1.7	1.3	0.5
		4	I	12.4	3.9	1.5	1.9	0.9	0.2
			II	11.2	4.7	1.7	2.0	0.8	0.2
	Monsoon	5	I	14.2	7.3	2.6	2.4	1.1	0.3
			II	10.4	5.1	2.0	2.1	1.1	0.2
		6	I	12.3	6.5	4.8	3.1	2.4	0.3
			II	13.7	7.4	5.7	3.7	3.2	0.4
Industrial +Farmland	Winter	1	I	9.4	2.5	1.0	0.7	0.6	0.3
			II	12.6	2.5	0.9	0.6	0.4	0.2
		2	I	7.5	2.5	0.8	0.5	0.5	0.2
			II	7.5	2.0	0.7	0.6	0.6	0.2
	Pre-monsoon	3	I	10.6	3.9	1.3	1.2	0.7	0.4
			II	10.9	3.7	1.3	1.3	0.7	0.3
		4	I	22.7	5.6	1.3	1.6	0.6	0.3
			II	8.6	2.9	1.6	1.8	1.1	0.7
	Monsoon	5	I	15.1	3.8	1.5	3.4	0.8	0.4
			II	13.1	4.3	1.6	1.6	1.0	0.4
		6	I	13.2	4.4	1.6	1.1	0.9	0.2
			II	19.9	6.2	2.0	1.6	0.9	0.3

Table SI-6b. Site specific concentrations (pg/m^3) of PCBs in different urban sites of Pokhara

Site type	Seasons	Sampling		*PCB-28*	*PCB-52*	*PCB-101*	*PCB-153*	*PCB-138*	*PCB-180*
Cropland	Winter	1	I	1.3	0.4	0.3	0.5	0.0	0.0
			II	1.0	0.2	0.2	1.3	0.0	0.0
		2	I	1.3	0.4	0.2	0.4	0.0	0.0
	Pre-monsoon	3	I	2.0	1.1	0.5	0.5	0.1	0.0
			II	1.4	0.5	0.2	0.5	0.0	0.0
		4	I	1.1	0.5	0.4	0.5	0.0	0.0
			II	2.0	0.5	0.3	0.6	0.1	0.0
	Monsoon	5	I	5.4	1.0	0.5	0.7	0.0	0.0
			II	2.0	0.8	0.5	0.7	0.0	0.0
		6	I	1.4	0.7	0.4	0.1	0.2	0.1
			II	0.8	0.3	0.2	0.0	0.0	0.0
Veg- production area/Market	Winter	1	I	1.9	0.9	0.7	0.9	0.5	0.1
			II	1.5	0.5	0.4	0.6	0.4	0.0
		2	I	1.0	0.5	0.6	0.5	0.0	0.2
			II	1.6	0.6	0.6	0.6	0.4	0.2
	Pre-monsoon	3	I	1.6	0.7	0.7	0.9	0.4	0.2
			II	3.3	1.3	0.7	1.6	0.3	0.1
		4	I	1.9	0.9	1.0	1.1	0.7	0.2
	Monsoon	5	I	3.1	2.1	0.3	0.4	0.3	0.1
			II	2.4	1.5	0.1	0.3	0.2	0.1
		6	I	1.8	0.8	0.6	0.6	0.3	0.1
			II	1.5	0.6	0.5	0.3	0.2	0.1
Industrial	Winter	1	I	2.5	1.0	0.6	0.2	0.2	0.0
			II	1.2	0.5	0.3	0.0	0.0	0.0
		2	I	5.7	1.8	0.8	0.4	0.3	0.0
			II	17.3	5.8	2.9	1.0	1.0	0.2
	Pre-monsoon	3	I	5.3	1.3	0.1	0.2	0.2	0.1
			II	6.2	1.6	0.1	0.3	0.3	0.1
		4	I	1.2	0.5	0.3	0.4	0.2	0.0
			II	2.0	0.4	0.4	0.5	0.1	0.0
	Monsoon	5	I	0.7	0.3	0.2	0.8	0.1	0.0
			II	0.7	0.3	0.2	1.1	0.1	0.0
		6	I	1.5	0.9	0.4	0.1	0.1	0.1
			II	1.9	1.1	0.5	0.2	0.2	0.0
Tourist	Winter	1	I	0.9	0.3	0.1	0.8	0.3	0.0
		2	I	1.8	0.4	0.2	0.1	0.2	0.0
			II	1.5	0.4	0.2	0.0	0.0	0.0
	Pre-monsoon	3	I	2.2	0.5	0.4	5.6	0.2	0.1
			II	1.4	0.5	0.3	1.6	0.2	0.0
		4	I	1.3	0.6	0.6	0.6	0.3	0.1

Site type	Seasons	Sampling		PCB-28	PCB-52	PCB-101	PCB-153	PCB-138	PCB-180
			II	0.7	0.4	0.4	0.5	0.2	0.0
	Monsoon	5	I	2.8	1.0	0.1	0.1	0.8	0.1
			II	2.4	0.9	0.1	0.2	0.1	0.1
		6	I	2.2	2.1	1.1	0.2	0.4	0.1
			II	7.3	6.2	2.7	1.2	0.9	0.2

Table SI-6c. Site specific concentrations (pg/m^3) of PCBs in different urban sites of Hetauda

Site type	Seasons	Sampling		*PCB-28*	*PCB-52*	*PCB-101*	*PCB-153*	*PCB-138*	*PCB-180*
Cropland	Winter	1	I	3.2	1.2	0.0	0.2	0.2	0.2
			II	3.6	0.6	0.0	0.1	0.2	0.0
		2	I	1.5	0.9	0.6	0.2	0.2	0.1
			II	2.0	0.9	0.3	0.2	0.2	0.0
	Pre-monsoon	3	I	1.8	0.7	0.4	0.2	0.2	0.0
			II	2.5	0.9	0.9	0.3	0.4	0.1
		4	I	0.9	0.4	0.5	0.4	0.2	0.0
			II	1.0	0.2	0.1	0.1	0.1	0.0
	Monsoon	5	I	0.8	0.5	0.7	0.2	0.2	0.0
			II	4.7	3.6	1.2	1.7	1.9	0.7
Vegetable production area	Winter	1	I	5.9	3.4	0.9	0.6	0.8	0.3
			II	10.6	1.4	0.0	0.1	0.0	0.2
		2	I	10.9	3.0	0.9	0.3	0.4	0.2
			II	4.0	1.5	0.0	0.1	0.7	0.6
	Pre-monsoon	3	I	6.0	4.3	0.9	0.9	2.2	0.5
			II	3.1	2.5	1.4	0.5	1.4	0.4
		4	I	1.6	1.5	1.8	0.3	0.9	0.3
			II	0.7	1.0	0.6	0.1	1.5	0.8
	Monsoon	5	I	2.9	1.7	0.8	0.3	0.5	0.3
			II	2.4	1.5	0.7	0.4	0.3	0.1
Industrial	Winter	1	I	4.2	2.0	1.1	1.2	1.9	0.4
			II	3.8	0.9	1.2	1.1	0.8	0.3
		2	I	1.4	0.5	0.3	0.2	0.4	0.1
			II	3.2	1.5	0.3	0.7	0.7	0.3
	Pre-monsoon	3	I	5.2	1.3	1.4	0.6	0.8	0.2
			II	1.4	0.8	1.0	0.5	0.6	0.1
		4	I	5.6	1.0	0.4	0.2	0.4	0.1
			II	6.8	1.8	0.8	0.5	0.7	0.3
	Monsoon	5	I	2.8	2.5	1.1	1.1	1.0	0.3
			II	2.1	1.7	0.7	0.7	0.6	0.2

Table SI-7. Comparison of current levels (pg/m^3) of various POPs with different tropical/subtropical urban sites

Places	o,p'-DDT	p, p'-DDT	p, p'-DDE	α-HCH	γ-HCH	α-endo	β-endo	∑PCBs	Sampling time
This study									
Kathmandu*	3–90	3–145	4–187	3–73	2–229	BDL–16	BDL– 35	2–47	Aug, 2014 - Aug, 2015
Pokhara*	3–69	6–621	9–364	3–14	5–39	BDL–13	1–12	1–28	Aug, 2014 - Aug, 2015
Hetauda*	1–7	2–49	2–22	1–11	3–3326	1–5	3–36	2–16	Oct, 2015 - Nov, 2016
GAPs study[a]									
Chengdu, China**		BDL	BDL–56	145–176	68–142	8–47	BDL–59	187–249	Jan-Jun2005
Kuwait city, Kuwait**		131	22–58	1–13	1–17	76–168	BDL–16	86–497	Jan-Sept 2005
Manila, Philippines**		190	14–45	BDL–1	BDL–15	13-66	BDL–4	629–2826	Jan-Sept 2005
Izmir, Turkey**		BDL	60–46	18–30	13–18	494–1352	46–464	174–287	Jan-Jun2005
Seoul, Korea**			34	84	43	4411	957	397	Jun-Sept 2005
Malawi, Africa			BDL	BDL	9	162	10	BDL	Mar-June 2005
Mexico[b]									
Mexico city	17	ND	21	8.9	49	320	68		2005-2006
Chihuahua	1.7	ND	25	5.9	11	351	95		2005-2006
San Luis Potosi	1.4	ND	13	9.4	16	260	40		2005-2006
Nepal[c]									
Kathmandu	9–15	8–62	4–83	3–51	4–272	6–30	6–15		Aug-Oct, 2014
Pokhara	10–18	8–120	10–25	7–13	4–36	8–34	6–14		Aug-Oct, 2014
Birgunj	16–86	105–1170	41–180	8–36	24–243	8–46	7–25		Aug-Oct, 2014
Biratnagar	25–136	236–3340	29–1760	9–21	34–138	12–20	14–31		Aug-Oct, 2014

All the studies used PUF-PAS

[a]*Pozo et al., 2009;* [b]*Wong et al., 2009;* [c] *Yadav et al., 2017*

**∑6PCBs*

***∑48PCBs*

Table SI-8. Range and average (pg/m^3) with Highest to lowest concentration ratio (H/L) of different isomers/congeners

	Minimum	Maximum	Mean	SD	H/L
o,p'-DDT	0.9	89.5	20.4	19.0	95.8
p,p'-DDT	2.4	620.7	42.7	71.8	263.8
o,p'-DDE	0.1	12.3	2.8	2.4	126.9
p,p'-DDE	2.2	364.1	37.6	50.7	162.4
o,p'-DDD	0.0	4.9	1.0	1.1	
p,p'-DDD	0.0	19.7	3.3	3.0	
∑DDTs	8.7	1020.3	107.9	133.0	117.1
α-HCH	1.2	72.9	11.2	12.4	58.3
β-HCH	0.0	16.0	2.7	3.1	
γ-HCH	2.5	3326.3	155.7	560.7	1351.3
δ-HCH	0.0	9.6	2.0	2.0	
∑HCHs	5.3	3334.6	171.6	559.7	632.4
HCB	5.8	347.0	33.1	41.0	59.7
α-endo	0.0	15.7	2.0	2.6	
β-endo	0.0	35.6	7.9	6.8	
∑endo	0.0	51.1	9.9	8.2	
PCB-28	0.7	22.7	5.0	4.5	33.6
PCB-52	0.2	21.7	2.1	2.4	119.6
PCB-101	0.0	5.7	1.0	0.9	
PCB-153	0.0	5.6	0.9	0.8	
PCB-138	0.0	3.3	0.6	0.6	
PCB-180	0.0	0.8	0.1	0.2	
∑PCBs	1.4	47.4	9.7	8.1	35.1

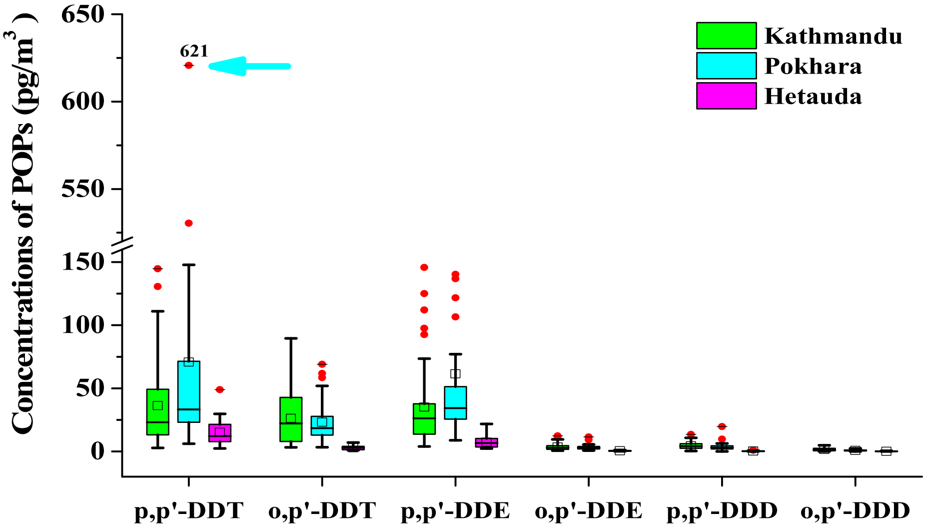


Figure SI-3. Box and whisker plot to show distribution of different isomers of DDT and its metabolites in Kathmandu Pokhara and Hetauda(Lower and upper limits of whisker indicate minimum and maximum, Lower and upper limits of the box indicate 25th and 75th percentiles, horizontal line in the box indicates median, small square in the box represents mean, red circle denotes outlier)

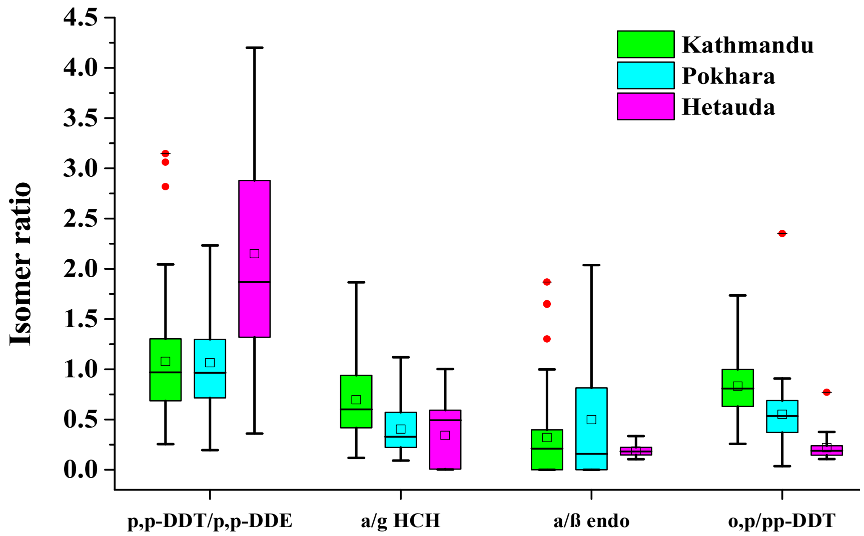


Figure SI-4. Isomers/ metabolites ratios of selected OCPs to predict source type(Lower and upper limits of whisker indicate minimum and maximum, Lower and upper limits of the box indicate 25th and 75th percentiles, horizontal line in the box indicates median, small square in the box represents mean, red circle denotes outlier)

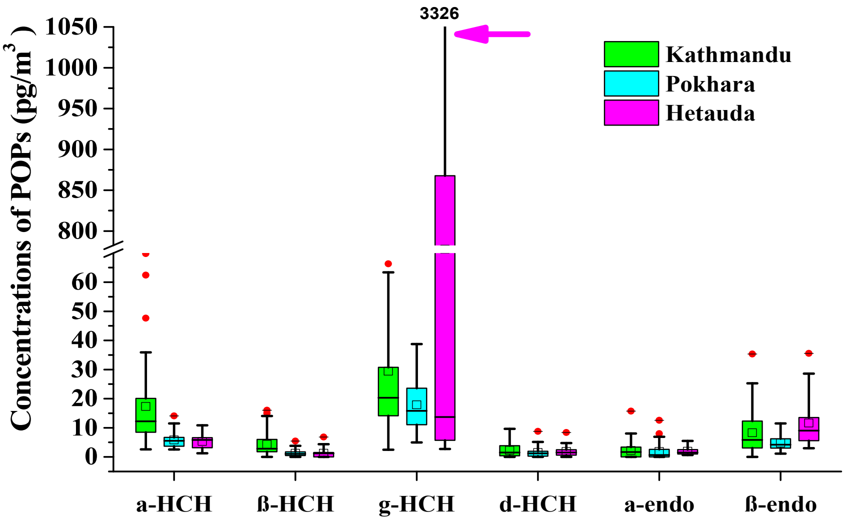


Figure SI-5. Box and whisker plot to show distribution of different isomers of HCH and endosulfan in Kathmandu Pokhara and Hetauda(Lower and upper limits of whisker indicate minimum and maximum, Lower and upper limits of the box indicate 25th and 75th percentiles, horizontal line inside the box indicates median, small square in the box represents mean, red circle denotes outlier)

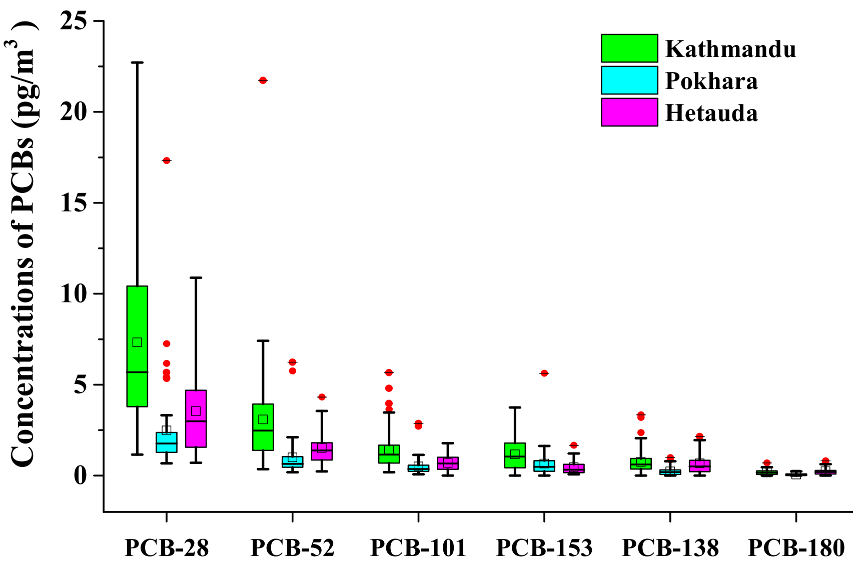


Figure SI-6. Box and whisker plot to show distribution of different congeners of PCBs in Kathmandu Pokhara and Hetauda(Lower and upper limits of whisker indicate minimum and maximum, Lower and upper limits of the box indicate 25th and 75th percentiles, horizontal line in the box indicates median, small square in the box represents mean, red circle denotes outlier)

Table SI-9. P-values (one-way ANOVA) for significant variation in levels of different POPs in different sites

	o,p'-DDT	*p,p'-DDT*	*o,p'-DDE*	*p,p'-DDE*	*α-HCH*	*γ-HCH*	***HCB***	*α-endo*	*β-endo*	***PCBs***
Kathmandu	0.40	**0.01**	**0.01**	**0.00**	0.15	**0.05**	**0.00**	0.37	0.21	**0.00**
Pokhara	0.65	0.27	0.34	0.18	0.29	0.08	0.49	0.17	0.13	0.54
Hetauda	0.14	0.17	**0.02**	**0.02**	0.69	**0.00**	0.82	0.18	0.13	**0.03**

Table SI-10. Significant differences (P<0.05, Tukey's Test) in OCPs concentrations among the sites in Kathmandu (only the chemicals with variations have been shown)

		p, p'-DDT	p, p'-DDE	γ-HCH	HCB	PCB
K1	K2	**0.03**	**0.00**	**0.05**	1.00	0.32
	K3	1.00	0.90	0.98	**0.00**	0.06
	K4	1.00	0.80	0.64	0.99	0.80
	K5	1.00	0.92	0.99	1.00	**0.00**
	K6	1.00	0.96	0.99	0.99	**0.01**
K2	K3	**0.04**	**0.01**	0.17	**0.00**	0.95
	K4	**0.01**	**0.02**	0.66	0.99	0.96
	K5	**0.05**	**0.01**	0.16	1.00	0.37
	K6	**0.04**	**0.01**	0.15	0.99	0.39
K3	K4	0.99	1.00	0.93	**0.00**	0.52
	K5	1.00	1.00	1.00	**0.00**	0.88
	K6	1.00	1.00	1.00	**0.00**	0.89
K4	K5	0.99	1.00	0.92	1.00	0.08
	K6	0.99	0.99	0.91	1.00	0.09
K5	K6	1.00	1.00	1.00	0.99	1.00

Table SI-11. Significant differences (P<0.05, Tukey's post hocTest) in OCPs concentrations among the sites in Hetauda (only the chemicals with variations have been shown)

		p, p'-DDE	β-HCH	γ-HCH	PCBs
H1	H2	0.29	0.32	**0.01**	**0.03**
	H3	**0.01**	0.43	1.00	0.19
H2	H3	0.20	**0.04**	0.**01**	0.53

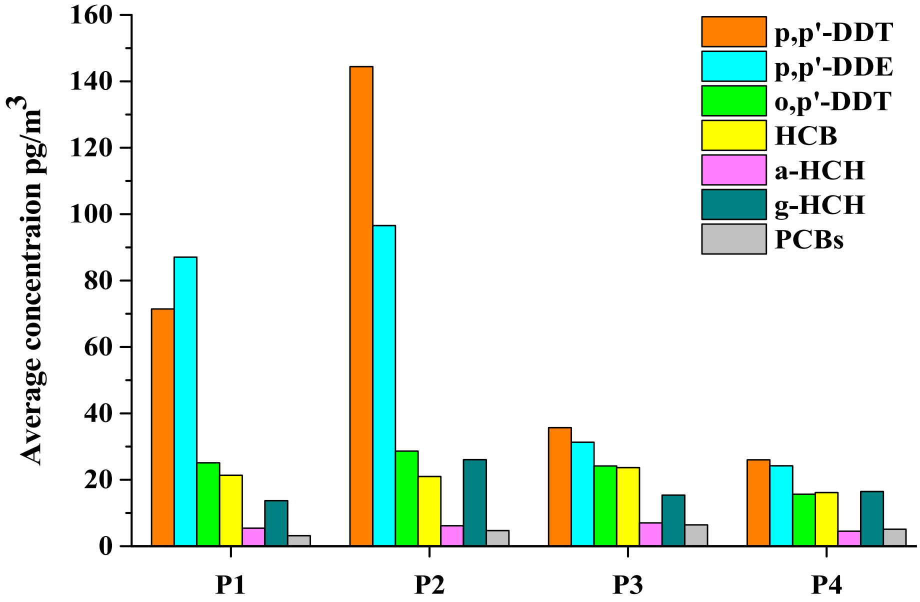


Figure SI-7. Atmospheric level of OCPs in different land cover types in Pokhara; (P1-Cropland; P2-Vegetable production and Market area; P3- Industrial area; and P4- Tourist place)

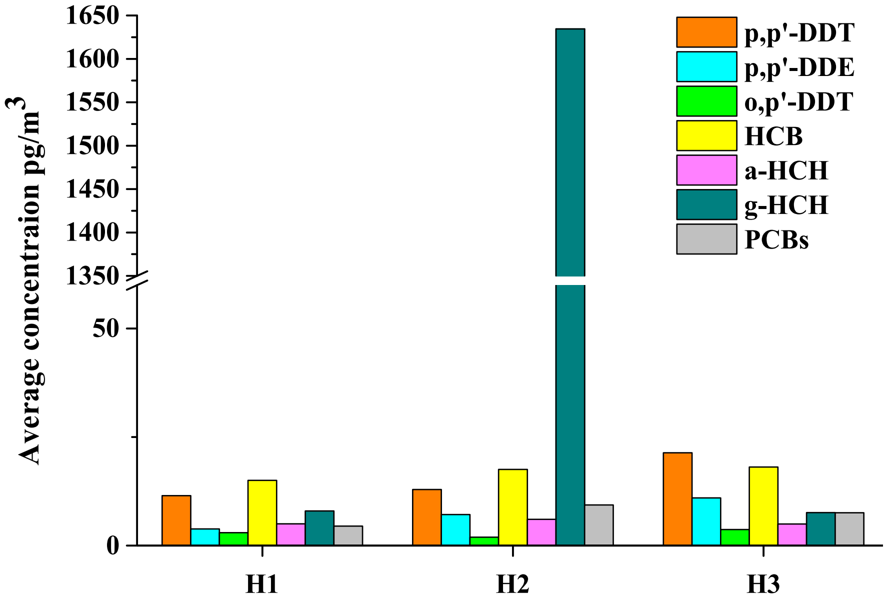


Figure SI-8. Atmospheric level of OCPs in different land cover types in Hetauda; (H1-Crop Land; H2-Vegetable production area; H3- Industrial area)

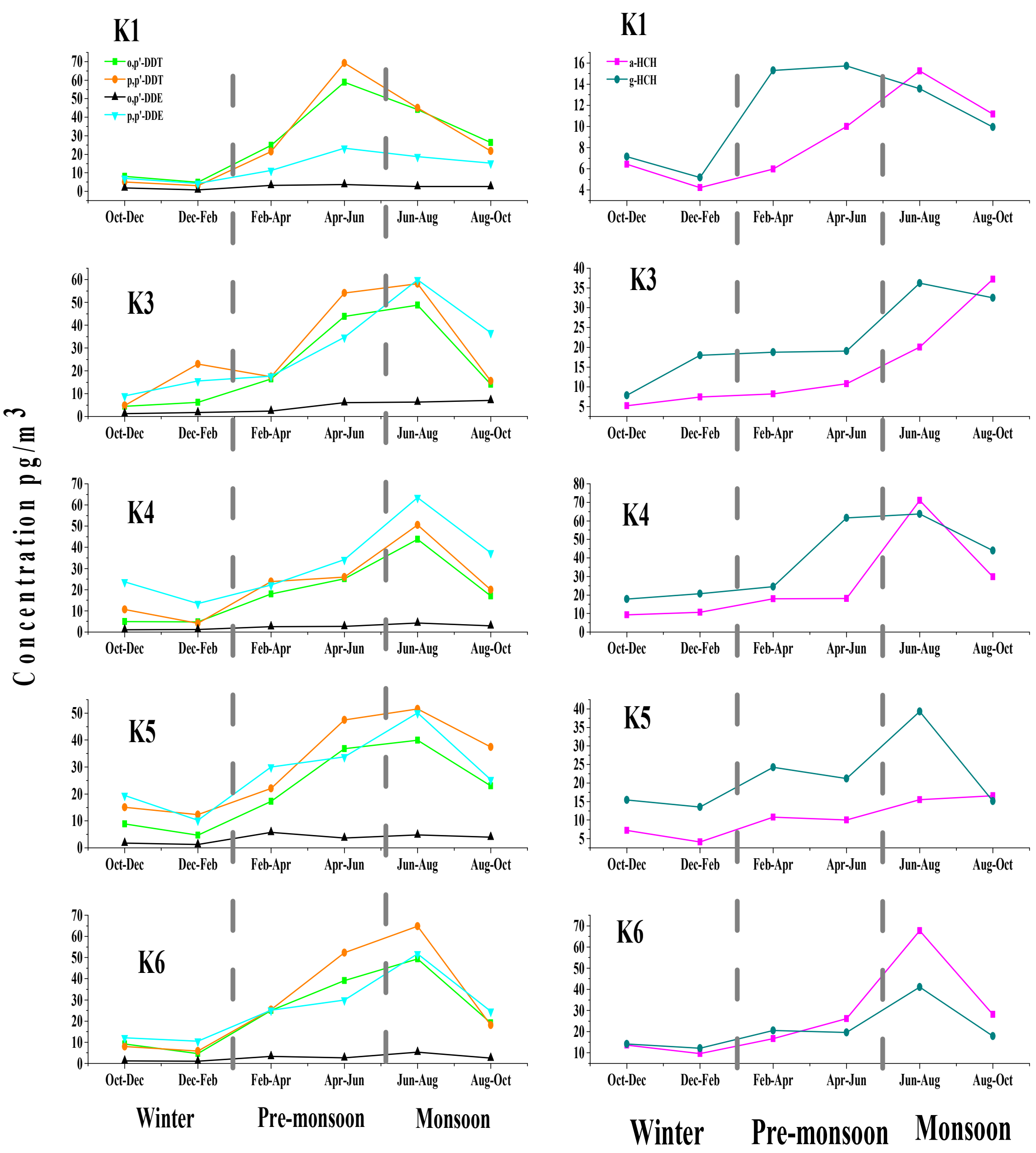
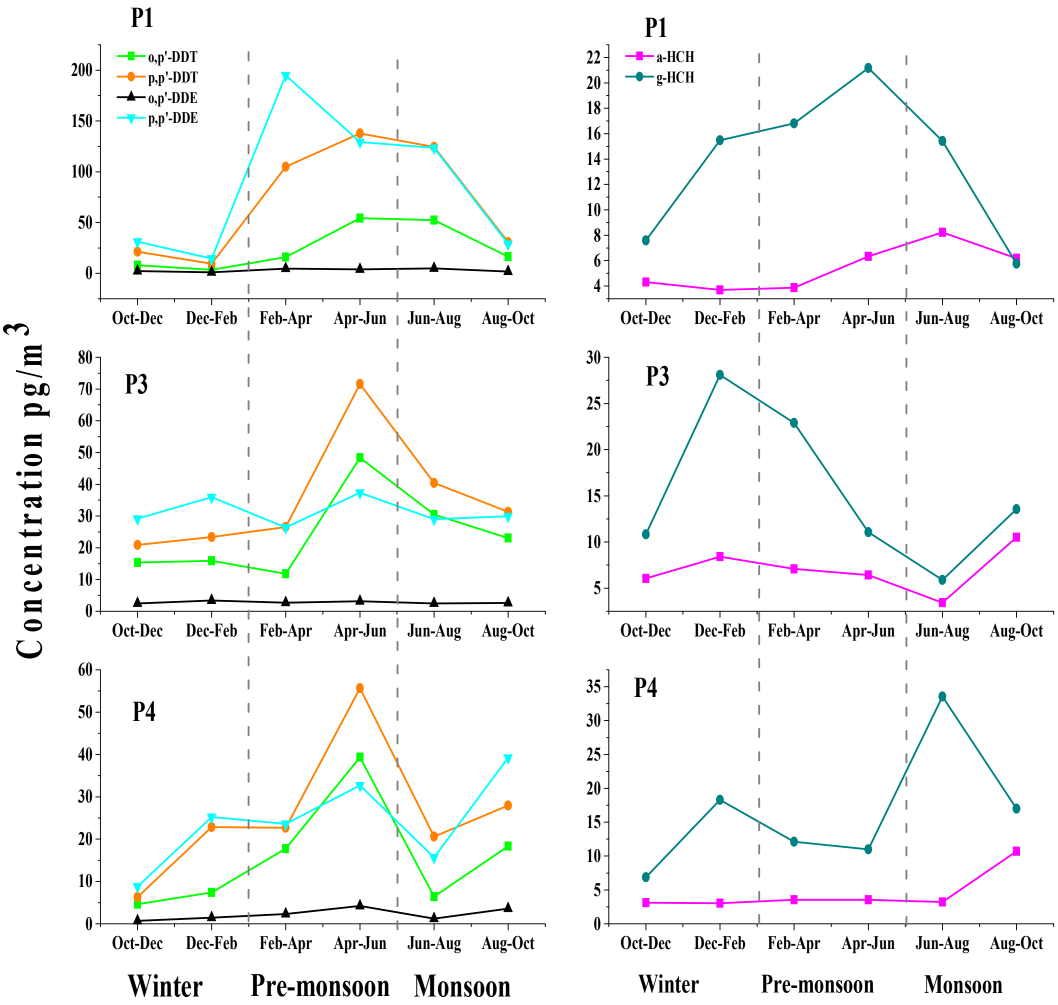


Figure SI-9. Seasonality of DDTs and HCHs in Kathmandu city (K1: Cropland, K3: Industrial area, K4: Tourist area, K5: Residential area, K6: mix of farm land and industrial area)



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216 **Figure SI-10. Seasonality of DDTs and HCHs in Pokhara city (P1: Cropland, P3: Industrial area,**
217 **P4: Tourist area)**

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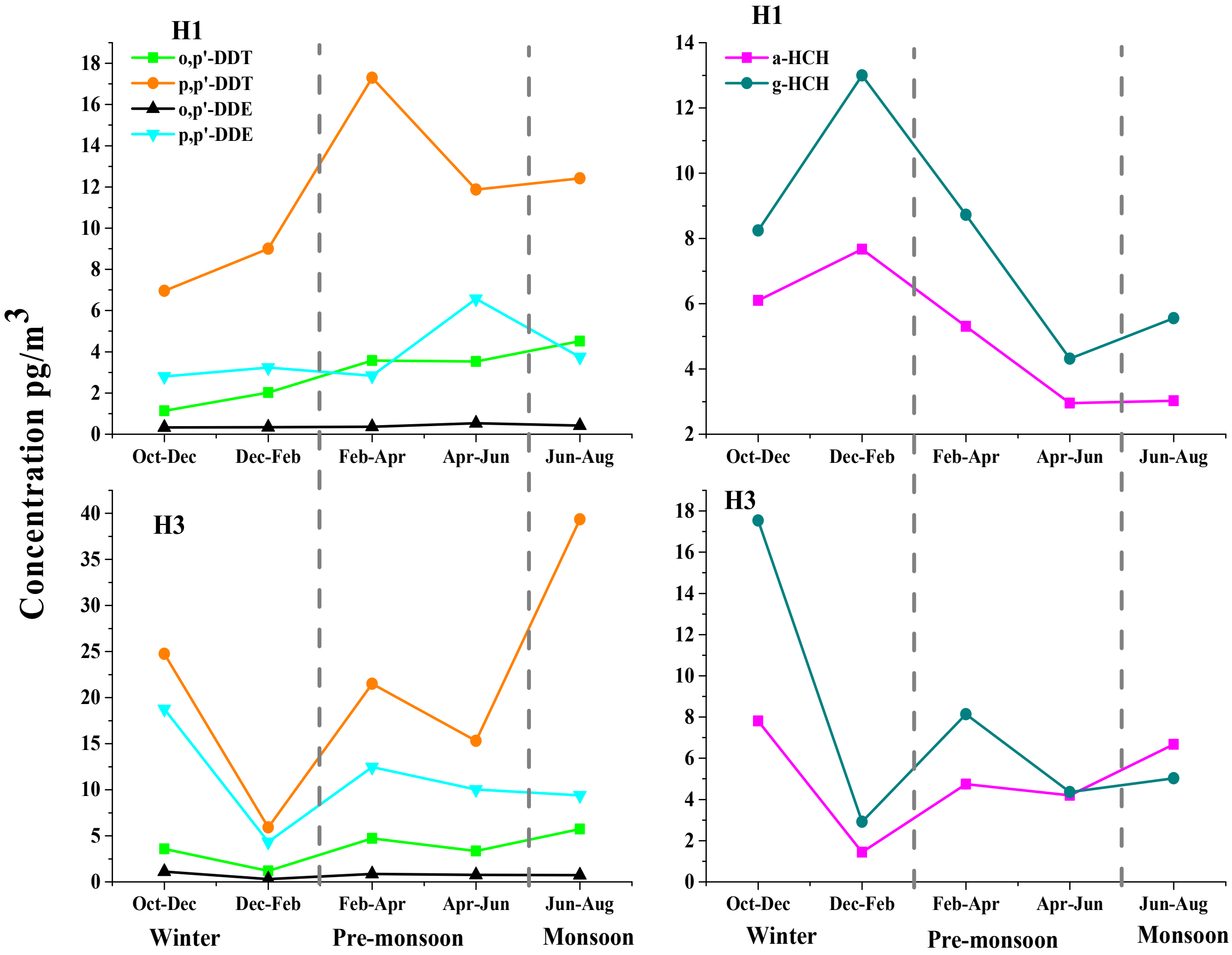

Figure SI-11. Seasonality of DDTs and HCHs in Hetauda (H1: Cropland, H3: Industrial area)

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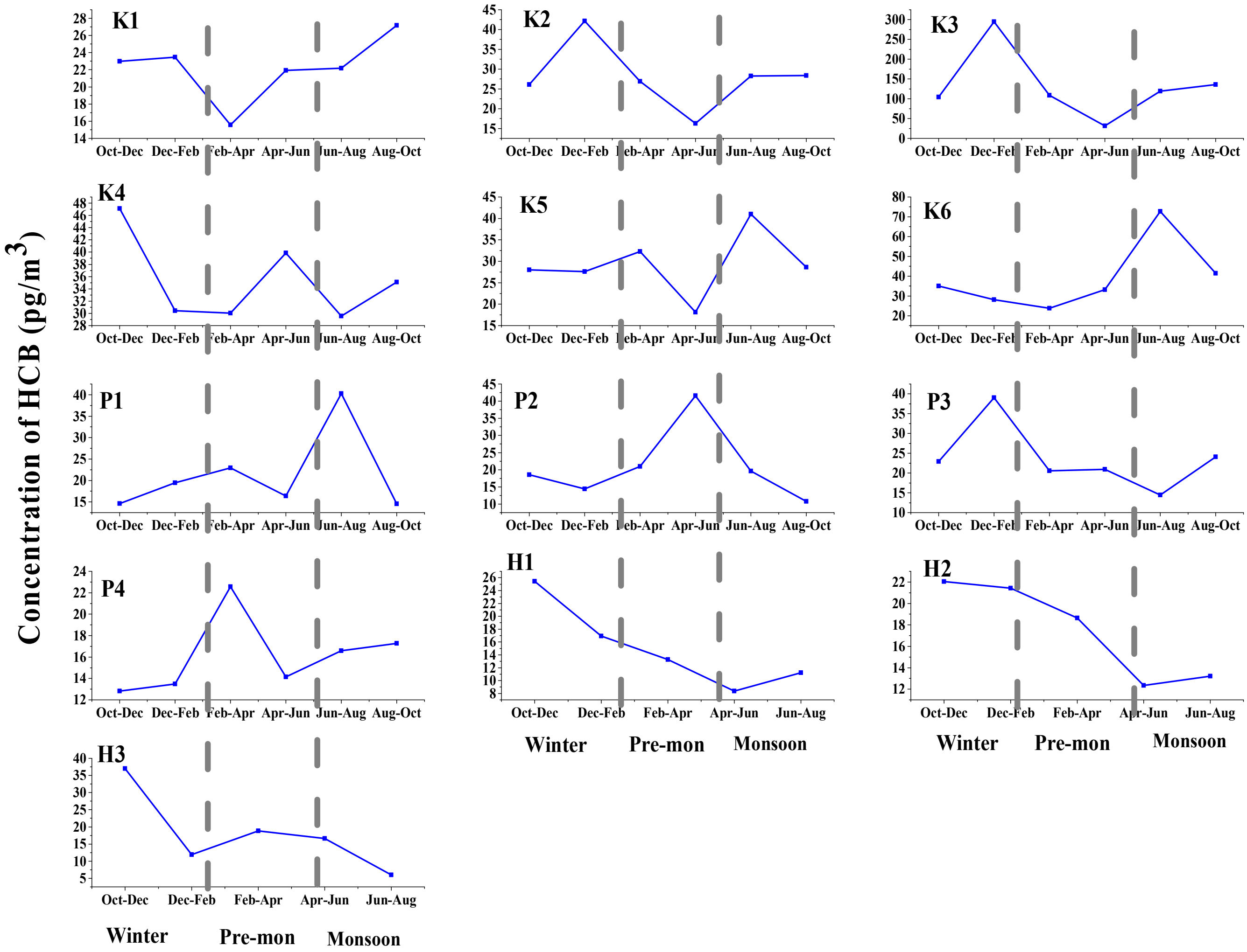

223 **Figure SI-12. Seasonal variation of HCB in 3 cities of Nepal**

Text SI-5. Estimation of loss rate of atmospheric OCPs

In the equation,

$$\tau_a = \frac{ln2}{k_{degr} + k_{wet} + k_{dry}} \quad (1)$$

Where τ_a is atmospheric residence time,

k_{degr} is photochemical degradation rate in air (s^{-1})

k_{wet} wet deposition rate (s^{-1})

k_{dry} dry deposition rate(s^{-1})

In general, degradation due to OH is considered the dominant process and Bayer et al., 2003 derived a simple temperature dependent relation to estimate OH concentration i.e. [OH] in atmosphere.

$$[OH] = 0.5 + 0.4\,(T - 273.15)\ \times\ 10^5 \quad (2)$$

where T is absolute temperature (K)

Then, using the rate constant K_{OH} (Table SI-12) the degradation rate k_{degr} is estimated as,

$$k_{degr} =\ K_{OH}[OH] \quad (3)$$

Assuming the gas phase as dominant form of the pollutants in the atmosphere wet deposition has been estimated using the relation

$$k_{wet} = \frac{R_i W_G}{h} \quad (4)$$

Where R_i = annual rain intensity (mm a^{-1})

W_G= gas phase scavenging ratio

h = atmospheric boundary layer height (m) and

effective gas phase scavenging ratio is estimated as reciprocal of Henry law coefficient

$$W_G = \frac{RT}{H} \quad (5)$$

where R = Gas law constant (8.314 Pa $m^3mol^{-1}K^{-1}$)

T= absolute temperature (K)

H = Henry's law constant

For dry deposition rate the k_{dry}, has been estimated as

$$k_{dry} = \frac{V_D}{h} \quad (6)$$

Where V_D is dry deposition velocity (cm s^{-1})

Temperature dependent dry deposition velocity for the gas phase pollutants can be estimated using relation proposed by González-Gaya et al., 2014

$$logV_D = -0.261 logPL - 2.670\ cm\ s^{-1}$$

Table SI-12. Temperature dependent Henry's law constant and vapor pressure with Rate constant of hydroxyl radical reaction at 25°C

Compounds	*logH (Pa m³ mol⁻¹)*	*logPL (Pa)*	K_{OH} *(25°C) cm³molec⁻¹s⁻¹*
p, p'-DDT	13.02-3369/T	13.02-4865/T	1.5×10^{-12}
α-HCH	8.98-1714/T	11.12 – 3497/T	1.4×10^{-13}
γ-HCH	11.58-3049/T	11.98-3905/T	1.9×10^{-13}
HCB	11.6-3013/T	11.11-3582/T	2.7×10^{-14}

Parameters about Henry's law constants, OH initiated atmospheric reaction rate and chemical's property data are found from literatures (Passivirta et al., 1999; Hinckley et al., 1990; Bai et al., 2013; Xiao et al., 2004; Brubaker et al., 1998; Jautunen et al., 2006)

Table SI-13. Calculated values of degradation and deposition rates (S^{-1}) based on field temperature and precipitation during monsoon season

		k_{degr}				k_{wet}				k_{dry}			
	Temp	p,p'-DDT	γ-HCH	α-HCH	HCB	p,p'-DDT	γ-HCH	α-HCH	HCB	p,p'-DDT	γ-HCH	α-HCH	HCB
Kathmandu													
Jan	284.15	9.66E-08	1.22E-08	9.02E-09	1.74E-09	2.48E-08	5.12E-08	4.08E-10	3.65E-08	8.38E-07	2.06E-07	1.45E-07	1.75E-07
Feb	286.15	2.23E-07	2.82E-08	2.08E-08	4.01E-09	2.07E-08	4.34E-08	3.73E-10	3.10E-08	7.80E-07	1.94E-07	1.38E-07	1.66E-07
Mar	290.15	8.52E-07	1.08E-07	7.95E-08	1.53E-08	1.44E-08	3.13E-08	3.13E-10	2.25E-08	6.77E-07	1.73E-07	1.25E-07	1.50E-07
Apr	293.15	1.92E-06	2.43E-07	1.79E-07	3.46E-08	1.11E-08	2.47E-08	2.75E-10	1.78E-08	6.11E-07	1.60E-07	1.16E-07	1.39E-07
May	295.15	3.09E-06	3.92E-07	2.89E-07	5.57E-08	9.33E-09	2.12E-08	2.53E-10	1.53E-08	5.71E-07	1.51E-07	1.10E-07	1.32E-07
Jun	297.15	4.78E-06	6.05E-07	4.46E-07	8.60E-08	7.87E-09	1.82E-08	2.32E-10	1.31E-08	5.34E-07	1.43E-07	1.05E-07	1.26E-07
Jul	297.15	4.78E-06	6.05E-07	4.46E-07	8.60E-08	7.87E-09	1.82E-08	2.32E-10	1.31E-08	5.34E-07	1.43E-07	1.05E-07	1.26E-07
Aug	297.15	4.78E-06	6.05E-07	4.46E-07	8.60E-08	7.87E-09	1.82E-08	2.32E-10	1.31E-08	5.34E-07	1.43E-07	1.05E-07	1.26E-07
Sep	296.15	3.86E-06	4.89E-07	3.60E-07	6.95E-08	8.57E-09	1.96E-08	2.42E-10	1.41E-08	5.52E-07	1.47E-07	1.08E-07	1.29E-07
Oct	293.15	1.92E-06	2.43E-07	1.79E-07	3.46E-08	1.11E-08	2.47E-08	2.75E-10	1.78E-08	6.11E-07	1.60E-07	1.16E-07	1.39E-07
Nov	289.15	6.29E-07	7.97E-08	5.87E-08	1.13E-08	1.58E-08	3.40E-08	3.27E-10	2.44E-08	7.02E-07	1.78E-07	1.28E-07	1.54E-07
Dec	285.15	1.49E-07	1.89E-08	1.39E-08	2.69E-09	2.27E-08	4.71E-08	3.90E-10	3.36E-08	8.08E-07	2.00E-07	1.42E-07	1.71E-07
Pokhara													
Jan	286.15	2.23E-07	2.82E-08	2.08E-08	4.01E-09	5.56E-08	1.17E-07	1.00E-09	8.34E-08	7.80E-07	1.94E-07	1.38E-07	1.66E-07
Feb	289.15	6.29E-07	7.97E-08	5.87E-08	1.13E-08	4.24E-08	9.14E-08	8.79E-10	6.55E-08	7.02E-07	1.78E-07	1.28E-07	1.54E-07
Mar	293.15	1.92E-06	2.43E-07	1.79E-07	3.46E-08	2.98E-08	6.65E-08	7.40E-10	4.79E-08	6.11E-07	1.60E-07	1.16E-07	1.39E-07
Apr	296.15	3.86E-06	4.89E-07	3.60E-07	6.95E-08	2.31E-08	5.27E-08	6.52E-10	3.81E-08	5.52E-07	1.47E-07	1.08E-07	1.29E-07
May	297.15	4.78E-06	6.05E-07	4.46E-07	8.60E-08	2.12E-08	4.89E-08	6.26E-10	3.53E-08	5.34E-07	1.43E-07	1.05E-07	1.26E-07

Jun	299.15	7.13E-06	9.03E-07	6.65E-07	1.28E-07	1.79E-08	4.20E-08	5.76E-10	3.04E-08	5.00E-07	1.36E-07	1.00E-07	1.20E-07
Jul	299.15	7.13E-06	9.03E-07	6.65E-07	1.28E-07	1.79E-08	4.20E-08	5.76E-10	3.04E-08	5.00E-07	1.36E-07	1.00E-07	1.20E-07
Aug	299.15	7.13E-06	9.03E-07	6.65E-07	1.28E-07	1.79E-08	4.20E-08	5.76E-10	3.04E-08	5.00E-07	1.36E-07	1.00E-07	1.20E-07
Sep	298.15	5.86E-06	7.42E-07	5.47E-07	1.05E-07	1.95E-08	4.53E-08	6.00E-10	3.28E-08	5.17E-07	1.39E-07	1.03E-07	1.23E-07
Oct	295.15	3.09E-06	3.92E-07	2.89E-07	5.57E-08	2.51E-08	5.70E-08	6.80E-10	4.11E-08	5.71E-07	1.51E-07	1.10E-07	1.32E-07
Nov	291.15	1.13E-06	1.44E-07	1.06E-07	2.04E-08	3.55E-08	7.79E-08	8.06E-10	5.60E-08	6.54E-07	1.69E-07	1.22E-07	1.46E-07
Dec	287.15	3.23E-07	4.09E-08	3.01E-08	5.81E-09	5.08E-08	1.08E-07	9.60E-10	7.69E-08	7.53E-07	1.89E-07	1.35E-07	1.62E-07
Hetauda													
Jan	288.15	4.56E-07	5.77E-08	4.25E-08	8.20E-09	2.68E-08	5.71E-08	5.30E-10	4.09E-08	7.27E-07	1.83E-07	1.31E-07	1.58E-07
Feb	290.15	8.52E-07	1.08E-07	7.95E-08	1.53E-08	2.24E-08	4.86E-08	4.85E-10	3.49E-08	6.77E-07	1.73E-07	1.25E-07	1.50E-07
Mar	294.15	2.45E-06	3.10E-07	2.29E-07	4.41E-08	1.58E-08	3.55E-08	4.09E-10	2.56E-08	5.91E-07	1.55E-07	1.13E-07	1.35E-07
Apr	299.15	7.13E-06	9.03E-07	6.65E-07	1.28E-07	1.03E-08	2.42E-08	3.32E-10	1.75E-08	5.00E-07	1.36E-07	1.00E-07	1.20E-07
May	301.15	1.03E-05	1.31E-06	9.64E-07	1.86E-07	8.75E-09	2.09E-08	3.06E-10	1.51E-08	4.69E-07	1.29E-07	9.58E-08	1.14E-07
Jun	301.15	1.03E-05	1.31E-06	9.64E-07	1.86E-07	8.75E-09	2.09E-08	3.06E-10	1.51E-08	4.69E-07	1.29E-07	9.58E-08	1.14E-07
Jul	300.15	8.61E-06	1.09E-06	8.04E-07	1.55E-07	9.50E-09	2.25E-08	3.19E-10	1.63E-08	4.84E-07	1.32E-07	9.80E-08	1.17E-07
Aug	300.15	8.61E-06	1.09E-06	8.04E-07	1.55E-07	9.50E-09	2.25E-08	3.19E-10	1.63E-08	4.84E-07	1.32E-07	9.80E-08	1.17E-07
Sep	299.15	7.13E-06	9.03E-07	6.65E-07	1.28E-07	1.03E-08	2.42E-08	3.32E-10	1.75E-08	5.00E-07	1.36E-07	1.00E-07	1.20E-07
Oct	298.15	5.86E-06	7.42E-07	5.47E-07	1.05E-07	1.12E-08	2.61E-08	3.46E-10	1.89E-08	5.17E-07	1.39E-07	1.03E-07	1.23E-07
Nov	293.15	1.92E-06	2.43E-07	1.79E-07	3.46E-08	1.72E-08	3.84E-08	4.27E-10	2.76E-08	6.11E-07	1.60E-07	1.16E-07	1.39E-07
Dec	288.15	4.56E-07	5.77E-08	4.25E-08	8.20E-09	2.68E-08	5.71E-08	5.30E-10	4.09E-08	7.27E-07	1.83E-07	1.31E-07	1.58E-07

Table SI-14. Comparison of characteristic travel distance (CTD, km) in current study areas with global and other specified regions

	This study (km)				Previous studies				
	Kathmandu	Pokhara	Hetauda	average	*Global (a)	*Global (b)	East & south china seas**	Indian Ocean**	South Atlantic **
HCB	11836	9834	9984	10551	10600	144304	13306	345	907
α-HCH	9346	7536	6250	7710	17946	22307	3629	605	484
γ-HCH	6016	4387	4035	4812	9732	22572	3024	544	363
p, p' -DDT	1269	956	776	1000	1045	1462	1331	774	

*Shen et al., 2005 *(a : estimation by TaPL3 model; b: estimation by ELPOS)*

** Gioia et al., 2012

Text SI-6 Uncertainties of CTD

Given soil can absorb atmospheric POPs, it may retard the transport of POPs. Previous study had investigated the air-soil exchange of POPs along south slope of Nepal Himalaya mountain, and the results found volatile compounds such as HCB, PCBs and HCHs reached air-soil exchange equilibrium in low elevation cities (Gong et al., 2014). This means for the volatile compounds, only the atmospheric processes (i.e. OH degradation and dry/wet deposition) are major loss process. Due to the possible overestimation of OH concentration reported by Anderson et al. (1996), τ_a will be underestimated and then CTD will be underestimated. With respect to less volatile compounds such as DDTs, their air-soil exchange showed deposition trend (Gong et al., 2014), suggesting soil absorption should not be ignored. As this will reduced τ_a of DDTs, and lead to the overestimation of CTD.

Text SI-7 Generation of forward trajectories

NOAA's HYSPLIT model and the NCEP/NCAR Global Reanalysis data set for Kathmandu were used to calculate forward trajectories. Forward trajectories were traced for 3 days at 6 h intervals at 100 m above sea level. All 416 trajectories were grouped into 5 clusters. Sixty present of trajectories (sum of cluster 1, 2 and 3) move northward, crossing the Himalaya and reaching southeastern Tibetan Plateau.

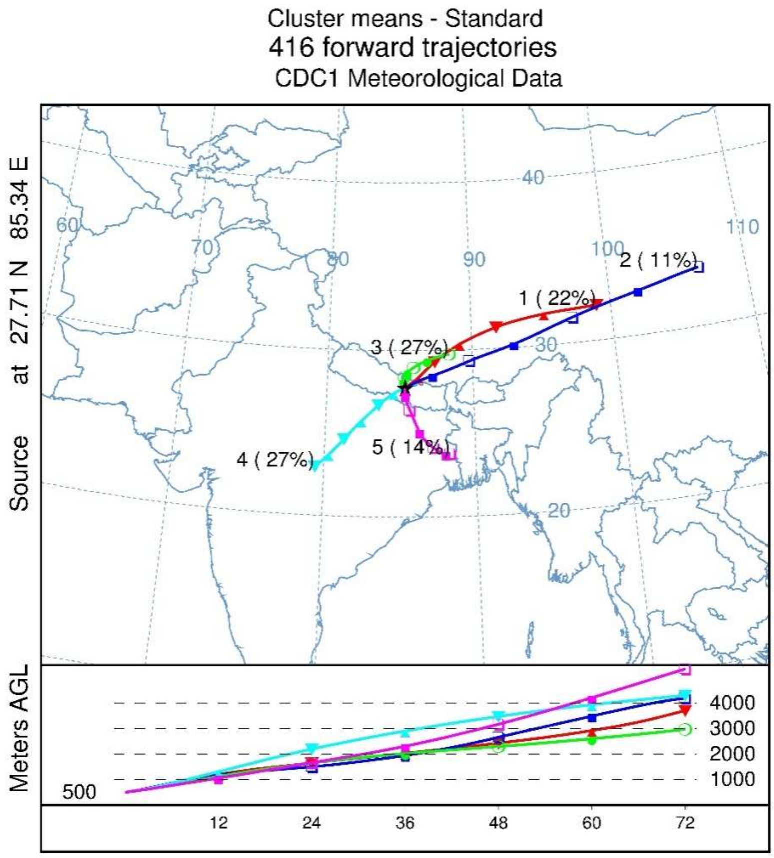

Figure SI-13. Clusters of forward trajectories for Kathmandu

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