



环境化学与生态毒理学  
国家重点实验室

State Key Laboratory of Environmental  
Chemistry and Ecotoxicology

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# Occurrence and fate of methylsiloxanes in soil from electronic-waste dismantling area, China

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# Outline

➤ **Background**

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➤ **Results and Discussion**

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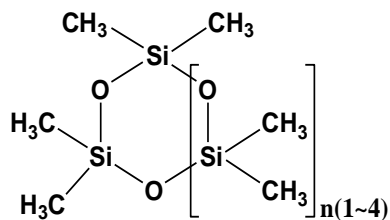
➤ **Conclusion**

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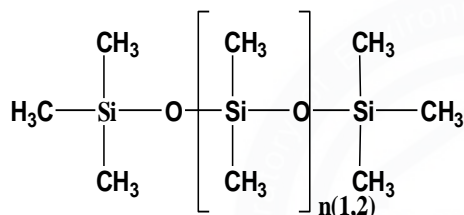
# Background



**Methylsiloxanes**

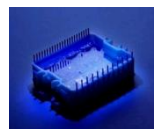


**Cyclic analogues (D)**



**Linear analogues (L)**

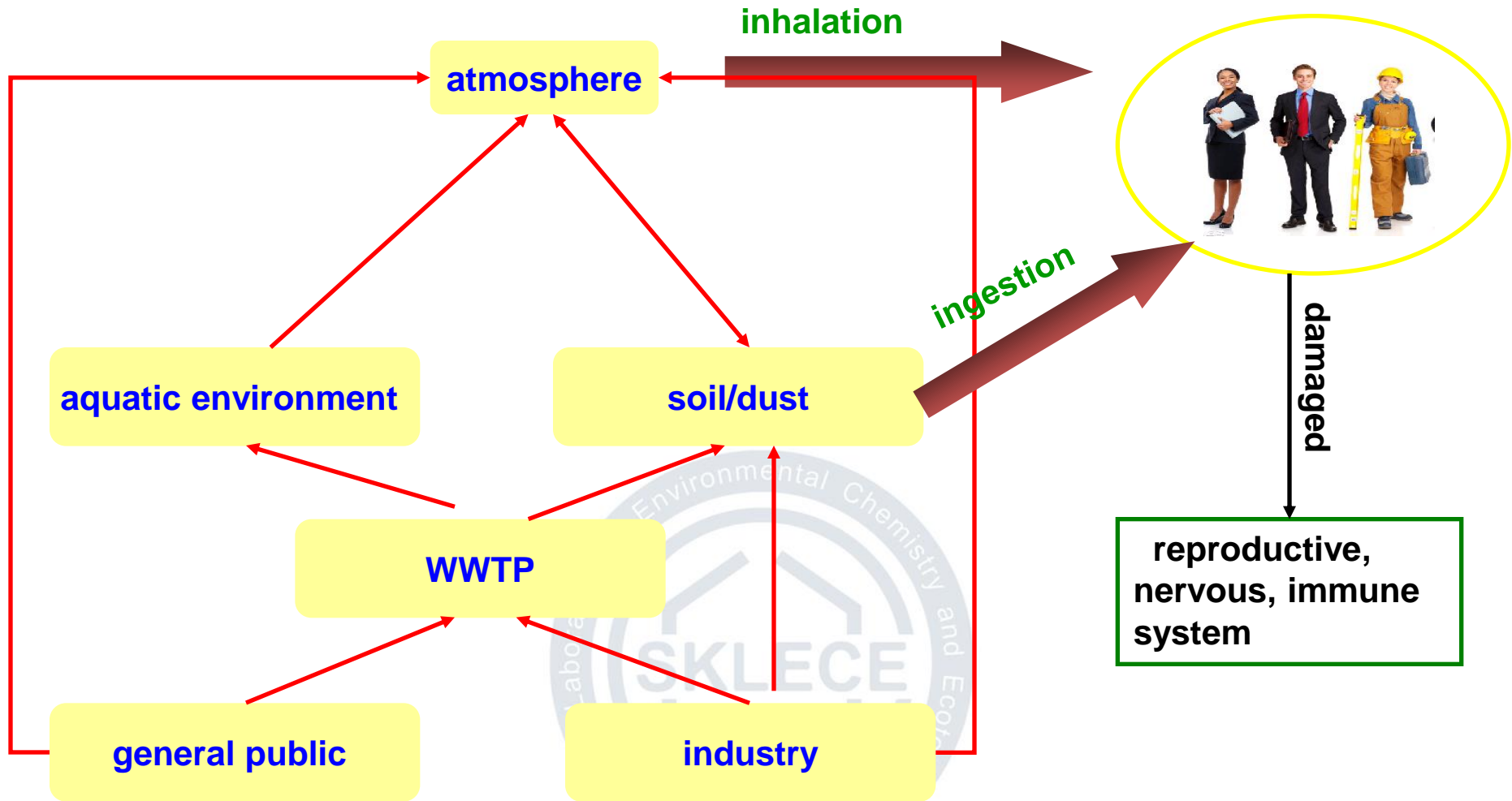
## Wide usage in industry and domesticity

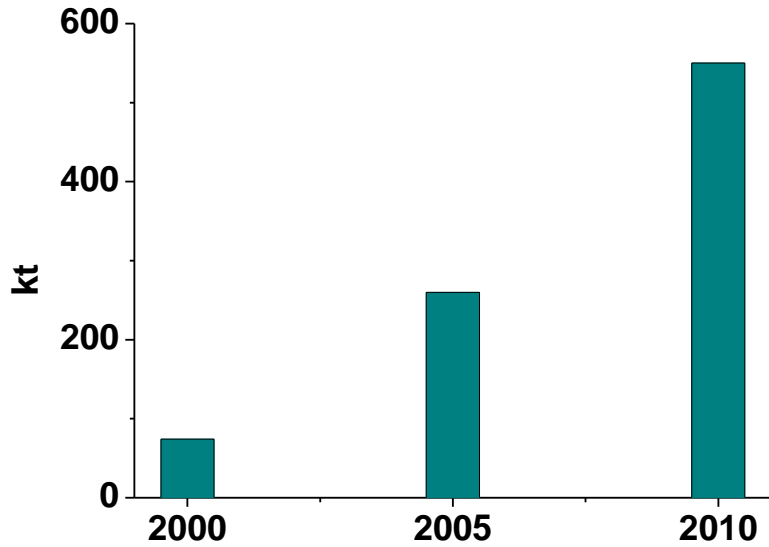


Methyl siloxanes consist of Si-O bonds with methyl groups attached to Si atoms.

Since 1980s, they have been wildly used as additives in industrial processes and products, including lubricants, polishes, paints, textile products, and personal care products because they have low surface tension, high thermal stability, and smooth texture.

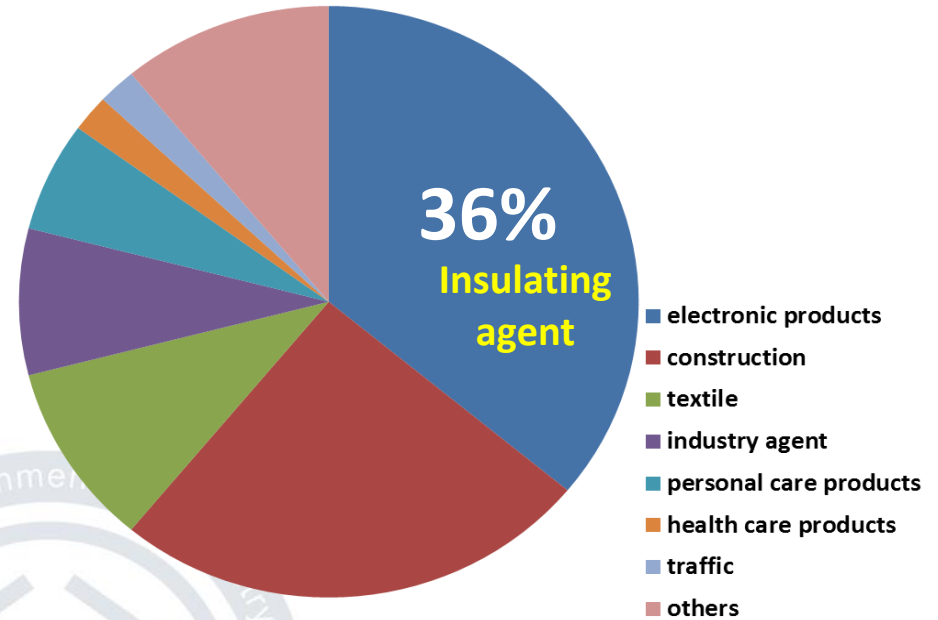
# Background





### Large production volume in China

China is leading the world (about 30%) in siloxane production capacity, with an annual production of about 500 million kilograms in 2010.



### Usage in China

# Occurrence of Cyclic and Linear Siloxanes in Indoor Dust from China, and Implications for Human Exposures

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## Introduction

Cyclic and linear siloxanes are synthetic organosilicon compounds, consisting of a backbone of alternating silicon and oxygen [Si–O] bonds, with organic side chains attached to each silicon atom (*D*). These compounds have been widely used in industrial appliances and a vast range of consumer products, such as electrical devices, health-care products, cosmetics, cookware, and household cleaning products (2). Horii and Kannan (4) determined the concentrations of cyclic and linear siloxanes in 76 consumer products sampled in Albany, NY, and showed widespread occurrence of octaethylcyclotetrasiloxane (D<sub>4</sub>, where D refers to the dimethylsiloxane unit, and the subscript refers to the number

**TABLE 2. Median Concentrations (ng g<sup>-1</sup>) of Silicones in Indoor Dust As Related to the Number of Electrical/Electronic Devices (N) Present in the Indoor Environment**

	<i>N</i> < 3 ( <i>n</i> = 32)	<i>N</i> = 3–5 ( <i>n</i> = 31)	<i>N</i> > 5 ( <i>n</i> = 25)
D <sub>4</sub>	5.10	10.4	17.7
D <sub>5</sub>	14.8	20.2	25.7
D <sub>6</sub>	11.0	17.5	20.5
D <sub>7</sub>	5.31	12.3	20.5
TCS <sup>a</sup>	44.9	65.1	115
L <sub>4</sub>	43.6	25.8	36.0
L <sub>5</sub>	1.12	1.66	1.17
L <sub>6</sub>	1.56	<LOQ	1.56
L <sub>7</sub>	1.53	2.50	10.8
L <sub>8</sub>	12.1	27.3	74.7
L <sub>9</sub>	22.7	68.7	232
L <sub>10</sub>	38.1	88.4	339
L <sub>11</sub>	29.9	71.0	238
L <sub>12</sub>	16.8	44.9	81.5
L <sub>13</sub>	11.1	23.3	24.5
L <sub>14</sub>	9.30	23.8	16.7
TLS <sup>b</sup>	242.1	578	1440

<sup>a</sup> TCS = Total cyclic siloxane. <sup>b</sup> TLS = Total linear siloxane.

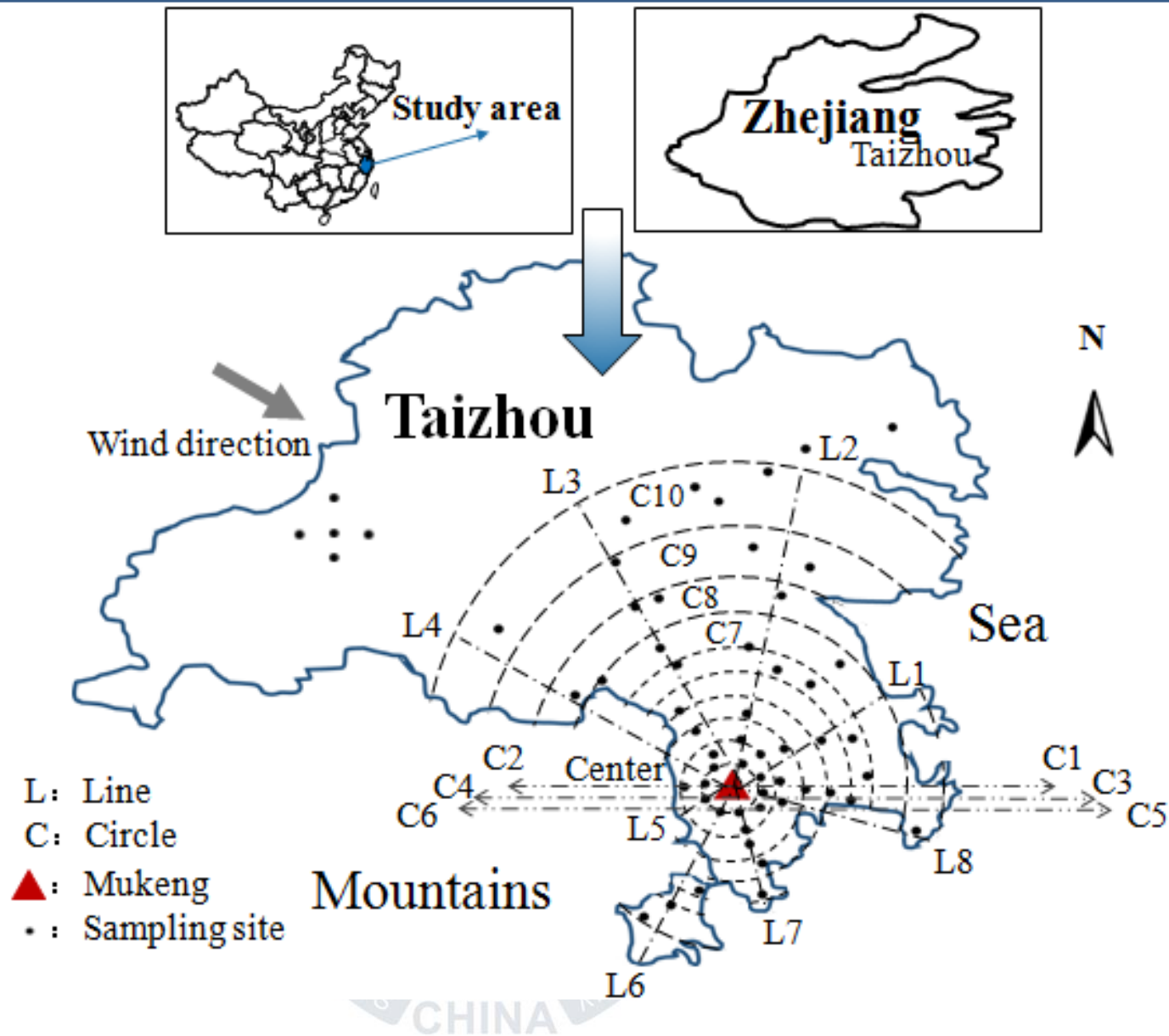
A general tendency of increasing siloxane concentrations in dust samples (median) with the number of electrical/electronic products used in the indoor environment was observed in present study (Table 2). Significantly higher concentrations of D<sub>4</sub>, L<sub>8</sub>, L<sub>9</sub>, and L<sub>10</sub> (*p* < 0.05; one-way ANOVA) were found in dust collected from rooms with more electrical devices (*N* > 5), than from rooms with fewer such appliances (*N* < 3).



China was the second largest country generating e-waste (700 million tonnes in 2012). And it was the most important country dismantling e-waste.



# Sample collection

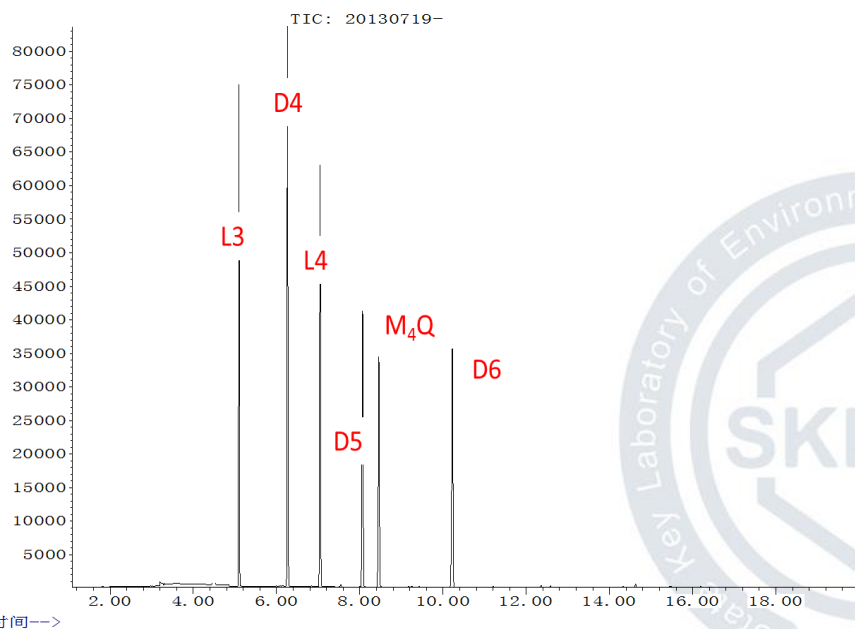




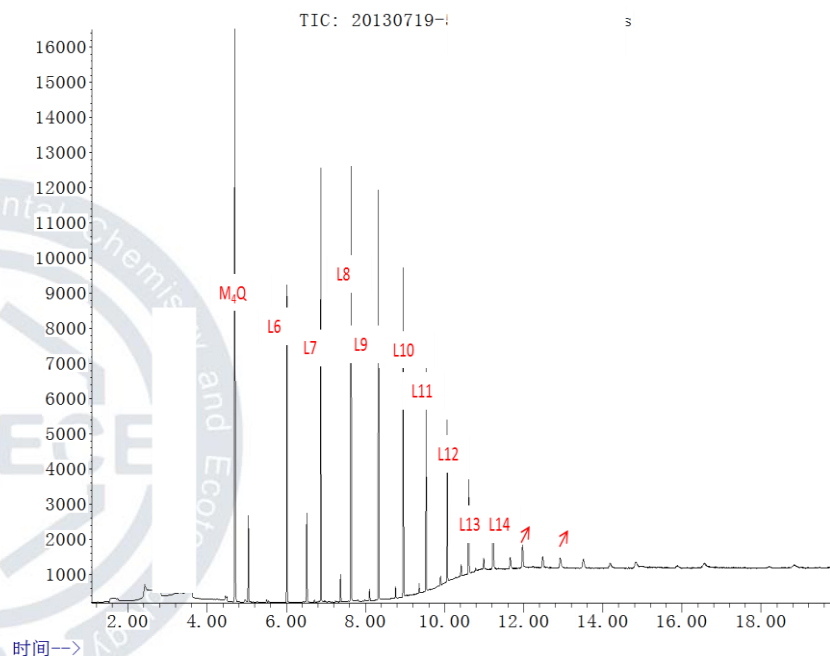
# GC-MS analysis for methylsiloxanes

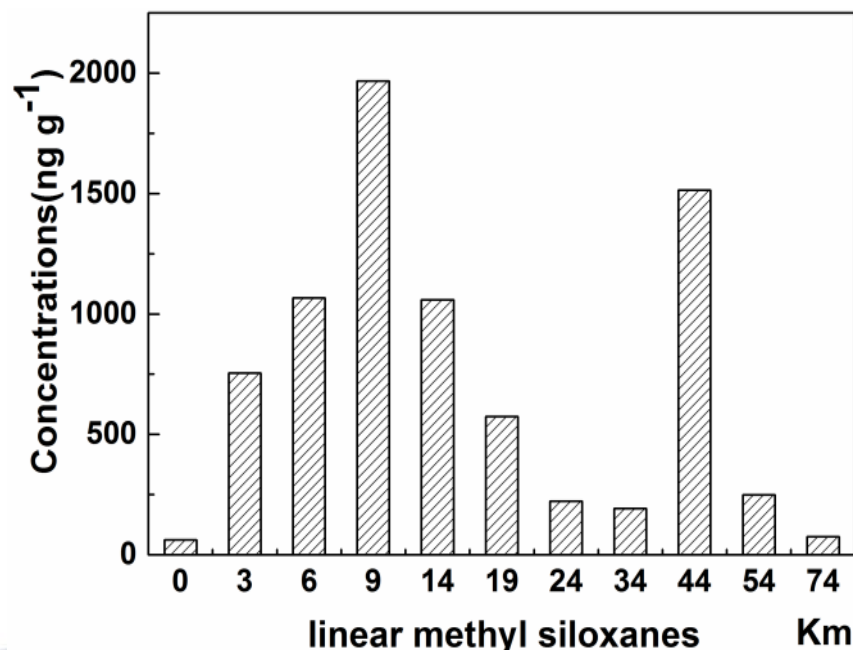
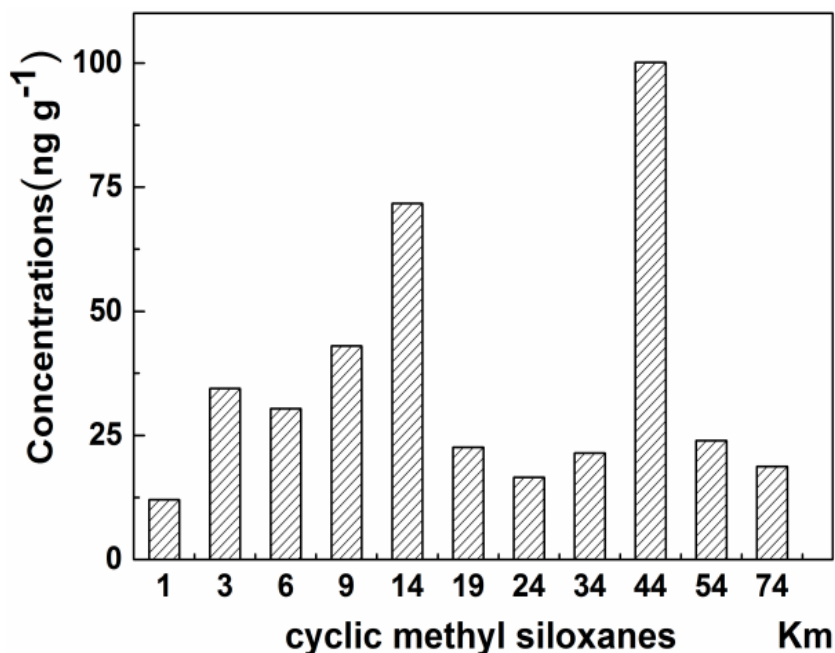


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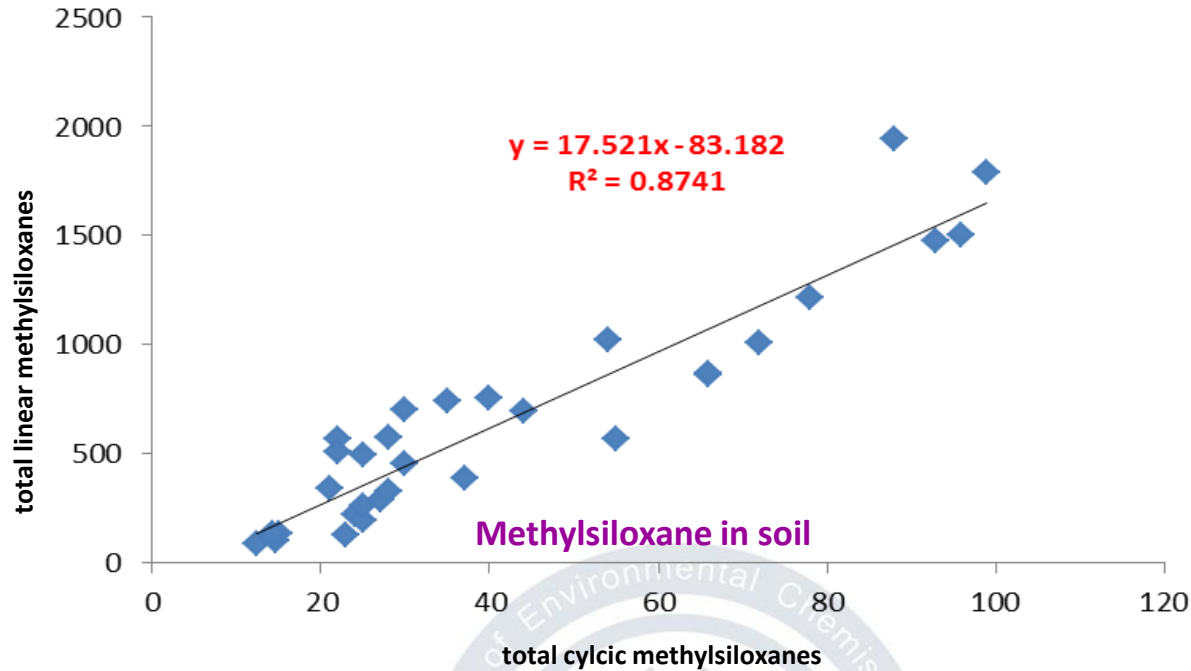


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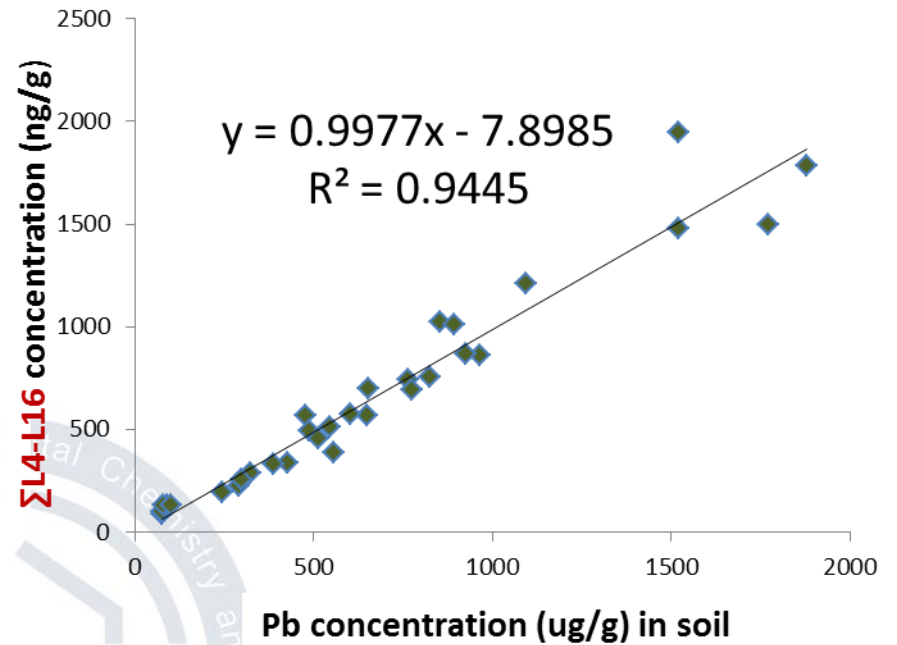
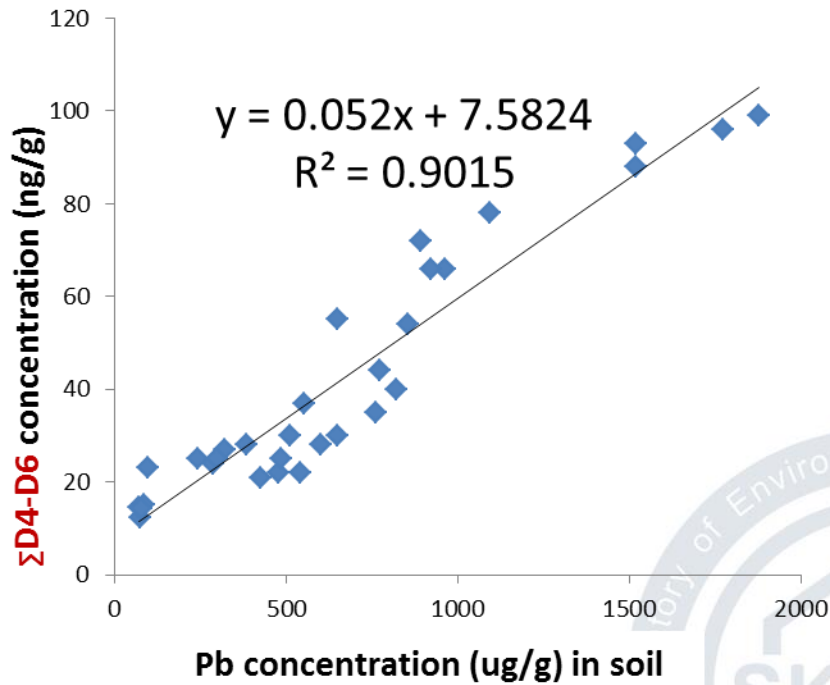




15 target compounds (D4—D6, L5—L16) in these soil samples were detected. The total concentrations were  $37.5\text{—}7.28 \times 10^3$  ppb for linear methyl siloxanes (L4—L16) and  $10.3\text{—}177$  ppb for cyclic methyl siloxanes (D4—D6), respectively, which were 17 and 4 times higher than those in controlling soil samples.

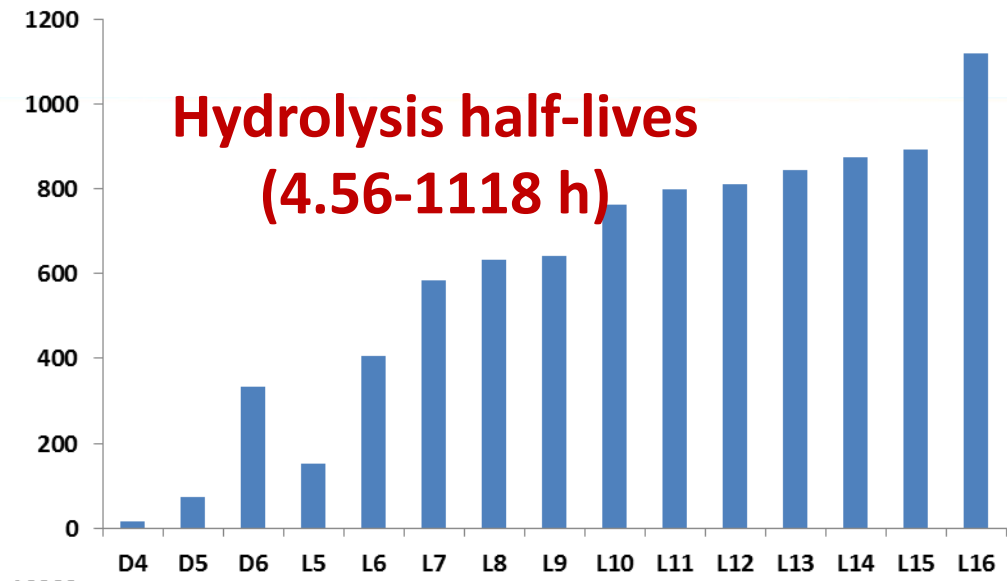


Concentrations of total cyclic siloxanes had correlations with those of total linear siloxanes



Concentrations of siloxanes in soil had correlations with Pb concentrations

# Elimination of methylsiloxanes in soil





# Conclusion

- **Methyl siloxane concentrations in soil samples around the e-waste dismantling area are higher than those in reference area (general public)**
- **E-waste dismantling should be the important pollution source of methylsiloxanes in the studied area**
- **Methylsiloxanes elimination rates of both cyclic and linear siloxanes in soil decreased with increasing number of Si-O bonds**





Thank you for your attention

