

Supplementary Information

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Role of height and position in vertical distribution pattern of urban surface-deposited sediments and associated heavy metals

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No. of figures: 3

No. of tables: 4

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1. Table S1

Table S1. The characteristics of urban surfaces with different spatial height and their surrounding environment

Sampling sites	The characteristics of urban surfaces *			Traffic nearby/ vehicle/hour **	Construction site nearby
	height	type	texture		
Anli Road	0 m	road surfaces	asphalt	2,500	No
	3 m	bus platform	plastic		
	5 m	over bridge	rubber		
	20 m	roof top	linoleum		
North Fourth Ring Road	0 m	road surfaces	asphalt	10,000	No
	3 m	bus platform	stainless steel		
	5 m	over bridge	rubber		
	15 m	roof top	concrete		
Shuangqing Road	0 m	road surfaces	asphalt	1,050	200 m away from the construction site
	3 m	bus platform			
	5 m	over bridge	rubber		
	20 m	roof top	linoleum		
Xiaoying East Road	0 m	road surfaces	asphalt	1,250	300 m away from the construction site
	3 m	bus platform			
	5 m	over bridge	concrete		
	18 m	roof top	linoleum		
Suzhou Road	0 m	road surfaces	asphalt	1,700	No
	3 m	bus platform	plastics		
	5 m	over bridge	rubber		
	20 m	roof top	linoleum		

* There's no data in the table because not enough samples were collected at this site ;

** The traffic flow refers to the period from 8:00 to 20:00.

2. Table S2

Table S2. The percentage of each RDS size fraction washed off (F_{wi} , %) on asphalt and concrete surfaces by rainfall simulation*

Surface types	Grain size fraction of RDS (μm)**						
	<44	44-62	62-105	105-149	149-250	250-450	450-1000
Asphalt	49.4	37.7	23.7	10.6	7.0	4.3	3.4
Concrete	61.2	51.2	47.5	35.2	13.3	6.6	5.5

* The rainfall event was rainfall intensity of 29.9 mm/h and rainfall duration of 1 hour.

** The wash-off percentage of 1000-2000 μm was missing and was replaced by 450-1000 μm

3. Table S3

Table S3. The dynamic variation of particle size composition with the input-output relationship of USDs on road surface

the first day										
grain size (μm)	mass (g/m^2)	percentage	sweep removal rate*	removal mass (g/m^2)	remaining mass (g/m^2)	percentage after sweeping	☐	☐	☐	percenta ge of <100 μm
<44	0.24	0.85%	0.16	0.04	0.20	1.10%	☐	☐	☐	39.25%
44-62	1.44	5.16%	0.05	0.07	1.37	7.55%	☐	☐	☐	☐
62-105	9.29	33.24%	0.05	0.46	8.83	48.61%	☐	☐	☐	☐
105-149	1.79	6.41%	0.48	0.86	0.93	5.13%	☐	☐	☐	☐
149-250	6.74	24.10%	0.48	3.23	3.50	19.29%	☐	☐	☐	☐
250-450	5.87	21.01%	0.60	3.52	2.35	12.94%	☐	☐	☐	☐
450-1000	1.74	6.21%	0.60	1.04	0.69	3.82%	☐	☐	☐	☐
1000-2000	0.85	3.03%	0.67	0.57	0.28	1.54%	☐	☐	☐	☐
the bulk size	27.96	☐	☐	9.80	18.16	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
the second day (urban soil input 9.53 g/m^2 , atmospheric dry deposition flux 0.27 g/m^2 **)										
grain size (μm)	mass (g/m^2)	urban soil input***	after urban soil input (g/m^2)	after urban soil and ADD input (g/m^2)	percentage after input	sweep removal rate	removal mass (g/m^2)	remaining mass (g/m^2)	percentage after sweeping	percenta ge of <100 μm
<44	0.20	2.03%	0.39	0.66	2.37%	0.16	0.11	0.56	3.08%	41.85%

44-62	1.37	2.66%	1.62	1.62	5.81%	0.05	0.08	1.54	8.55%	☐
62-105	8.83	6.15%	9.41	9.41	33.67%	0.05	0.47	8.94	49.52%	☐
105-149	0.93	3.13%	1.23	1.23	4.40%	0.48	0.59	0.64	3.54%	☐
149-250	3.50	12.35%	4.68	4.68	16.74%	0.48	2.25	2.43	13.48%	☐
250-450	2.35	25.85%	4.81	4.81	17.21%	0.60	2.89	1.92	10.66%	☐
450-1000	0.69	21.63%	2.76	2.76	9.85%	0.60	1.65	1.10	6.10%	☐
1000-2000	0.28	26.21%	2.78	2.78	9.94%	0.67	1.86	0.92	5.08%	☐
the bulk size	☐	☐	☐	27.96	☐	☐	9.90	18.06	☐	☐
the third day (urban soil input 9.63 g/m², atmospheric dry deposition flux 0.27 g/m²)										
grain size (μm)	mass (g/m²)	urban soil input	after urban soil input (g/m²)	after urban soil and ADD input (g/m²)	percentage after input	sweep removal rate	removal mass (g/m²)	remaining mass (g/m²)	percentage after sweeping	percenta ge of <100 μm
<44	0.56	2.03%	0.75	1.02	3.66%	0.16	0.16	0.86	4.72%	44.20%
44-62	1.54	2.66%	1.80	1.80	6.44%	0.05	0.09	1.71	9.40%	☐
62-105	8.94	6.15%	9.54	9.54	34.10%	0.05	0.48	9.06	49.83%	☐
105-149	0.64	3.13%	0.94	0.94	3.36%	0.48	0.45	0.49	2.69%	☐
149-250	2.43	12.35%	3.62	3.62	12.96%	0.48	1.74	1.88	10.36%	☐
250-450	1.92	25.85%	4.41	4.41	15.79%	0.60	2.65	1.77	9.71%	☐
450-1000	1.10	21.63%	3.18	3.18	11.39%	0.60	1.91	1.27	7.01%	☐
1000-2000	0.92	26.21%	3.44	3.44	12.31%	0.67	2.31	1.14	6.25%	☐
the bulk size	☐	☐	☐	27.96	☐	☐	9.79	18.18	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
the fourth day (urban soil input 9.52 g/m², atmospheric dry deposition flux 0.27 g/m²)										
grain size (μm)	mass (g/m²)	urban soil input	after urban soil input	after urban soil and ADD	percentage after input	sweep removal rate	removal mass (g/m²)	remaining mass (g/m²)	percentage after	percenta ge of

			(g/m ²)	input (g/m ²)					sweeping	<100 µm
<44	0.86	2.03%	1.05	1.32	4.73%	0.16	0.21	1.11	6.05%	46.24%
44-62	1.71	2.66%	1.96	1.96	7.02%	0.05	0.10	1.86	10.15%	□
62-105	9.06	6.15%	9.64	9.64	34.49%	0.05	0.48	9.16	49.90%	□
105-149	0.49	3.13%	0.79	0.79	2.81%	0.48	0.38	0.41	2.23%	□
149-250	1.88	12.35%	3.06	3.06	10.94%	0.48	1.47	1.59	8.67%	□
250-450	1.77	25.85%	4.23	4.23	15.12%	0.60	2.54	1.69	9.21%	□
450-1000	1.27	21.63%	3.33	3.33	11.92%	0.60	2.00	1.33	7.26%	□
1000-2000	1.14	26.21%	3.63	3.63	12.99%	0.67	2.43	1.20	6.53%	□
the bulk size	□	□	□	27.97	□	□	9.61	18.36	□	□
□	□	□	□	□	□	□	□	□	□	□
the fifth day (urban soil input 9.34 g/m ² , atmospheric dry deposition flux 0.27 g/m ²)										
grain size (µm)	mass (g/m ²)	urban soil input	after urban soil input (g/m ²)	after urban soil and ADD input (g/m ²)	percentage after input	sweep removal rate	removal mass (g/m ²)	remaining mass (g/m ²)	percentage after sweeping	percentage of <100 µm
<44	1.11	2.03%	1.30	1.57	5.62%	0.16	0.25	1.32	7.11%	47.99%
44-62	1.86	2.66%	2.11	2.11	7.56%	0.05	0.11	2.01	10.82%	□
62-105	9.16	6.15%	9.74	9.74	34.82%	0.05	0.49	9.25	49.86%	□
105-149	0.41	3.13%	0.70	0.70	2.51%	0.48	0.34	0.36	1.97%	□
149-250	1.59	12.35%	2.74	2.74	9.82%	0.48	1.32	1.43	7.69%	□
250-450	1.69	25.85%	4.10	4.10	14.68%	0.60	2.46	1.64	8.85%	□
450-1000	1.33	21.63%	3.35	3.35	11.99%	0.60	2.01	1.34	7.23%	□
1000-2000	1.20	26.21%	3.65	3.65	13.04%	0.67	2.44	1.20	6.49%	□
the bulk size	□	□	□	27.97	□	□	9.42	18.55	□	□

the sixth day (urban soil input 9.15 g/m ² , atmospheric dry deposition flux 0.27 g/m ²)										
grain size (μm)	mass (g/m ²)	urban soil input	after urban soil input (g/m ²)	after urban soil and ADD input (g/m ²)	percentage after input	sweep removal rate	removal mass (g/m ²)	remaining mass (g/m ²)	percentage after sweeping	percentage of <100 μm
<44	1.32	2.03%	1.51	1.78	6.35%	0.16	0.28	1.49	7.96%	49.49%
44-62	2.01	2.66%	2.25	2.25	8.05%	0.05	0.11	2.14	11.41%	
62-105	9.25	6.15%	9.81	9.81	35.09%	0.05	0.49	9.32	49.74%	
105-149	0.36	3.13%	0.65	0.65	2.33%	0.48	0.31	0.34	1.81%	
149-250	1.43	12.35%	2.56	2.56	9.15%	0.48	1.23	1.33	7.10%	
250-450	1.64	25.85%	4.01	4.01	14.33%	0.60	2.40	1.60	8.55%	
450-1000	1.34	21.63%	3.32	3.32	11.87%	0.60	1.99	1.33	7.09%	
1000-2000	1.20	26.21%	3.60	3.60	12.88%	0.67	2.41	1.19	6.34%	
the bulk size				27.97			9.24	18.74		
the seventh day (urban soil input 8.97 g/m ² , atmospheric dry deposition flux 0.27 g/m ²)										
grain size (μm)	mass (g/m ²)	urban soil input	after urban soil input (g/m ²)	after urban soil and ADD input (g/m ²)	percentage after input	sweep removal rate	removal mass (g/m ²)	remaining mass (g/m ²)	percentage after sweeping	percentage of <100 μm
<44	1.49	2.03%	1.67	1.94	6.95%	0.16	0.31	1.63	8.64%	50.76%
44-62	2.14	2.66%	2.38	2.38	8.50%	0.05	0.12	2.26	11.94%	
62-105	9.32	6.15%	9.87	9.87	35.31%	0.05	0.49	9.38	49.63%	
105-149	0.34	3.13%	0.62	0.62	2.21%	0.48	0.30	0.32	1.70%	
149-250	1.33	12.35%	2.44	2.44	8.72%	0.48	1.17	1.27	6.71%	
250-450	1.60	25.85%	3.92	3.92	14.02%	0.60	2.35	1.57	8.30%	

450-1000	1.33	21.63%	3.27	3.27	11.69%	0.60	1.96	1.31	6.92%	□
1000-2000	1.19	26.21%	3.54	3.54	12.66%	0.67	2.37	1.17	6.18%	□
the bulk size	□	□	□	27.98	□	□	9.08	18.90	□	□
□	□	□	□	□	□	□	□	□	□	□
the eighth day (urban soil input 8.67 g/m ² , atmospheric dry deposition flux 0.27 g/m ²)										
grain size (μm)	mass (g/m ²)	urban soil input	after urban soil input (g/m ²)	after urban soil and ADD input (g/m ²)	percentage after input	sweep removal rate	removal mass (g/m ²)	remaining mass (g/m ²)	percentage after sweeping	percentage of <100 μm
<44	1.63	2.03%	1.81	2.08	7.44%	0.16	0.33	1.75	9.18%	51.84%
44-62	2.26	2.66%	2.49	2.49	8.91%	0.05	0.12	2.37	12.42%	□
62-105	9.38	6.15%	9.92	9.92	35.48%	0.05	0.50	9.43	49.48%	□
105-149	0.32	3.13%	0.60	0.60	2.14%	0.48	0.29	0.31	1.63%	□
149-250	1.27	12.35%	2.36	2.36	8.42%	0.48	1.13	1.22	6.43%	□
250-450	1.57	25.85%	3.85	3.85	13.75%	0.60	2.31	1.54	8.07%	□
450-1000	1.31	21.63%	3.21	3.21	11.49%	0.60	1.93	1.28	6.75%	□
1000-2000	1.17	26.21%	3.48	3.48	12.44%	0.67	2.33	1.15	6.02%	□
the bulk size	□	□	□	27.98	□	□	8.94	19.05	□	□
□	□	□	□	□	□	□	□	□	□	□
the ninth day (urban soil input 9.52 g/m ² , atmospheric dry deposition flux 0.27 g/m ²)										
grain size (μm)	mass (g/m ²)	urban soil input	after urban soil input (g/m ²)	after urban soil and ADD input (g/m ²)	percentage after input	sweep removal rate	removal mass (g/m ²)	remaining mass (g/m ²)	percentage after sweeping	percentage of <100 μm
<44	1.75	2.03%	1.92	2.19	7.85%	0.16	0.35	1.84	9.58%	52.75%
44-62	2.37	2.66%	2.60	2.60	9.29%	0.05	0.13	2.47	12.82%	□
62-105	9.43	6.15%	9.96	9.96	35.62%	0.05	0.50	9.46	49.17%	□

105-149	0.31	3.13%	0.58	0.58	2.08%	0.48	0.28	0.30	1.57%	□
149-250	1.22	12.35%	2.30	2.30	8.21%	0.48	1.10	1.19	6.20%	□
250-450	1.54	25.85%	3.78	3.78	13.52%	0.60	2.27	1.51	7.86%	□
450-1000	1.28	21.63%	3.16	3.16	11.30%	0.60	1.90	1.26	6.57%	□
1000-2000	1.15	26.21%	3.42	3.42	12.23%	0.67	2.29	1.13	5.87%	□
the bulk size	□	□	□	27.99	□	□	8.81	19.17	□	□
□	□	□	□	□	□	□	□	□	□	□
the tenth day (urban soil input 8.54 g/m², atmospheric dry deposition flux 0.27 g/m²)										
grain size (μm)	mass (g/m²)	urban soil input	after urban soil input (g/m²)	after urban soil and ADD input (g/m²)	percentage after input	sweep removal rate	removal mass (g/m²)	remaining mass (g/m²)	percentage after sweeping	percenta ge of <100 μm
<44	1.84	2.03%	2.02	2.29	8.18%	0.16	0.37	1.92	9.99%	53.53%
44-62	2.47	2.66%	2.69	2.69	9.64%	0.05	0.13	2.56	13.30%	□
62-105	9.46	6.15%	9.99	9.99	35.71%	0.05	0.50	9.49	49.30%	□
105-149	0.30	3.13%	0.57	0.57	2.04%	0.48	0.27	0.30	1.54%	□
149-250	1.19	12.35%	2.25	2.25	8.04%	0.48	1.08	1.17	6.08%	□
250-450	1.51	25.85%	3.72	3.72	13.30%	0.60	2.23	1.49	7.73%	□
450-1000	1.26	21.63%	3.11	3.11	11.13%	0.60	1.87	1.24	6.47%	□
1000-2000	1.13	26.21%	3.37	3.37	12.04%	0.67	2.26	1.11	5.78%	□
the bulk size	□	□	□	27.98	□	□	8.71	19.28	□	□
□	□	□	□	□	□	□	□	□	□	□
the tenth day (rainfall event, intensity 29.9 mm/h, duration 1 hour)										
grain size (μm)	mass (g/m²)	urban soil input	after urban soil input (g/m²)	after urban soil and ADD input (g/m²)	wash-off rate	rainfall removal mass	percentage after rainfall	□	□	percenta ge of <100 μm

<44	1.84	2.03%	2.02	2.29	0.49	1.16	4.95%	□	□	□
44-62	2.47	2.66%	2.69	2.69	0.38	1.68	7.18%	□	□	44.70%
62-105	9.46	6.15%	9.99	9.99	0.24	7.62	32.57%	□	□	□
105-149	0.30	3.13%	0.57	0.57	0.11	0.51	2.18%	□	□	□
149-250	1.19	12.35%	2.25	2.25	0.07	2.09	8.94%	□	□	□
250-450	1.51	25.85%	3.72	3.72	0.04	3.56	15.22%	□	□	□
450-1000	1.26	21.63%	3.11	3.11	0.03	3.01	12.85%	□	□	□
1000-2000	1.13	26.21%	3.37	3.37	0.03	3.25	13.91%	□	□	□
the bulk size	□	□	□	27.98	□	22.87	□	□	□	□

* Sweep removal rate was the change of RDS before and after sweeping based on field investigation.

** Atmospheric particulate deposition flux in Beijing in 2012-2013, was $0.27 \text{ g} \cdot (\text{m}^2 \cdot \text{d})^{-1}$ (Yao et al., 2017).

*** The soil particle size percentage was obtained from field measurement. The urban soil input mass was calculated based on the difference between input and output, assuming that RDS mass remains constant after its dynamic equilibrium mass of USDs (27.96 g/m^2) before next rainfall event.

4. Table S4

Table S4. Sampling sites' surface characteristics

Sampling site	Height (m)	Surface material	Roughness
Bridge	5	Concrete; Plastic	2-4
Bus platform	3	Stainless steel	1
Road	0	Bituminous	3
Roof	20	Concrete	2
Sidewalk	0	Brick	4

5. Figure S1

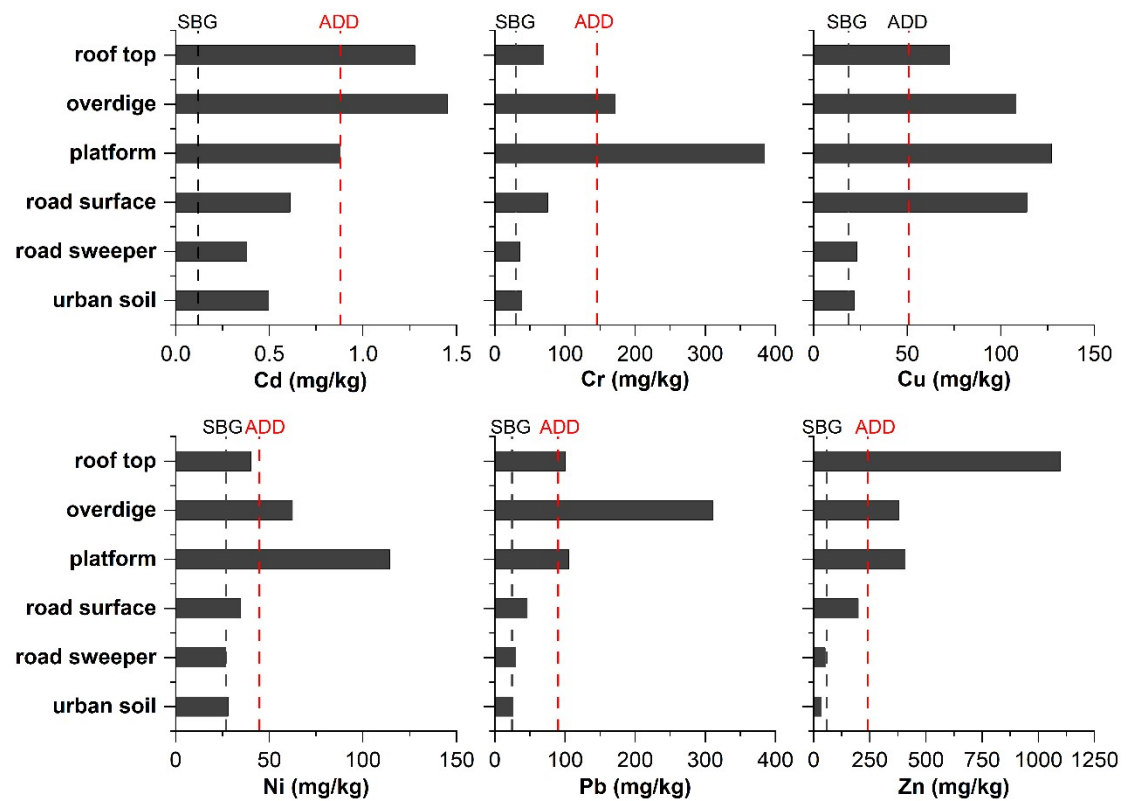


Figure S1. Heavy metal concentrations in urban surface-deposited sediments. ADD (atmospheric dry deposition): red dashed lines on each subfigure refer to corresponding metal concentrations in atmospheric dry deposition of Beijing. SBG (soil background): black dashed lines on each subfigure refer to corresponding background values of Beijing soils (Chen et al., 2004).

6. Figure S2

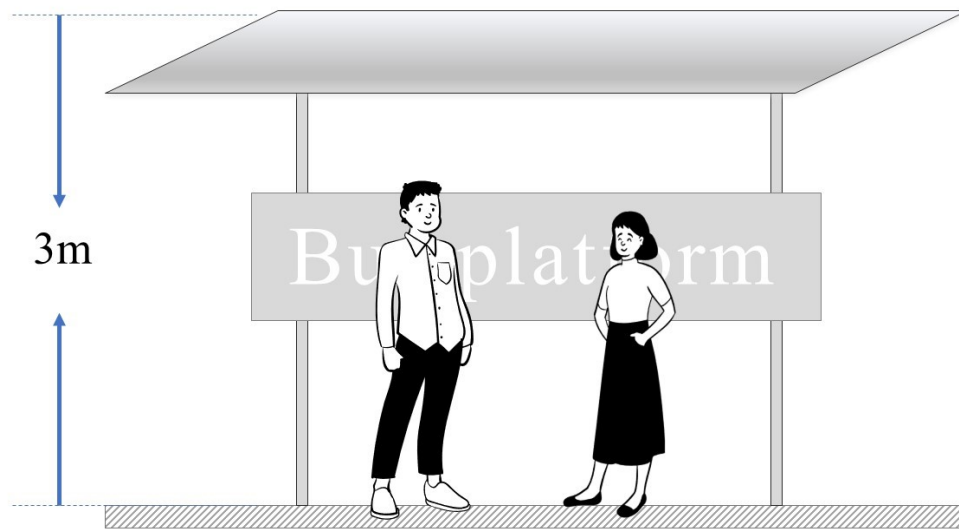


Fig S2. Bus platform

7. Figure S3

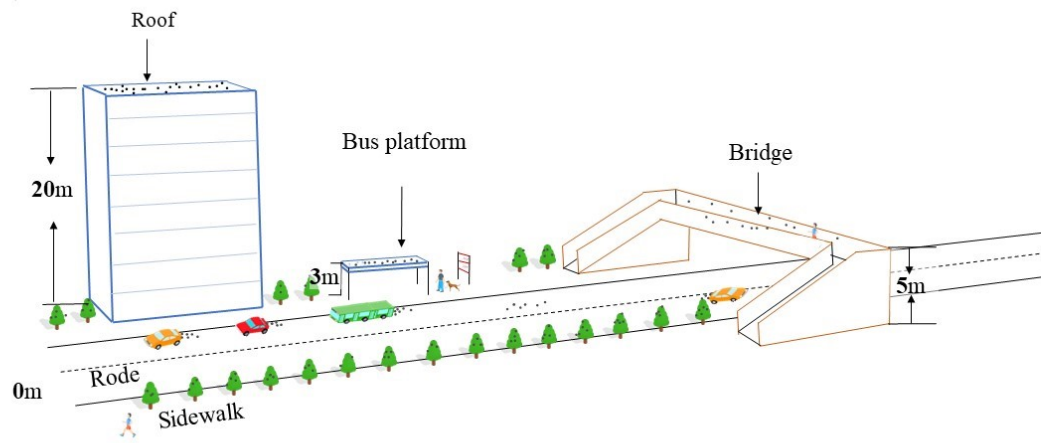


Fig S3. Buildings' shape and location

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