Article

Variations of Soil Lead in Different Land Uses Along the Urbanization Gradient in the Beijing Metropolitan Area

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Abstract: Understanding the spatial pattern of soil lead (Pb) levels is essential to protecting human health. Most previous studies have examined soil Pb distributions by either urbanization gradient or land-use type. Few studies, however, have examined both factors together. It remains unclear whether the impacts of land use on soil Pb levels are consistent along the urbanization gradient. To fill this gap, we investigated variations in soil Pb level under different land-use types along the urbanization gradient in Beijing, China. We classified the degree of urbanization as the urban core, transitional zone, or suburban area and the land-use type as industrial area, roadside, residential area, institutional area, road greenbelt, park, or forest. Our results showed that the range of soil Pb levels in Beijing is <1 mg/kg–292 mg/kg, with a mean of 22 mg/kg. Along the urbanization gradient, the mean soil Pb level increased from the suburban area to the urban core. Land-use types have an impact on soil Pb levels, however, when the degree of urbanization is considered, the impact from land use on soil Pb level was only significant in the transitional zone. Parks and road greenbelts were found to have lower soil Pb, primarily due to soil restoration. Roadside and residential areas were found to have higher

soil Pb because of traffic emissions, leaded paint, and previous industrial contamination. In the urban core and suburban area, the soil Pb level showed no significant differences among various land-use types. Given the results of soil Pb in various land-use types, we suggest that future studies consider the urbanization gradient in which different land-use samples are located.

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1. Introduction

Lead (Pb) exposure has adverse effects on human health [1,2], especially for young children. Low-dose Pb exposure can cause long-term effects on central nervous system functioning and brain development in children [3,4]. Soil is an important pathway of human Pb exposure [5]. The blood Pb levels of young children have been strongly correlated with the soil Pb levels in their neighborhood environment [6], therefore, understanding soil Pb patterns is crucial for identifying Pb sources and communities at risk of lead poisoning.

The spatial pattern of soil Pb pollution levels has been studied extensively. Many studies have examined how soil Pb level varies by urbanization phase in cities all over the world, including Hong Kong [7,8], Baltimore, New York City, Budapest [9], Bergen [10], Wuhan [11] and Beijing [12]. All of these studies concluded that soil Pb levels tend to increase with the increasing amount of urbanization.

Researchers found soil metals, in particular Pb, were positively related to intensive urbanization metrics (e.g., urban population density, length of roads and highways, traffic volume, and percent urban land use) [9]. Distance to urban core was a good predictor of soil metals (including Pb) relative to the above metrics [9]. Meanwhile, many studies have indicated that urban soil Pb varied greatly between urban core, transitional zone, and suburban areas [7,8,13].

Other studies have explored whether soil Pb varies between different land uses in urban areas. Soil Pb level was found to be higher near roads [14–16], buildings [17], and industrial and business land uses [7,18,19]. However, studies were not consistent regarding the soil Pb level in parks. For example, parks in Oakland (CA, USA), contained lower soil Pb levels than residential and industrial areas [20], whereas parks were found to have higher soil Pb levels than other land-use areas in Beijing, China [12], and Seville, Spain [21]. In Baltimore, (Maryland, USA) the soil Pb level did not differ significantly by land-use area [22].

In studies of urban soil Pb, land-use classification varies by research purpose and data availability. Some studies have classified land use into residential, industrial, commercial, park, forest, and transport regions [19,21–23]. Others surveyed agricultural lands [7,21], urban vacant plots [20,24], ornamental areas [21], institutional green spaces [22], and household gardens [20]. Furthermore, the definition of a certain land use may also change across studies. For example, in 2012 Wang *et al.* referred to ancient palaces and gardens in Beijing as "parks" [12], by which other studies meant "open space for recreational use" [21] or forests [7]. The inconsistency of land-use classifications and definitions may lead to divergence among studies, which will be discussed later.

While both urbanization process and land use have been considered when exploring the spatial patterns of soil Pb levels, few studies have considered both factors at the same time. The parks that McClintock studied in Oakland are distributed throughout the entire city [20]. In contrast, the parks studied in Beijing are primarily located in the urban core area [12]. It remains unclear whether soil Pb level varies by land-use area when the urbanization gradient is considered. This study aims to fill this gap by analyzing the spatial patterns of soil Pb level by urbanization gradient and land use in Beijing, China. Specifically, we focus on three questions: (1) How does soil Pb level vary along the urbanization gradient? (2) How does soil Pb level vary by land-use area? (3) Lastly, considering both the urbanization gradient and land use simultaneously, how does soil Pb level vary across different land-use areas in the urban core, transitional zone and suburban areas? Answers to these questions will help to articulate the impact of urbanization and land use on the spatial patterns of soil Pb levels and will contribute to identifying areas with Pb-related health risks.

2. Materials and Method

2.1. Study Area

We selected the city of Beijing as our study area. Beijing has an area of approximately 16,410 km^2 and a population of 20.69 million [25]. Located in the northwestern edge of the North China Plain, Beijing has experienced rapid urban sprawl with homocentric expansion around a ring-road system [26]. Beijing's urban land area increased by a factor of 3.4 from 1984 to 2008 [26]. The degree of urbanization and subsequent variety of land-use types makes Beijing an ideal study site to investigate our study questions.

The main sources of Pb in Beijing include industry emissions, motor vehicle emissions, coal burning, the long-range dust transported from outside Beijing [27], and leaded paints [12,15]. In Beijing, the zone within 3rd ring road is the heart of city (central business district, hospital, administrative center, public management), also includes the oldest districts (Dongcheng and Xicheng districts) [28], which simultaneously have the most dense traffic network. The zone between the 3rd and 5th ring road is the main residential area [28], parts of which were transferred from industrial areas [26]. The zone between the 5th and 6th road includes the suburbs and the satellite cities, which are developing as the residence-manufacturing zones [28], and the main industrial site, the Shougang Construction Group, is located in this area. Differences in land use and sources of Pb pollution in Beijing would cause the variability of soil Pb levels in the different urban zones and land-use types.

2.2. Sample Collection

To characterize the urbanization gradient, we sampled along eight transects from the city center to the suburban areas (east, southeast, south, southwest, west, northwest, north, and northeast) and established 78 survey plots at 3-km intervals along these transects, and we define the area within a 500-m radius as a plot. Next, we added 52 additional plots at 6-km intervals to capture the area between the eight transects in more detail. Our study includes 130 plots in total (Figure 1). We recorded the dominant land-use type at each plot. Within each land-use type, one composite

surface soil sample (0–20 cm) was obtained by mixing three subsamples diagonally distributed within a representative 20 m × 20 m open space. A total of 451 soil samples were collected from July to September 2009.

Figure 1. Study area and soil sampling sites.
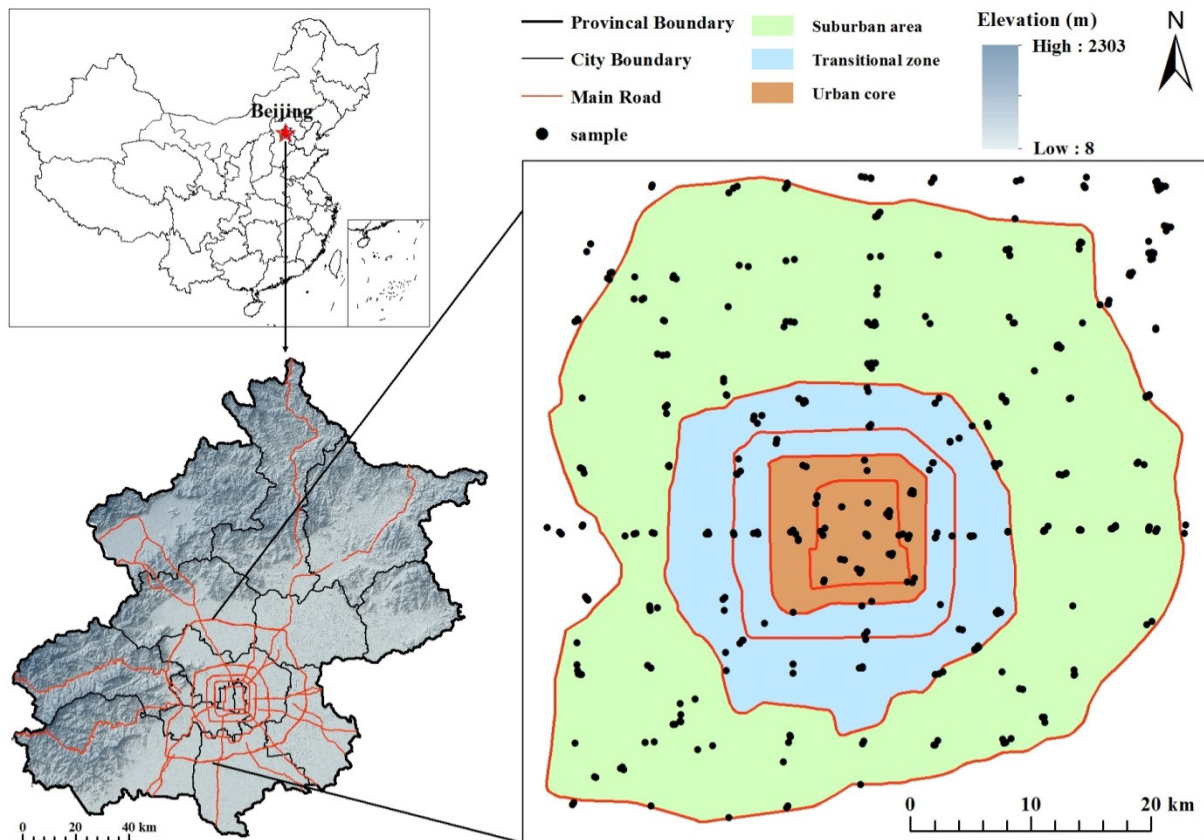
2.3. Sample Preparation and Instrument Analysis

The soil samples were stored indoors and dried at room temperature. Debris (e.g., leaves, stones, and worms) were removed by hand. The samples were then ground to pass through a 0.15-mm nylon sieve. Next, samples were extracted using HNO_3 and HF according to USEPA method 3052 with a microwave laboratory unit [29]. The Pb content was determined using inductively coupled plasma optical emission spectrometry (ICP-OES). Quality assurance and quality control procedures were conducted using the Geochemical Standard Soil (GSS-1) standard reference materials. In each assay array, we used two GSS-1 samples and ultrapure water as a blank control. The recoveries of soil Pb in our study were 90%–105% for Pb. A duplicated sample was used for 30% of the soil samples; the standard deviation of the results was within ±5%.

2.4. Defining the Urbanization Gradient

Beijing has five circular express roads, named the 2nd–6th ring roads (Figure 1). Built in 1924, the 1st ring road was merged into other roads and disappeared during the urbanization process [30]. The construction of the ring roads reflects urbanization expansion in Beijing (Table 1). Therefore, the ring roads provide a good measurement of the urban development in Beijing.

In this study, we define the area within the 3rd ring road as the urban core (number of samples n = 61), the area between the 3rd and 5th ring roads as the urban transitional zone (n = 92), and the area outside the 5th ring road as the suburban area (n = 298) (Table 1, Figure 1).

Table 1. Information of ring roads and urbanization in Beijing.

Road	Built Year	Length (km)	Enclosed Area (km^2)
1st ring	Built in early 1900s	16.9	17.7 (within 1st ring)
2nd ring	1992	32.38	44.4 (between 1st and 2nd ring road)
3rd ring	1994	48.24	96.17 (between 2nd and 3rd ring road)
4th ring	2001	65.19	143.3 (between 3rd and 4th ring road)
5th ring	2003	98.39	364.5 (between 4th and 5th ring road)
6th ring	2009	185.82	1,580 (Between 5th and 6th ring road)

2.5. Classification of Land Use

We categorized land use into seven types: residential area, institutional area, industrial area, road greenbelt, roadside, park, and forest. Table 2 provides detailed descriptions of the seven types of land use, and Figure 2 depicts examples of each type.

Table 2. Description of seven typical land use types in the urban area.

Land Use	Description
Forest (55)	Located in suburban area, include large area of managed or unmanaged woodland (*Populus x canadensis*)
Neighborhood park (55)	Open space for recreational use
Residential (76)	Residential buildings and the surrounding neighborhood
Industrial (15)	Factories, often located in suburban area
Institutional (38)	School, hospital and office building
Roadside (101)	Lines of single trees next to road
Road greenbelts (111)	Relatively large area of vegetation distributed along road

2.6. Statistical Analysis

We arranged the raw data in MS Excel 2010 (Microsoft, Redmond, WA, USA) and performed statistical analyses in SPSS 21 (IBM, Armonk, NY, USA). We used the Kolmogorov-Smirnov (K-S) test for normality to determine whether the Pb data were normally distributed, and the result showed the Pb data was non-normal. An F-test was conducted to examine whether the soil Pb level varies between different areas. Considering the log-normality of the Pb data, we employed the multiple comparison with Kruskal–Wallis test to compare soil Pb levels in different areas.

Figure 2. The seven types of land use in our study: (**a**) Road greenbelts; (**b**) Roadside; (**c**) Residential area; (**d**) Neighborhood park; (**e**) Forest; (**f**) Industrial area; (**g**) Institutional sites.
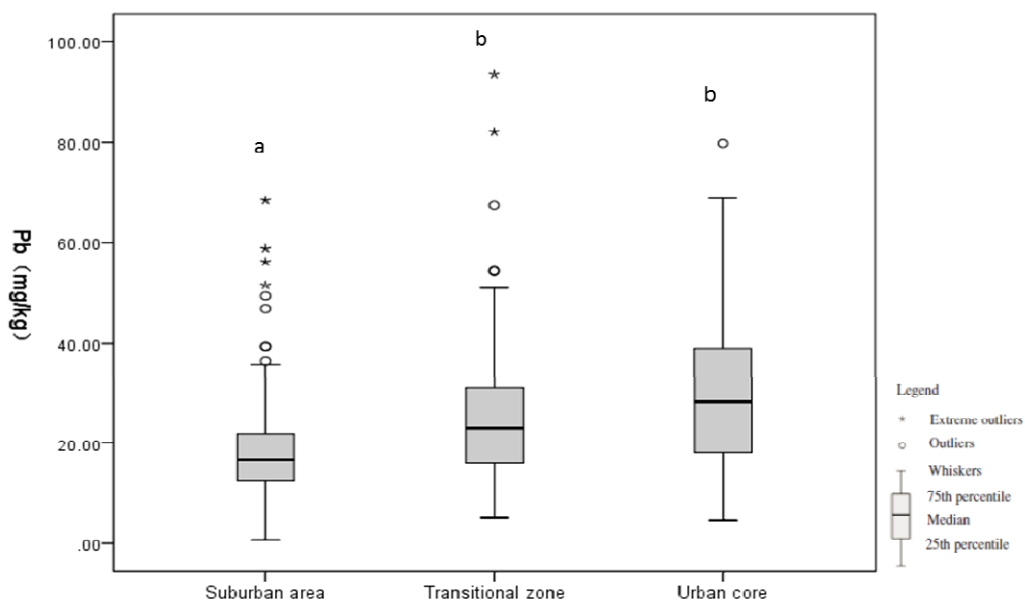

3. Results

3.1. Soil Pb Level along the Urban Gradient

The results show that the mean Pb level is 22 mg/kg (range: <1 to 292 mg/kg) (Table 3) and increases from the suburban area to the urban core (Table 3, Figure 3).

Figure 3. Box-and-whisker plots for soil Pb levels along the urbanization gradient.

Notes: a, b represent the results of multiple comparisons, and the different letters represent the significant difference between two land use types.

The mean Pb level is 19 mg/kg in the suburban area, 26 mg/kg in the transitional zone, and 29.56 mg/kg in the urban core. Our results indicated that the soil Pb level in the suburban area is lower than those in the urban core and transitional area, and the difference is statistically significant ($P < 0.001$). Although the soil Pb level in the transitional zone is lower than that in the urban core, the difference is not statistically significant ($P = 0.764$).

Table 3. Descriptive statistic and Kruskal-Wallis Test of soil lead (mg/kg) for different land uses in urban core, transitional zone and suburban area.

Urbanization	Land Use	Industrial	Roadside	Residential	Institutional	Road Greenbelts	Park	Forest	Total
Entire study	N	15	101	76	38	111	55	55	451
	Mean	42	25	24	20	19	17	20	22
	Min	8	2	4	7	1	5	4	1
	Max	292	93	82	69	60	32	52	292
	Multiple comparisons	ab	a	ab	ab	b	b	ab	
Urban core	N		14	18	8	16	5		61
	Mean		34	30	30	27	23		30
	Min		6	5	7	5	16		5
	Max		80	55	69	60	32		80
	Multiple comparisons		a	a	a	a	a		
Transitional zone	N	4	24	17	8	27	12		92
	Mean	33	35	33	23	19	16		26
	Min	18	11	14	10	8	5		5
	Max	51	93	82	32	37	29		93
	Multiple comparisons	ab	a	a	ab	b	b		
Suburban area	N	11	63	41	22	68	38	55	298
	Mean	45	19	18	15	17	16	20	19
	Min	8	2	4	7	1	6	4	1
	Max	292	49	68	25	59	32	52	292
	Multiple comparisons	a	a	a	a	a	a	a	

Notes: a, b represent the results of multiple comparisons, and the different letters represent the significant difference between two land use types.

3.2. Soil Pb Level by Land Use Type

Table 3 lists the mean Pb level by land use. The difference in the soil Pb among the seven land-use types is statistically significant ($P = 0.004$), which suggests that the soil Pb level varies by land use (Figure 4). The results of multiple comparisons detected statistically significant differences in soil Pb between roadside and parks ($P = 0.006$) and between roadside and road greenbelts ($P = 0.028$) (Figure 4).

3.3. Soil Pb Level by Land-Use Type along the Urbanization Gradient

Table 3 summarizes the soil Pb levels by land-use type in the urban core, transitional zone, and suburban area. Soil Pb levels vary significantly by land use in the transitional zone ($P < 0.001$), whereas the soil Pb level in the urban core and suburban area do not show any statistically significant differences among land-use types ($P = 0.578$ and $P = 0.097$, respectively).

Figure 4. Box-and-whisker plots for soil Pb levels among different land uses.
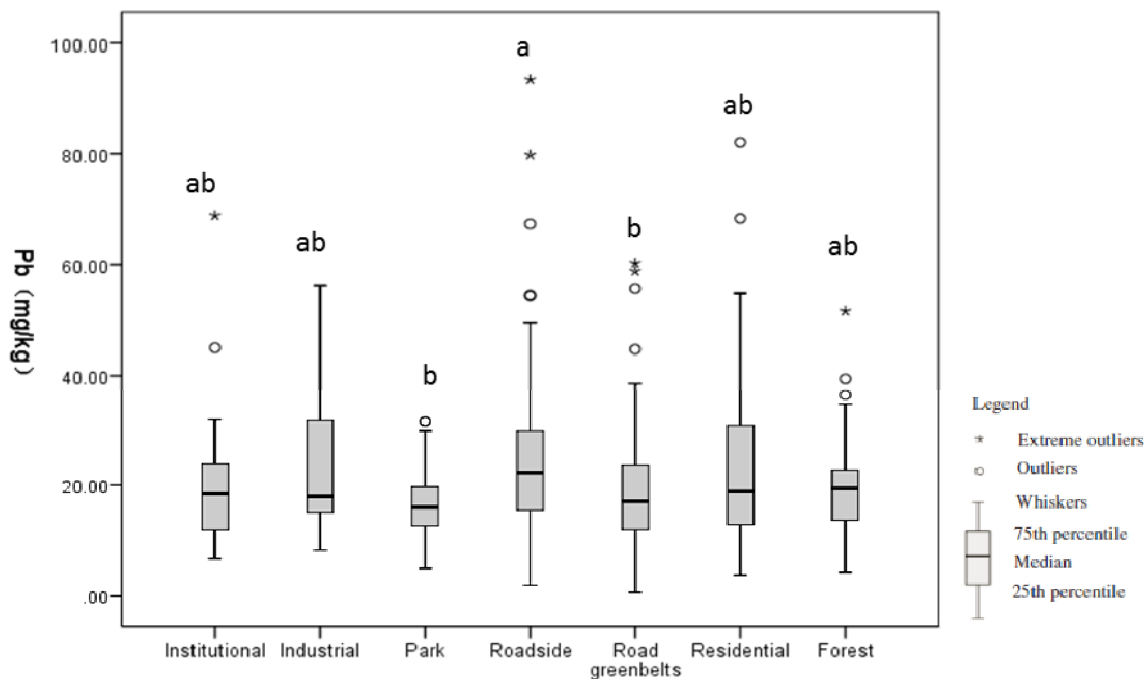
Notes: a, b represent the results of multiple comparisons, and the different letters represent the significant difference between two land use types.

The soil Pb distribution by land-use type is shown in Figure 5. Significant differences in soil Pb among various land-use types were detected between parks and roadside ($P = 0.003$), parks and residential areas ($P = 0.006$), road greenbelts and residential areas ($P = 0.019$), and road greenbelts and roadside places ($P = 0.007$).

4. Discussion

4.1. Soil Pb Level in Beijing

Our study reveals that the mean Pb level in Beijing is 22 mg/kg. Compared with other studies in Beijing (Table 4), our result is lower than those of studies limited to the 5th ring road [12,23,31,32] and higher than those of studies that include areas outside the 6th ring road [33,34]. The different study areas and sampling approach likely contributes to the variability in soil Pb levels in different studies. Because soil Pb levels tend to be higher in more urbanized area, this variability is expected.

Figure 5. Box-and-whisker plots for soil Pb levels among different land uses in transitional zone.
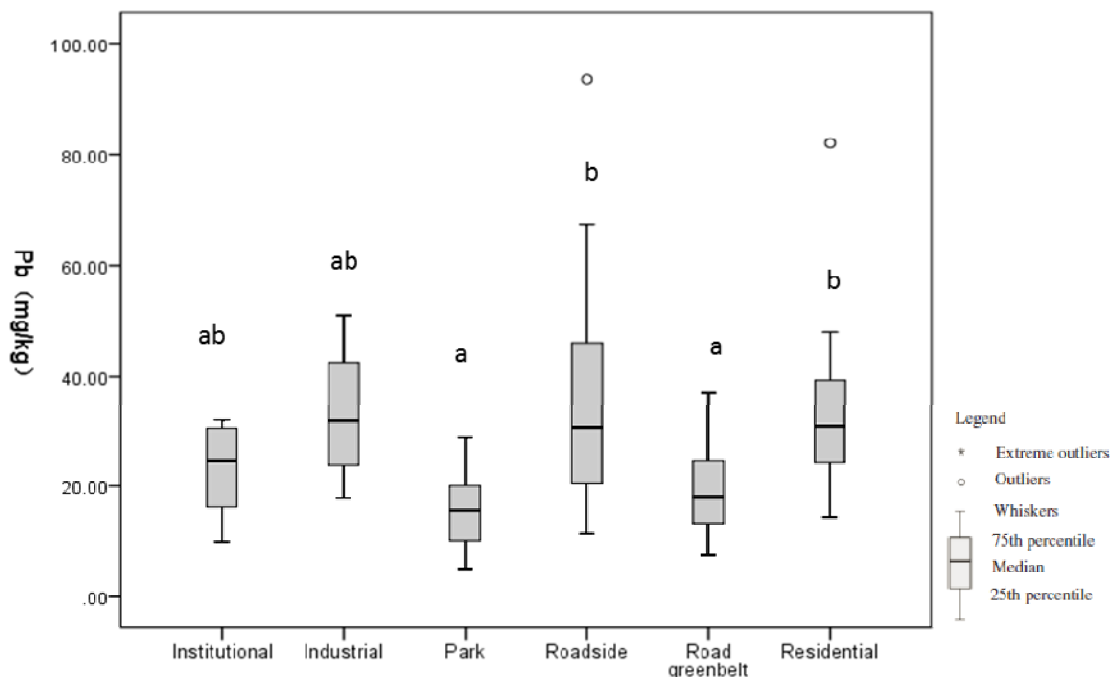
Notes: a, b represent the results of multiple comparisons, and the different letters represent the significant difference between two land use types.

Table 4. Soil Pb levels according to different studies in Beijing.

Reference	Mean-Pb (mg/kg)	Number of Samples	Time of Survey	Location of Study Area	Land Use
This study	22	457	2009	All areas within 6th ring road	Park/residential/institutional/road greenbelts/roadside/industrial area/forest
Hu *et al*. 2006 [33]	18.8	70	2000	Daxing District	—Not described by authors
Lu *et al*. 2012 [34]	20.4	412	2009	Shunyi District	Agricultural area
Wang *et al*. 2012 [12]	23.3	233	2008	All areas within 5th ring road	Public parks/traffic/schools/ agricultural/industrial/ residential/waste land
Li *et al*. 2010 [32]	28.3	123	2008	All areas within 5th ring road	Industrial/residential/commercial/ traffic/parks/square/campuses
Zheng *et al*. 2005 [35]	28.8	600	2001	The city of Beijing, including 18 district	Crop/forest/orchard/urban green spaces
Chen *et al*. 2010 [15]	35.4	80	2008	All areas within 5th ring road	Roadside
Xia *et al*. 2011 [23]	39.5	120	2008	All areas within 5th ring road	Business area/classical garden/ culture and education area/public green space/residential area/ roadside area
Chen *et al*. 2005 [31]	66.2	30	2001–	All areas within 4th ring road	Urban park

The soil background value for Beijing is 25 mg/kg, representing the natural Pb level in soil without human disturbance [36]. In our study, 27% of samples exceed the soil background value in Beijing, indicating that one fourth of the soil in Beijing is contaminated by Pb. Moreover, the Pb contents of 11% of the samples are higher than 35 mg/kg, exceeding the first criterion of the environment quality standards for soil to protect the ecological environment and sustain the natural soil background [37]. All of the samples are below the second criterion of the Chinese environment quality standard for soils (300 mg/kg), which represents the threshold for protecting human health. All of the soil Pb levels in our study are under 400 ppm, the USEPA's guideline for Pb in exposed play areas to protect children's health [38]. Comparisons with standards indicate that although the soil Pb content in some places in Beijing likely has a negative ecological impact, the overall health risk of soil Pb to humans in Beijing is low.

Compared with other cities that have been studied for soil Pb contamination, Beijing's soil Pb level is relatively low (Table 5). Bedrock sources, level of urbanization and industrialization, society development trajectory, and environmental regulations all affect Pb level in urban soils [39]. For example, Kerman has the highest soil mean Pb level because of mining and smelting operations [16]. The soil in Naples is derived from volcanic parent material, which contributes to its high Pb level [40]. Although Beijing is one of the oldest and largest cities in the word, its soil Pb level is relatively low due to bedrock sources, and the fact that Beijing has never hosted massive industrial activity.

Table 5. Urban soil Pb levels in different cities.

City	Pb-mean (mg/kg)	Number of Samples	Population Density (Inhabitants/km²)	Study Area (km²)	Reference
Beijing, China	22	457	3,000	2,246	This study
Turku, Finland	20	100	718	306.4	Salonen and Korkka-Niemi 2007 [41]
Tampa, USA	47.3	106	1,146	2,078	Hagan *et al*. 2012 [24]
Annaba, Algeria	53.1	101	431.6	49	Maas *et al*. 2010 [42]
Calabria, Italy	63.67	149	137	92	Guagliardi *et al*. 2012 [43]
Vienna, Austria	64	286	4,002.2	414.6	Pfleiderer *et al*. 2012 [18]
Galway, Ireland	78.4	166	40.73	54	Zhang 2006 [14]
Bergen, Norway	91	474	551	465	Haugland *et al*. 2008 [10]
Ibadan, Nigeria	95.1	106	828	400	Odewande and Abimbola 2008 [44]
Oakland, USA	109	112	1,934	202	McClintock 2012 [20]
Mexico, Mexico	116	146	58	1,200	Rodríguez-Salazar *et al*. 2011 [45]
Seville, Spain	156	52	5,002.9	140	Ruiz-Cortes *et al*. 2005 [21]
Baltimore, USA	231	122	2,635.2	238.4	Pouyat *et al*. 2008 [9]
Naples, Italy	262	173	8,182.6	292	Imperato *et al*. 2003 [40]
Kerman, Iran	925.7	38	1,617.7	450	Hamzeh *et al*. 2011 [16]

4.2. Soil Pb Levels along the Urbanization Gradient

Our results show that the soil Pb level in Beijing increases along the suburb-urban core gradient (Figure 3). The mean Pb levels are 19 mg/kg in the suburban area, 26 mg/kg in the transitional zone,

and 30 mg/kg in the urban core (Table 3). This finding is consistent with previous studies indicating that the soil Pb level tends to be higher in more urbanized areas [8,9,12].

While soil Pb is lower in the transitional zone than in the urban core, the difference is not statistically significant (P = 0.764) (Figure 3). Three factors may contribute to Pb accumulation in the transitional zone. First, the transitional zone previously contained a number of industrial sites [26]. Although these sites were closed, Pb derived from industrial sources could have accumulated due to its high persistence. Second, the transitional zone has a higher density of urban residential land than the urban core and suburban area [26]. Frequent use of lead-based paints and household wastes [46] may contribute highly to the soil Pb accumulation in this area. Lastly, diesel trucks are allowed outside the 4th ring roads in Beijing, which is another source of soil Pb accumulation in the transitional area.

4.3. Soil Pb Level by Land-Use Type

Our results found that soil Pb levels tend to vary by land use (Table 3, Figure 4). We found higher Pb levels in industrial (41.51 mg/kg), roadside (25 mg/kg), and residential (24mg/kg) areas, which echoes findings in Hangzhou [47] and Hong Kong [7]. Moreover, 40%, 36%, and 33% of samples from roadside, residential, and industrial areas exceed the soil background of Beijing. These results indicate that emissions from industrial pollutants, traffic, and leaded paints are the main sources of soil Pb in Beijing.

We found that parks have the lowest soil Pb level (16.85 mg/kg), with the difference between parks and roadsides being statistically significant (P = 0.006) (Figure 4). In contrast, several studies in Beijing found soil Pb levels in parks to be higher than those in other land uses [12,23]. This apparent contradiction is due to differences in the definition of "park". Parks in previous studies included historical sites, such as the Forbidden City and Temple of Heaven, which are primarily located in the urban core. The application of Pb-containing paints and traffic emissions both contribute to Pb accumulation in such parks [31]. In contrast, parks in our study refer to neighborhood parks for recreational use (Figure 2d). Scattered throughout the entire city, these parks do not incur Pb from disproportionally high traffic emissions or from the paint used in ancient palaces.

We found that the soil Pb levels in roadsides are significantly higher than those in road greenbelts (P = 0.028) (Figure 4). Roadsides are in close contact to roads (Figure 2b) and could directly receive street dust with elevated levels of traffic pollutants, which is a major source of Pb in urban soil [48,49]. In addition, many road greenbelts were recently covered with garden soil, which normally has low Pb content. The trees and grass in road greenbelts may dilute traffic pollutants from street dust from reaching the soil and therefore decrease the soil Pb level in road greenbelts [32].

While many studies found that soils in industrial areas have significantly higher Pb levels [7,18,19], our results indicate that the soil Pb level in industrial areas is within the range of that in other land uses. Dramatic land-use transformation, converting industrial area to other land use, could have masked differences in Pb content and lead to the observed similarity. Understanding the land change history will help explain the soil Pb patterns. For example, we found the highest Pb level (291.98 mg/kg) in suburban areas, which hosted the Shougang Construction Group, a steel production factory, beginning in 1919.

4.4. Soil Pb Level by Land-Use Type along the Urbanization Gradient

Our results show that when the suburb-urban gradient is considered, only the transitional zone showed significant differences between soil Pb levels across land-use types (*P* < 0.001). In the transitional zone, multiple comparison of soil Pb level among land-use types shows that soil Pb is significantly higher in roadsides and residential areas than in parks and road greenbelts, swhile no obvious difference is found between other land uses (Figure 5).

Since 2000, Beijing has been experiencing rapid urban expansion, which has resulted in drastic land-use changes [26,50]. Vegetation increased between the 4th and 5th ring roads due to the creation of parks and road greenbelts [50,51]. We found that most of the road greenbelts and neighborhood parks, particularly those between the 4th and 5th ring roads, were newly built and filled with garden soils. This finding explains why the soil Pb in parks and road greenbelts is lower than that in other land uses. This finding illustrates how human intervention, especially soil restoration, can effectively reduce soil Pb and decrease human exposure to Pb [10,20,52].

Residential areas in the transitional zone have relatively high Pb levels for the following reasons: first, housing decoration waste containing Pb-based paint is a major source of Pb. Second, some residential areas in the transitional zone were built on former industrial sites and are affected by the past use of Pb in industrial activities. Lastly, household and yard waste (e.g., paper, plastics, cans, ceramics, toys, and waste batteries) and construction materials (e.g., lead pipes and solders) also increase the soil Pb level [46,53]. In addition, converting vegetation to residential and commercial areas is also occurring in suburban areas [51], albeit less intensively than in the transitional zone. Will soil Pb levels increase in the suburban area because of future increases in residential and traffic land use? Alternatively, will the soil Pb level remain relatively constant due to standards requiring the replacement of Pb-based gasoline, paint, and other construction materials. Future studies may include time-series comparisons to answer these questions.

Some limitations exist in this study. First, we measured the total soil Pb content. Total soil Pb should not be confused with available Pb, although they are closely related [54–56]. Second, our study has a limited sample size restrained by time and resources. In particular, we did not sample historical parks, which have been discussed by many researchers.

5. Conclusions

This study examined soil Pb levels in Beijing and found that it ranged from <1 mg/kg to 292 mg/kg, with a mean of 22 mg/kg. We investigated soil Pb levels across an urbanization gradient and in different land uses. Consistent with previous studies, the soil Pb level increases from the suburban area to the transitional zone and then to the urban core. Comparing the results from previous studies, we found that the average degree of urbanization, the scope of the study area and the choice of sampling sites all have an important impact on the reported results. Studies focusing more on suburban areas of Beijing tend to report lower mean values of soil Pb. Furthermore, we illustrated how the degree of urbanization may affect soil Pb levels among land-use types. While land use has an effect on soil Pb for Beijing as a whole, the impact was significant only in the transitional zone. Parks and road greenbelts tend to have lower soil Pb, primarily due to soil restoration. Roadside and residential areas

tend to have higher soil Pb because of traffic emission, leaded paints, and previous industrial contamination. The spatial patterns of soil Pb were examined in this study, which provides the foundation for future investigations of the temporal variation. Whether new technology and legislation banned Pb-based paint, gasoline, and other construction material gradually mitigate the urbanization impact on soil Pb could be investigated through temporal studies focusing on soil Pb change by land use in rapidly urbanizing regions.

Acknowledgments

Author Contributions

Qizheng Mao and Keming Ma designed research; Qizheng Mao conducted research and analyzed data; Qizheng Mao and Ganlin Huang wrote the paper; Zexiang Sun provided the Figure 1; Qizheng Mao had primary responsibility for final content. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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