Review Articles

Heavy Metal Pollution in China: Origin, Pattern and Control

A State-of-the-Art Report with Special Reference to Literature Published in Chinese Journals

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Abstract

Goal, Scope and Background. Heavy metal is among one of the pollutants, which cause severe threats to humans and the environment in China. The aim of the present review is to make information on the source of heavy metal pollution, distribution of heavy metals in the environment, and measures of pollution control accessible internationally, which are mostly published in Chinese.

Methods. Information from scientific journals, university journals and governmental releases are compiled focusing mainly on Cd, Cu, Pb and Zn. Partly Al, As, Cr, Fe, Hg, Mn and Ni are included also in part as well.

Results and Discussion. In soil, the average contents of Cd, Cu, Pb and Zn are 0.097, 22.6, 26.0 and 74.2 mg/kg, respectively. In the water of the Yangtze River Basin, the concentrations of Cd, Cu, Pb and Zn are 0.080, 7.91, 15.7 and 18.7 µg/L, respectively. In reference to human activities, the heavy metal pollution comes from three sources: industrial emission, wastewater and solid waste. The environment such as soil, water and air were polluted by heavy metals in some cases. The contents of Cd, Cu, Pb and Zn even reach 3.16, 99.3, 84.1 and 147 mg/kg, respectively, in the soils of a wastewater irrigation zone. These contaminants pollute drinking water and food, and threaten human health. Some diseases resulting from pollution of geological and environmental origin, were observed with long-term and non-reversible effects.

Conclusions. In China, the geological background level of heavy metal is low, but with the activity of humans, soil, water, air, and plants are polluted by heavy metals in some cases and even affect human health through the food chain.

Recommendations and Outlook. To remediate and improve environmental quality is a long strategy for the polluted area to keep humans and animals healthy. Phytoremediation would be an effective technique to remediate the heavy metal pollutions.

Keywords: Cd; Cu; emission; food chain; health; Pb; phytoremediation; waste fertilization; wastewater irrigation; Zn

Introduction

With the developing industry of mining, smelting and metal treatment, heavy metal pollution becomes serious (Wu et al. 1989, Liao 1993, Guo 1994, Su et al. 1994, Wang et al. 2001). Cd polluted farmland over 12,000 ha is seen in 11 irrigation regions in China (Liao 1993), the Cd content in heavily polluted soil reaches levels of 5–7 mg/kg in Zhangshi Irrigation at Shenyang, and the content in rice is 1–2 mg/kg (Wu et al. 1989). Since long farmed history, the contents of Cu and Pb have been high and acommon pollution in vegetable fields of China (Zhang and Gong 1996).

Heavy metal pollution not only affects the production and quality of crops, but also influences the quality of the atmosphere and water bodies, and threatens the health and life of animals and human beings by way of the food chain. Most severe is that this kind of pollution is covert, long-term and non-reversible (Zhang 1999). How to clean the heavy metals from the environment in order to avoid their entrance into the food chain, however, is important for protecting the health of animals and human beings. But, understanding the status of heavy metal pollution is the basic idea for remediating the pollution from the environment. This review would compile the references, which have mostly been published in Chinese, to try to provide a comprehension of the heavy metal pollution in China.

1 Heavy Metal Pollution

The geological background level of heavy metal is low (Wei et al. 1991) and the contents of several metals in soil are listed in **Table 1**. In soil, the average contents of Al, Cd, Cu, Mn, Pb and Zn are 66200, 0.097, 22.6, 583, 26.0 and 74.2 mg/kg, respectively. In the water of the Yangtze River Basin, the concentrations of Cd, Cu, Mn, Pb and Zn are 0.080, 7.91, 259, 15.7 and 18.7 µg/L, respectively (Zhang and Zhang 1992). During 1996–2000, Ye (2001) monitored the concentration of Cd, Cu, Hg and Pb in the water of Pearl River estuary at lower, normal and higher water levels and the results are shown in **Table 1**. Generally, concentrations of heavy metals at higher water level conditions are lower than those found in other situations.

Because of the activity of human beings, a high anthropogenic emission of heavy metals enters into the biosphere. Wastes (emission, wastewater and waste solid) are the origin of heavy metal pollution to water, soil and plants.

Table 1: Contents of several heavy metals in soil and water in China

Element	Soil of all over the country [mg/kg DW][a]		Water of Yangtze River Basin [μg/L][b]		Water in estuary of Pearl River [μg/L][c]
	95% Confidence Interval	Average	Scope	Average	Average
Cd	0.017–0.33	0.097	0.008–0.329	0.080±0.098	b.l.[d]–2.50
Cr	19.3–150	61.0	4.51–99.4	41.4±36.9	n.d.[e]
Cu	7.3–55.1	22.6	1.47–23.1	7.91±7.19	b.l.–6.0
Hg	0.006–0.272	0.065	0.003–0.192	0.014±0.015	b.l.–2.90
Mn	130–1786	583	77–500	259±162	n.d.
Ni	7.7–71.0	26.9	0.43–6.29	2.97±2.36	n.d.
Pb	10.0–56.1	26.0	1.36–57.1	15.7±17.0	b.l.–9.7
Zn	28.4–161	74.2	1.33–45.7	18.7±16.0	n.d.
Al	33,700–98,700	66,200	n.d.	n.d.	n.d.
Fe	10,500–48,400	29,400	1,980–9,790	6,280±3,940	n.d.

a) Wei et al. (1991); b) Zhang and Zhang (1992); c) Ye (2001); d) b.l.: below detection limits; e) n.d.: no data

1.1 Pollution by emission

Pollution from industry emission is the main source of heavy metal pollution in China. In rural areas without industries, the concentration of Cd in the atmosphere is usually lower than 1.0 pg/L, but the values are very much higher in industrialization areas, reaching up to 100 pg/L. Cd can be precipitated to the soil and amounts of Cd are accumulated in the soil and leaves of trees in industrial pollution areas (Xu and Yang 1995). Heavy metal pollution in the air increases through human activities. Smelting and burning of coal, oil and waste will bring heavy metal pollution into the atmosphere. In coal burning areas, the different contents of heavy metals (As and Cr) in the coal have affected the emission of heavy metals into the atmosphere (Chen et al. 1989). The content of As in coal was in the range of 0.32–119 mg/kg and that of Cr was 0.46–125 mg/kg. Yang et al. (1987) studied the particles in the atmosphere at Tianjing, where 6.0% of the particles came from the petroleum consumption during winter, and these levels rose to 6.4% in summer. The concentration of Pb in the emission of petroleum consumption is 1.0 mg/kg, while it is 0.35 mg/kg in the smelting industry, 0.02 mg/kg in oil, and 0.002 mg/kg in coal. Therefore, Pb pollution in the atmosphere in the city mainly comes from leaded petroleum.

Case studies (Fan 1999) have shown the concentrations of Cr, Fe, Mn and Zn in the air under dust-sandstorm weather conditions in a northwesterly region (**Table 2**). Compared to the background value, they were 42.5, 3.0, 4.3 and 0.8 times higher, respectively. Heat supplied by burning coal, led to an increased concentration of heavy metals in the atmosphere in cities (Li et al. 2000a) (see Table 2). Heavy metal pollution could be declined with an increase in the distance from the pollution source, as shown in the report of Zhuang and Wang (2000). The concentrations were seen to be much higher at the power station than those found at the campus of the university further away (see Table 2). Case studies also showed heavy metal pollution in the atmosphere of big cities such as Shanghai (Zhou et al. 1994a) and Chongqing (Chen et al. 1997).

Heavy metals in air will be precipitated to soil. Zhang (2001) measured the effects of air precipitation on heavy metal accumulation in soil and found that the importation of Hg, Cd and Pb into soil was 4.48, 5.79 and 347 g/ha.a, respectively.

Analysis of the Guliya ice core from the Qinghaitibet plateau showed the Cd pollution in air from 1900–1991, to be in the range of 2.28–301 pg/ml with an average of 51 pg/ml in the ice core (Li et al. 2000b). Cd pollution increased year by year during the century and the maximum value occurring in 1991 may be related to pollutants originating from the oil fires during the Gulf war of this year.

The air pollution can also be transported from continent to ocean and even to the Antarctic. Chen et al. (1994) collected the heavy metal data (Mn, Fe, Cu, Pb, Cd) in the atmosphere over oceans by making a cruise to the Antarctic for scientific survey and found that the aerosol metals over the North Pacific and the South Pacific was higher than that over the Antarctic Peninsula, which showed obvious gradient in the transport process from the continent to the ocean. For example,

Table 2: The concentrations of heavy metals in the air in case studies [μg/m³]

Region / Element	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Ref.
A northern west region									
Background value	n.d[a]	0.0076	n.d	1.74	0.037	n.d	n.d	0.19	c
Dust-sandstorm weather	n.d	0.026	n.d	6.95	0.20	n.d	n.d	0.16	c
Chaotan in Xi'an city									
Normal season	0.016	0.071	n.d	n.d	1.07	0.072	33.3	n.d	d
Heating season	0.046	0.104	n.d	n.d	1.41	0.092	42.6	n.d	d
Yantai city[b]									
Power station	0.021	n.d	4.9	n.d	n.d	n.d	15.5	1.82	e
University of Yantai	0.003	n.d	0.1	n.d	n.d	n.d	1.1	0.04	e

a) n.d.: no data; b) unit: mg/kg; c) Fan (1999); d) Li et al. (1999); e) Zhuang and Wang (2000) the aerosol Pb was 11.5 ng/m^3 over the North Atlantic, but less over the South Pacific and the Antarctic Peninsula, although there was also 1.1 ng/m^3 over the Antarctic Peninsula. Therefore, air precipitation would be responsible for bringing Pb to the Antarctic, and the pollution of Pb and Cd mainly come from the industrial emissions (Chen et al. 1999).

Human activities increase the heavy metal pollution of the air. The contribution of emissions is seen to be the primary factor influencing heavy metal pollution.

1.2 Pollution by wastewater irrigation

Development of mining, zincification, stabilized compounds of dye and plastics, colorants in oil paint and the tire manufacturing industry are considered to be main sources for heavy metal pollution (Guo 1994). Wastewater irrigation is very common in China, especially in the northwestern area, where there is a lack of water resources (Zhang and Bai 1988, Wang and Zhou 1995, Ji 1996, Wang et al. 1997b, Zhang et al. 1997, Nan and Li 2001a). There is also a wastewater irrigation zone in the southern areas such as Wuhan (Wen and Bian 1996). In China, 60–80% of the wastewater is due to industrial effluents, the compositions are complicated and there are different amounts of the individual heavy metals (Ou 1989). Untreated sewage water irrigation was the major source of increasing soil and crop metals.

Table 3 shows the investigation of heavy metal pollution in wastewater irrigation zones. In Taiyuan, for example, concentrations of Cd, Cr and Zn in the irrigation wastewater were 1.3 fold, 2.8 fold and 3.9 fold of the national irrigation water quality standards, which are 0.005, 0.1 and 2 mg/L, respectively (China EPA 1992). Therefore, the content of Hg, Pb and Zn in the soil increased 190–310%, 30–50% and 30–70%, respectively (Ji 1996). By Kriging analysis, the soil in the eastern suburb of the Beijing irrigation area was highly polluted by heavy metals and the pollution situation varied in space significantly (Wang and Xi 1997), since it was irrigated by wastewater for its long history of more than 30 years (Wang et al. 1997b). Except for Cr and Pb, the average contents of Cu, Hg, and Zn in crops do not exceed the food standard value (CMH 1991, 1994).

However, from these case studies, the wastewater irrigation zones are seen to be polluted by heavy metals. The contents of heavy metals in soil and crop are higher than background values. Strategies should therefore be developed to avoid the pollution transferred to the food chain, which is threatening human health.

1.3 Pollution by waste fertilization

Fertilizing sludge in farm fields, has led to an increase of nitrogen and phosphate in nutrients, and heavy metals such as Cd, Pb, Cu and Zn have also been seen to increase. The mean content of Cd in the nitrification sludge was 10–16 mg/kg (Guo 1994). Table 4 shows some case sites in the rural suburb of cities, where fields were polluted by waste fertilization.

In the rural suburb of Guangzhou at Guangdong Province, 9.5% of the vegetable fields were polluted by As, Cd and Pb because of the municipal waste fertilization (Dai and Liu 1995). The content of As, Cd and Pb in the soil were 1.4, 1.4, 3.2 fold that of the background values in Guangzhou,

Table 3: Contents of heavy metals in wastewater [mg/L], soil, crops and vegetables [mg/kg DW] in wastewater irrigation zones

Site	Element	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Zn	Ref.
Xian	Soil	0.2–1.2						4.0–10.0		a
Taiyuan	Wastewater	0.0065	0.28						7.8	b
Beijing	Soil		62.4	41.6		484	30.0	31.7	124	c
Baiyang ding	Wastewater	0.0002	0.016	0.0003	0.0002			0.0005	510	d
	Soil	0.36	91.3	37.5	0.08			20.6	83.6	d
	Crop		1.88	6.26	0.005			0.59	48.2	d
Baiyin	Wastewater	0.192–3.45		0.684–4.08				0.993–6.86	1.29–15.3	e
	Soil	3.16		99.3			44.2	84.1	147	f
	Wheat root	2.17		27.8			3.08	9.63	131.8	e, g
Wuhan	Wastewater	0.006		0.018		0.251	0.007	0.017	0.050	h
	Soil	0.185–3.87		36	0.095–0.516	628	26	19	113	h, i
	Vegetable			20.4	0.146				77.1	i
Irrigated by leather industrial eff.	Soil	0.56	16.1	9.63				15.6		j

a) Li and Xie (1994); b) Ji (1996); c) Wang et al. (1997b); d) Zhang et al. (1997); e) Nan and Li (2001a); f) Nan et al. (2001); g) Nan and Li (2001b); h) Wen and Bian (1996); i) Deng et al. (1989); j) Yang et al. (1999)

Table 4: Heavy metal pollution by waste fertilization in case sites [mg/kg DW]

Site	Element	As	Cd	Cu	Hg	Ni	Pb	Zn	Ref.
Guangzhou	Soil	19.0	0.23				85.5		a
Tianjing	Soil	10.7	0.6	73.0	0.8	44.0	36.0		b
Xian	Sludge		0.7	434		374	201	3,040	c
Beijing	Soil		0.2–1.5		0.4–2.5				d

a) Dai and Liu (1995); b) Pan and Lu (1997); c) Ma et al. (2000); d) Ouyang et al. (1994)

respectively. In Tianjing, the vegetable fields were also polluted by heavy metals (Table 4) (Pan and Lan 1997). The contents of heavy metals were all higher than the background value, while the pollution of Cd and Hg were severely increased, being some 10 to 30 fold that of the background value. Zhou et al. (1994b) reporting on fertilizing the sludge to soil, found that the content of Zn in the soil evidently increased from 90 mg/kg DW in the control to 103 mg/kg in the treated soil. Since this soil is heavily polluted by heavy metals, the selection of crops with low uptake rates should be considered when fertilizing the sludge (Ma et al. 2000).

In addition, the usage of chemical fertilizer and agro-chemicals also increased heavy metal pollution in the farmland. It was reported that there was 2–3 mg/kg Cd in the phosphorous fertilizer and calcareousness at Guangzhou (He and Hu 1991).

2 Heavy Metals in Food and their Transfer through the Food Web

Since the development of a polluted environment, wastewater irrigation and waste fertilization have led to the heavy metal pollution of foods for humans and animals, as well as crops and vegetables for humans, and of pasturage herbs for animals in the field.

In China, there are a series of standards on the tolerance limit of As, Al, Cd, Cr, Cu, Hg, Pb, Se and Zn in foods as well as for crops, beans, vegetables, fruits, meat, fish and milk production in markets (CMH 1991, 1994a, b, c, d, e, f, g). **Table 5** lists the tolerance levels for crops, beans, vegetables and fruits. According to this standard, the edibility of foods can be determined and the safety of foods can be guaranteed.

Table 5: Tolerance limit of several metals in foods in China [mg/kg DW][a]

Element	Crop	Soybean	Vegetable	Fruit
As	0.7	n.d.[b]	0.5	0.5
Al	100	n.d.	n.d.	n.d.
Cd	0.05	0.05	0.05	0.03
Cr	1.0	1.0	0.5	0.5
Cu	10	20	10	10
Hg	0.02	0.01	0.01	0.01
Pb	0.4	0.8	0.2	0.2
Zn	50	100	20	5

a) China Ministry of Health (1991; 1994a; 1994b; 1994c; 1994d; 1994e; 1994f; 1994g); b) n.d.: no data

Some research results on food for humans and/or for animals are listed in **Table 6**. Heavy metals in crops, wheat and rice (Zhang et al. 1996, Du et al. 1999), soybeans (Yun et al. 2001), vegetables such as *Oenanthe javancia* DC., spinach, cabbage, carrot, cucumber, potato, tomato, and kohlrabi (Hou et al. 1995, Zhang et al. 1996), fruits such as apples, oranges, bananas, and eggs, seafood, milk were measured (Zhang et al. 1996, Du et al. 1999). The contents of Hg is around 13% in vegetables and fruits, while 16% of the seafood samples were higher than the standards held in the Qingdao free market. However, the daily uptake of Hg per person was 0.27 µg/kg per person per day, it was lower than the standard of WHO, which is 0.7 µg/kg per person per day (Zhang et al. 1996).

Heavy metals are distributed in cotyledons with 90%, 78% and 91% of the total Cd, Cu and Pb, respectively, in soybeans, and are mainly combined with proteins with 80.6%, 69.1% and 68.9% of the Cd, Cu and Pb being distributed in protein, respectively. In bean curd, bean milk and bean sprouts, the contents of heavy metals decreased significantly. Thus, to produce bean curd and milk may abate 50–60% of the Cd, 30–70% of the Cu and 70–80% of the Pb pollution of soybeans (Yun et al. 2001).

Most of the contents of heavy metals in the vegetables are below the sanitary standard, which is 0.3 mg/kg for As and Cr, although Pb and Cr in some samples are 5%–45% higher in the Linyi Region (Hou et al. 1995). Cr pollution came from the industrial uses of Cr in electroplating, medicine producing, printing, dyeing, etc. to result in the high pollution of Cr (0.5–2.91 mg/kg) in vegetables of Guiyang (Yang et al. 2000). Measures should to be taken to control these pollution sources.

The heavy metal pollution in herbs should also be considered. Yin et al. (1999) surveyed the contents of As, Cd, Cr, Hg and Pb in ten species of natural herbs at Kunming, such

Table 6: Contents of heavy metals in food [mg/kg]

Food	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Ref.
Crop			0.205		0.01				c, d
			1.88	6.26	0.005		0.59	48.2	e
Soybean		0.105–0.310	0.278	12.4–26.2			17.4–46.7		d, f
Vegetable	0–0.01	0.007–0.031	0.010–0.316	0.762–1.302			0.112–0.289	3.27–14.8	g
	b.l.[a]	b.l.			0.0001–0.0031		b.l.		h
	0–0.055	0.002–0.039	0.06–0.11	0.35–1.35	0–0.002	0.02–0.20	0.05–0.19 (0.45)[b]	2.71–9.19	i
			0.128		0.007				c, d
Fruit			0.096		0.008				c, d
Egg			0.064		0.015				c, d
Seafood			0.367		0.23				c, d
Milk			0.317		0.006				c, d
Herb	33.4	0.420	1.11		2.52		36.8		j
		0.06–0.20		2.74–3.26			0.60–2.36	10.0–17.6	k

a) b.l.: below detection limits; b)one sample was 0.45; c) Zhang et al. (1996); d) Du et al. (1999); e) Zhang et al. (1997); f) Yun et al. (2001); g) Hou et al. (1995); h) Yang et al. (2000); i) Wang and Wang (1993); j) Yin et al. (1999); k) Wang et al. (1997a)

Table 7: Heavy metal pollution in two case villages

Element	Soil [mg/kg DW]	River [mg/L]	Drinking water source [mg/L]	Rice (or wheat) [mg/kg DW]	Vegetable [mg/kg DW]	Ref.
As	84.2–296.2	0.5–14.5	<0.05	0.196–0.620	0.026–0.091	b
As	16.4–19.8	n.d.[a]	n.d.	0.82	0.022–0.084	c
Cd	0.097–0.113	n.d.	<0.001	0.021	0.001–0.16	c
Cr	76.6–121	n.d.	n.d.	3.98	0.37–1.98	c
Cu	34.9–58.4	n.d.	<0.001	3.58	0.22–7.61	c
Hg	0.017–0.087	n.d.	n.d.	0.01	0.0008–0.003	c
Ni	42.5–70.4	n.d.	n.d.	1.01	0.18–1.41	c
Pb	32.5–42.9	n.d.	0	0.52	0.03–0.51	c
Zn	92–130	n.d.	n.d.	140	1–77	c

a) n.d.: no data; b) Wang et al. (1999); c) Wang et al. (2001)

as *Polygonum cymosum, Pteridium revolutum, Artemisia mairei, Melilotus officinalis, Poa annua, Canna chinensis, Maboa verticillata, Galinsoga paruiflora, Bidens bipinnata* and *Rumex nepalensis*, which are favorite sources of fodder for cows, horses and sheep (see Table 6). Compared with the heavy metals generally formed in herbs, the test herbs exceeded these values by 90%, 20%, 0, 50% and 50%, respectively, for the elements noted above. At Jiulong Estuary, on the other hand, the accumulation of heavy metals are lower than standards seen in the adult leaves of five mangrove species, *Kandelia candel, Bruguiera gymnorrhiza, Rhizophora stylosa, Avicennia marina* and *Aegiceras corniculatum* (see Table 6), and produced safe food for wildlife there (Wang et al. 1997a).

Although some elements were lower than food standards, the heavy metal pollution cannot be ignored. To protect the farm field free of heavy metal pollution is a basic way to avoid the threats of heavy metals to human beings via the food chain. The pollution in crops, vegetables and fruits directly affect the health of humans via consumption, but heavy metal pollution in pasturage herbs will affect animals and indirectly threaten humans.

Fed with a diet containing 1 mg/kg of Cd for 12 days, the maximum of Cd in Nile tilapia (*Oreochromis niloticus*) was 0.129 mg/kg DW, but declined to 86% following a no-Cd diet (Chen et al. 1996). Growth contributed 60% of the total decline, while excretion contributed 21%. That is to say, Cd accumulated in the organism is not easy to excrete and affect the health of animals in the whole lifecycle.

Wang et al. (1999) studied As pollution in three villages near an As mine in 1994 (**Table 7**). As calculated, the uptake amount of As was 0.195–1.13 mg per day and person. The residuals of As in the hair of human were 0.972–2.46 µg/g, which increased with age. Although the levels of As in water and food were lower than the national food standard, the levels of As exposure of residuals were equal to or even over that of the severe cases of chronic arsenic poisoning reported in China, which occurred in the area with As concentrations in drinking water which were 0.18–0.85 mg/L in the case of Xinjiang (Sun 1994) and 0.05–1.86 mg/L in the case of Inner Mongolia (XMC 1984). With long-term exposure, As was transported and concentrated through the food chain, and accumulated in the human body to lead to chronic poisoning.

A case study reported that disease was caused by the ecological environment (Wang et al. 2001). There were only 30 families and a population of 154 in 1970, but 31 persons died of cancer during the three decades in the studied village. By analysis of the heavy metals in the soil, water source, vegetables, wheat and human hair, the contents of As, Cu, Zn, Cr and Ni in the farmland were higher than the standard, As, Cr, Pb and Zn were higher than standard in wheat, Cd and Pb were higher than standard in vegetables and beans (see Table 7), and As, Cr and Ni were higher than the reference in the hair with the content of 0.021–0.51, 3.36–4.76 and 0.75–1.45 mg/kg, respectively. These values indicated that As, Pb and Cd pollution were the main reason for cancer in the village, with the transport and accumulation of As, Pb and Cd caused by human activities leading to the eco-environment pollution.

3 Conclusion

The geological background level of heavy metal is low in China, but with the activity of human being, a high anthropogenic emission of heavy metals occurs into the biosphere from the industrial emission, wastewater and waste solids. Those contaminants pollute the environment such as the soil, water and foods, which animals and human beings live on. Heavy metals will accumulate in plants, and especially in foods to bring the toxicity and diseases of geological and environmental origin to human beings. Most severe is that this kind of pollution is covert, long-term and non-reversible.

4 Recommendations and Outlook

Therefore, humans should be careful with heavy metal polluted water and food. To import food from areas notpolluted by heavy metals and drink safe water would be a way to avoid these heavy metals from being transferred to humans via the food chain, but to remediate and improve environmental quality is a long-term strategy for the polluted area to keep humans healthy and away from geological disease. How to clear the heavy metals in the environment and to avoid their entrance into the food chain is a hot topic throughout the world. The soil-plant system plays an important role in the solar energy transport to bio-energy, and plants would be helpful to clear the heavy metal pollution in the biosphere. Phytoremediation would be an effective technique to remediate heavy metal pollutions. Fortunately, studies on phytoremediation for heavy metals is wide spread throughout the world. As an optimum, a clean biosphere could be displayed in front of us in the near future.

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