

Table 1 The data resource of metal in Provincial capatial city

Cities	Reference
Beijing	Bai et al., 2014; Chen et al., 2010; He et al., 2016; Li, 2013; Li, 2009; Li He et al., 2009; Li, 2012; Ma, 2007; Meng, 2017; Xu, 2008; Zhai et al., 2013;
Changsha	Cheng, 2008; Guo et al., 2014; Li, 2007; Ma et al., 2011; Wang et al., 2018; Wei et al., 2012b; Yuan et al.,2006;
Changchun	Guo et al., 2014; Ma et al., 2011; Wang et al., 2018; Zhao, 2011;
Chengdu	An, 2015; Li, 2006; Li, 2015; Wang et al., 2018;
Chongqing	Chen et al., 2006; Chen et al., 2004; Ding, 2008; Wang et al., 2018; Zhao, 2008;
Fuzhou	Guo et al., 2014; Ma et al., 2011; Wang et al., 2018; Yang et al.,2012; Yi, 2005;
Guangzhou	Cai, 2013; Guo, 2007; Huang et al., 2015; Xie et al., 2014; Zhang et al., 2013;Zhang et al., 2008;
Guiyang	Chen, 2007; Li et al., 2011; Wang, 2016b; Wang et al., 2018; Wang et al., 2014; Wang et al., 2015; Wen et al., 2016; Zhao, 2014;
Haikou	Guo et al., 2014; Ma et al., 2011; Wang, 2016a; Wang et al., 2018;
Hangzhou	Chang, 2013; Guo et al., 2014; Ma et al., 2011; Shang and Liu, 2018; Sun,2007; Wang et al., 2018;
Harbin	Bian, 2009; Guo et al., 2014; Ma et al., 2011; Meng et al., 2013; Wang et al., 2018; Zhang,2013; Zhao, 2011;
Hefei	Deng et al., 2015; Guo et al., 2014; Jin et al., 2009; Ma et al., 2011; Wang et al., 2018; Zhang et al., 2011a; Zhang et al., 2011b;
Hohhot	Guo et al., 2014; Ma et al., 2011; Wang et al., 2018;
Ji'nan	Guo et al., 2014; Ma et al., 2011; Wang et al., 2018; Wang, 2016c; Zhao, 2008; Zhao and Ma, 2008;
Kunming	He et al., 2010; Li et al., 2015; Liu, 2014; Lu and Yang, 2013; Wang et al., 2018; Wu, 2011;

Cities	Reference
Lanzhou	Guo et al., 2014; Jing et al., 2010; Liu et al., 2015; Ma et al., 2011; Pan, 2011; Wang, 2013; Wang et al., 2015; Wang et al., 2018;
Lhasa	Guo et al., 2014; Ma et al., 2011; Wang et al., 2018;
Nanchang	Chen, 2011; Ding et al., 2014; Hu et al., 2010; Sun, 2015; Wang et al., 2018; Zhao et al., 2013;
Nanjing	Li et al., 2017; Lu et al., 2012; Ma, 2007; Wang et al., 2018; Zheng, 2007;
Nanning	Guo et al., 2014; Lin et al., 2016; Ma et al., 2011; Wang et al., 2018;
Shanghai	Liang et al., 2013; Lu, 2013a; Su, 2015b; Wang et al., 2018; Zhang et al., 2013;
Shenyang	Fu et al., 2010; Guo et al., 2014; Ma et al., 2011; Song et al., 2012; Tie et al., 2012; Wang et al., 2018; Zhao, 2013; Zhou, 2013;
Shijiazhuang	Guo et al., 2014; Ma, 2011; Wang et al., 2018; Yu, 2011; Zhao et al., 2009;
Taiyuan	Cui and Wang, 2011; Guo, 2007; Han, 2011; Liu, 2007; Wang, 2006; Wang et al., 2018; Xu and Zhang, 2012;
Tianjin	Guo et al., 2014; Wang and Jiang, 2012; Wang et al., 2010; Zeng et al., 2009;
Urumqi	Gu and Ai, 2013; Guo et al., 2014; Liu et al., 2012; Luo et al., 2011; Luo et al., 2014; Ma et al., 2011; Wang et al., 2018;
Wuhan	Lu, 2006; Su, 2015a; Wang et al., 2006; Wang et al., 2018; Ye T., 2007; Zhu et al., 2010;
Xi'an	Li et al., 2014; Liu, 2012; Wang et al., 2018; Wang et al., 2012a; Wang et al., 2008; Yi et al., 2013;
Xining	Guo et al., 2014; Ma et al., 2011; Wang et al., 2018; Zhao and Shi, 2006;
Yinchuan	Bao, 2008; Guo et al., 2014; Lu, 2013b; Wang et al., 2018; Wang et al., 2016; Zhang et al., 2006;
Zhengzhou	Guo et al., 2014; He ang Shen, 2009; Huang et al., 2017; Ma et al., 2011; Niu and Zheng, 2011; Wang et al., 2018; Wang, 2008;

Table 2 The descriptive statistics of baseline and background value in provincial capital city

Unit: mg/kg

Cities	Statistics	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Beijing	Mean	43.10	1.70	80.81	198.72	12.42	56.68	65.70	1018.97
	SD	60.58	0.91	45.93	73.05	3.85	61.78	38.21	403.95
	Range	7.9-216	0.24-3	31-192.5	48.9-315.5	7-20	16-246.4	25.77-157	654.99-2000
Changchun	Mean	14.70	2.12	101.50	194.55	3.38	33.67	67.56	691.54
	SD	1.73	1.22	27.65	28.86	1.65	6.77	35.34	127.62
	Range	13.65-16.7	0.82-3.25	71.05-125.05	172.3-227.16	2.27-5.28	28.26-41.26	39.3-107.18	604.8-838.08
Changsha	Mean	28.96	5.98	252.50	226.06	1.69	46.11	120.08	584.02
	SD	30.54	2.64	175.46	129.19	0.28	9.44	48.88	304.44
	Range	10-64.19	3.37-8.9	134.5-454.13	94.07-387.14	1.37-1.9	35.61-53.9	73.82-184.16	273.81-1000.14
Chengdu	Mean	15.86	2.02	118.34	129.50	2.10	76.76	38.21	797.10
	SD	5.90	0.43	67.64	75.37	0.59	62.99	19.41	412.63
	Range	11.9-22.64	1.64-2.48	71.23-195.84	47.68-196.11	1.31-2.7	37.27-149.4	21.27-59.38	465.2-1259.1
Chongqing	Mean	9.44	3.16	102.72	106.20	2.01	55.21	62.27	477.68
	SD	4.04	1.07	36.71	3.25	0.41	12.95	10.36	103.67
	Range	4.2-12.82	2.34-4.73	64.93-139.4	103.81-109.9	1.54-2.26	45.2-69.83	53.55-73.72	357.97-537.53
Fuzhou	Mean	10.95	3.76	234.33	265.63	1.61	51.10	100.85	722.76
	SD	6.74	1.87	180.11	136.15	0.49	41.95	56.62	509.31

Cities	Statistics	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	Range	5.9-18.6	1.6-5.9	22.48-482.19	129-472.3	1.3-2.18	9.4-93.3	64-200.03	326.13-1529.8
Guangzhou	Mean	30.36	2.44	236.46	751.60	1.62	65.04	120.71	789.32
	SD	14.41	1.27	248.84	955.70	0.35	32.97	66.68	285.25
	Range	19.15-49.7	1.15-5	51.9-828.05	146-2538.89	1.16-1.91	18.15-102.7	48.95-245	340.41-1219.8
Guiyang	Mean	28.19	5.07	135.66	224.68	1.40	61.19	144.65	1028.55
	SD	26.16	5.54	138.85	231.43	0.79	55.71	108.44	713.42
	Range	6-60	1-17.1	23.81-373	80.45-632.5	0.58-2.7	13.09-152.7	40.57-282	286.5-2126
Haikou	Mean	13.23	4.69	136.68	309.72	1.73	45.56	83.28	1158.64
	SD	10.93	3.41	25.66	79.01	0.49	20.70	27.14	467.25
	Range	5.91-25.8	1.4-8.2	121.3-166.31	222.67-376.9	1.37-2.29	22.2-61.6	57.99-111.96	780.5-1681
Hangzhou	Mean	30.03	6.32	369.28	591.06	2.04	111.01	111.82	1457.97
	SD	19.52	2.57	461.05	322.03	0.50	80.46	34.23	552.45
	Range	8.34-59	4.54-10.07	117-1190.66	287.99-1135.99	1.3-2.37	50.6-251.25	83.93-167.75	924.1-2198.25
Harbin	Mean	13.75	2.31	77.95	138.19	3.59	27.32	50.83	709.33
	SD	4.84	1.98	15.33	100.71	1.65	2.88	16.30	400.64
	Range	6.96-17.67	0.56-4.49	64.7-92.29	11.69-310	2.27-5.93	25.5-31.55	33.42-74.48	394.39-1449.8
Hefei	Mean	13.52	3.32	124.23	279.66	1.52	49.75	75.55	1087.97
	SD	9.93	1.94	46.63	181.89	0.24	30.99	48.09	758.31

Cities	Statistics	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	Range	1.3-27.16	1.25-5.9	95.17-193.85	96.69-530	1.3-1.79	21.78-93.3	18.64-146.51	9.12-1677.76
Hohhot	Mean	15.48	3.24	121.90	197.92	7.54	56.74	85.63	743.50
	SD	2.18	0.83	52.30	31.83	6.57	17.07	23.54	85.64
	Range	13.65-17.9	2.4-4.06	68.1-172.55	164.01-227.16	1.97-15.4	41.26-75.05	60.5-107.18	671.22-838.08
Ji'nan	Mean	11.54	3.73	159.80	271.04	2.22	69.46	85.11	802.00
	SD	6.11	1.88	46.45	176.30	0.89	31.84	33.87	466.76
	Range	7.99-18.6	1.52-5.9	99.38-201.67	38.58-472.3	1.3-3.07	21.09-93.73	44.16-122	452-1529.8
Kunming	Mean	27.11	6.71	120.79	190.20	2.42	38.65	70.09	494.17
	SD	12.14	4.46	43.18	22.24	0.90	9.72	20.74	415.99
	Range	18.5-45.06	2.38-12.5	67.1-171.85	165.38-210.95	1.4-3.55	27.63-46	45.3-101.8	34.58-1044.43
Lanzhou	Mean	14.79	1.94	145.64	99.21	2.05	22.54	34.27	411.93
	SD	2.07	1.22	52.40	7.99	0.14	6.48	7.89	113.91
	Range	12.4-16.06	0.87-3.7	86.56-186.5	91.23-107.3	1.9-2.18	17.09-30.14	23.32-41.15	286.74-532.04
Lhasa	Mean	14.04	4.90	140.49	203.76	2.20	39.88	102.65	900.31
	SD	1.86	1.68	16.01	59.14	0.23	6.12	26.07	145.01
	Range	12.4-16.06	3.25-6.6	125.05-157.02	136.5-247.616	1.9-2.44	33.19-45.2	74.6-126.155	796.8-1066.04
Nanchang	Mean	11.78	3.48	99.11	232.52	1.13	45.46	77.24	666.61
	SD	3.77	4.21	79.19	130.47	0.83	24.36	58.77	467.28

Cities	Statistics	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	Range	7.64-15	0.13-11.72	2.16-203	14.94-383.47	0.17-1.62	27.56-73.2	3.34-169.5	31.58-1460.9
Nanjing	Mean	9.27	4.96	77.03	112.28	2.89	61.55	58.24	576.14
	SD	3.66	3.65	66.46	44.88	0.75	37.13	36.46	217.68
	Range	6.42-13.4	0.61-9.47	30.2-153.1	55.69-165.4	2.23-3.7	30.95-114.8	23.15-107.3	371.55-871.2
Nanning	Mean	20.60	4.74	105.02	249.55	1.69	49.80	64.76	675.77
	SD	10.65	3.36	34.59	150.30	0.45	12.22	29.78	314.07
	Range	8.34-27.65	1.48-8.2	65.29-128.46	83.76-376.9	1.3-2.18	37.2-61.6	30.45-83.93	322.72-924.1
Shanghai	Mean	30.46	1.76	307.20	497.74	1.74	77.27	69.82	1215.50
	SD	39.11	0.97	238.38	335.38	1.12	49.16	43.90	549.14
	Range	8.4-89	0.7-2.88	46.8-578	186-1067.5	0.21-2.8	47.2-134	15-136.5	442-1819
Shenyang	Mean	11.72	4.43	85.85	245.58	1.95	33.86	157.26	376.80
	SD	4.49	1.48	51.70	137.70	1.14	15.19	119.47	273.69
	Range	7.99-16.7	1.49-5.48	26.71-122.44	51.97-413.3	0.26-2.65	15.89-52.89	34.68-357.4	90.85-720
Shijiangzhuang	Mean	13.90	6.91	129.08	197.80	7.50	55.60	111.85	1555.22
	SD	1.05	5.03	63.93	51.57	3.25	3.85	56.17	1110.28
	Range	12.8-14.9	2.4-13.9	68.1-218	144-246.8	3.97-10.5	52.89-60	60.5-190	721.2-2815.45
Taiyuan	Mean	17.90	4.06	172.55	164.01	1.97	75.05	89.20	671.22
	SD	5.14	2.07	182.62	97.95	1.57	52.49	45.63	280.60

Cities	Statistics	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	Range	12.7-24.2	0.05-6.14	4.56-482.95	33.85-316.4	0.64-3.7	18.88-165	54.45-160.34	214.9-913.5
Tianjin	Mean	17.19	2.61	481.86	467.80	8.49	87.17	241.80	1374.11
	SD	7.95	0.77	344.99	355.50	3.34	22.57	246.23	794.87
	Range	10-27	1.1-3.08	136-1050	156-1078	4.35-11.8	53.9-101.67	22.4-669	611.33-2272
Urumqi	Mean	14.79	4.86	157.02	247.62	2.44	33.19	126.16	1066.04
	SD	2.07	2.32	61.29	262.39	1.38	9.75	182.71	584.51
	Range	12.4-16.06	2.4-8	86.56-198	17.57-700	1.3-3.97	22-39.87	27.95-400	550.33-1880
Wuhan	Mean	11.07	3.11	255.12	301.87	1.54	52.34	80.25	1535.63
	SD	1.42	2.31	146.38	297.75	0.45	32.06	35.84	877.17
	Range	10.1-12.7	0.47-6.21	144.8-421.18	111.5-645	1.04-1.91	32.11-89.3	54.08-133	785.27-2500
Xi'an	Mean	48.33	7.13	343.62	210.48	4.16	67.21	93.20	950.65
	SD	60.71	4.77	285.64	81.13	4.48	28.60	29.15	618.41
	Range	13.7-156.4	1.14-11.41	189.3-771.63	139.17-346	0.19-12.2	46.4-116.4	50.8-131.55	465.7-2009
Xining	Mean	14.57	2.34	163.85	153.15	2.18	30.12	68.52	464.20
	SD	1.30	1.98	33.76	100.53	0.80	14.26	43.30	303.63
	Range	13.65-16.06	0.074-3.7	125.05-186.5	38.7-227.16	1.3-3.21	9.5-41.26	18-107.18	127-838.08
Yinchuan	Mean	16.06	3.22	139.78	263.30	3.71	33.37	94.24	504.65
	SD	3.85	2.18	78.21	209.44	2.12	9.44	27.42	80.30

Cities	Statistics	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	Range	10.7-19	0.54-5.6	45.3-218.9	97.6-498.7	0.97-6.3	22.54-39.87	48.5-122.7	411.93-551.7
Zhengzhou	Mean	15.69	2.02	163.95	276.53	1.99	47.38	54.07	657.44
	SD	7.64	1.21	64.96	118.43	0.42	10.25	25.69	266.74
	Range	10-24.37	1.14-3.77	100.49-251.93	163.35-455.22	1.67-2.6	35.61-54.29	21.25-81	335.24-916.65

References

- Wang SP., Liu XA., Zheng Q., Yang ZL., Zhang RX., Yin BH. 2012. Analysis on sewage sludge characteristics and its feasibility for landscaping in Xi'an City. *China Water & Wastewater* 23:134-137. 10.3969/j.issn.1000-4602.2012.23.036
- Liu XA. 2012. Feasibility study on sewage sludge landscaping application in Xi'an. Xi'an University of Architecture And Technology
- Wang B., Jiang W. 2012. Study on sludge pollution and reuse of municipal sewage treatment plants in Tianjin. 2012 annual meeting of the national drainage Commission.
- An MJ. 2015. Concentration and chemical fractions of heavy metals in sewage sludge. Chengdu University of Technology
- Bai LL., Qi HT., Fu YP., Li P. 2014. Nutrient contents and heavy metal pollutions in composted sewage sludge from different municipal wastewater treatment plants in Beijing region. *Environmental Science* 12: 4648-4654. 10.13227/j.hjlx.2014.12.031
- Bao JQ. 2008. The composting techniques of sludge of wastewater treatment plant. *Journal of Agricultural Sciences* 4: 41-44. 10.3969/j.issn.1673-0747.2008.04.012
- Bian W. 2009. Heavy metal distribution in cropland soils amended with sewage sludge and heavy metal uptake by soybean. Northeastern Agricultural University.
- Cai WM. 2013. Characteristics and comprehensive utilization of sludge from municipal wastewater treatment plant: a case study of three cities in Shenzhen, Foshan and Guangzhou. *Resources Economization & Environment Protection* 6:30-31. 10.3969/j.issn.1673-2251.2013.06.018
- Chang BQ. 2013. Analysis on the content of heavy metals in sludge of municipal sewage treatment plants in Hangzhou City. *Refrigeration Air Conditioning & Electric Power Machinery* 5: 64-66. 10.3969/J.ISSN.2095-3429.2013.05.017
- Chen HL. 2007. Control of heavy metal content in municipal sewage sludge compost — Determination of green fertilization amount. Guizhou university. 10.7666/d.y1187398
- Chen PL. 2006. Characteristics of sewage sludge and its agricultural utilization in Chongqing. Southwest University. 10.7666/d.y937529
- Chen WJ. 2011. Study on applying sewage sludge to Petunia hybrida Vilm planting. Jiangxi Agricultural University.
- Chen X., Yang LB., Wang JC., Zou YG., Tian ZH., Zuo Q., Xiao Q., Zhang L. 2010. Effect of Sewage Sludge Compost Application on Heavy Metals Accumulation in Soil and

Wheat Shoots. Chinese Agricultural Science Bulletin 8):278-283.

Chen YC., Guo Y., Wei SP. 2004. Removal of Cd and Cr from municipal sludge by complexing of chelators and surfactants. China Environmental Science 1 100-104.10.3321/j.issn:1000-6923.2004.01.023

Cheng M. 2008. Speciation distribution and electrokinetic remediation of heavy metals in municipal sludge. Hunan University. 10.7666/d.y1259897

Cui JL., Wang ZZ. 2011. Removal of Heavy Metals in Urban Sewage Sludge by Bioleaching. Journal of Taiyuan University of Technology 4: 383-387. 10.16355/j.cnki.issn1007-9432tyut.2011.04.015

Deng BB., Tian C., Si YB. 2015. Heavy metal characteristics and its potential ecological risk assessment in the sludge from Hefei municipal wastewater treatment plants. Environmental Pollution & Control 8:46-51. DOI:10.15985/j.cnki.1001-3865.2015.08.009

Ding WQ. 2008. Analysis of characteristics of sludge in Chongqing wastewater treatment plant. Journal of Anhui Agricultural Sciences 26: 11508-11509. 10.3969/j.issn.0517-6611.2008.26.141

Ding Y., Zhao GP., Liu YK., Zhang H., Liu Q. 2014. Accumulation and Toxicity Characteristics of Heavy Metal in Sewage Sludge Contained in *Corbicula fluminea*. Acta Agriculturae Universitatis Jiangxiensis (Natural Sciences Edition) (6) :1393-1397. 10.13836/j.jjau.2014222

Effects of Biosolid on the Accumulation and Transfer of Trace Elements in Soil-Wheat/Maize System. Journal of Agro-Environment Science 10 : 2042-2049. 10.3321/j.issn:1672-2043.2009.10.008

Fu JX., Sha MZ., Yu PF., Tag YL., Qu K. 2010. The analysis of heavy metal forms in sewage sludge. Water & Wastewater Engineering 1:119-122. 10.3969/j.issn.1002-8471.2010.z1.031

Gu ZY., Ai Y. 2013. Analysis on different characteristics of Cd and Pb in the sludge of Hedong Sewage Treatment Plant in Urumqi. National Seminar on sludge treatment technology research and resource utilization and comprehensive utilization of new technologies and equipment

Guo GH. 2007. Heavy Metals and Nutrients in Sewage Sludge from Different Areas in China and its Potential Agricultural Landuse. Southeastern University.

- Guo GH. 2008. Heavy Metals and Nutrients in Sewage Sludge from Different Areas in China and its Potential Agricultural Landuse. Southeastern University.
- Guo GH., Chen TB., Yang J., Zheng GD., Gao D. 2014. Regional distribution characteristics and variation of heavy metals in sewage sludge of China[J]. *Acta Scientiae Circumstantiae* 10 : 2455-2461.10.13671/j.hjkxxb.2014.0608
- Han YZ. 2011. Research on the changes of heavy metals morphology and the removal mechanism by bio-leaching. Taiyuan University of Technology.
- He J., Zhang X., Xiao D., Bai T., Zheng GD, Chen TB. 2010. Feasibility of Land Application of Sewage Sludge from Kunming Wastewater Treatment Plants. *China Water & Wastewater* 17: 103-105.
- He XW., Fang ZQ., Wang YX., Jia MY., Song JY., Cheng YJ. 2016. Pollution characteristics, potential ecological risk and health risk assessment of heavy metal in a sewage treatment plant in Beijing. *Acta Scientiae Circumstantiae*, 3: 1092-1098.10.13671/j.hjkxxb.2015.0562
- He YF., Shen AL. 2009. Influences of Application of Sludge on Yield of Brassica chinensis and Accumulation of Heavy Metal Cadmium and Chromium. *Journal of Henan Agricultural Sciences* 10:1418-1422. 10.3969/j.issn.1004-3268.2009.10.026
- Hu JH., Yuan JH., Huang HP. 2010. Fraction Distributions and Availabilities of Heavy Metals in Municipal Sludge of Nanchang City. *Bulletin of Soil and Water Conservation* 5: 63-67
- Huang L., Qiao JH., Guo KL., Ji ZY., Liu X., Zhang JF. 2017. Effect of consecutive application of sewage sludge on soil fertility and soil microbial properties of sandy fluvo-aquic soil. *Soils and Fertilizers Sciences in China* 5:80-86. 10.11838/sfsc.20170514
- Jin J., Yu ZM., Wu K., Zhao HH., Ma XF., Ding CX., Cai JM., Michael N. 2009. Investigation on the Systematic Distribution of Sewerage Treatment and the Outputs of Municipal Sludge with Analysis on Properties for Hefei. *Environmental Science and Management* 4:32-39. 10.3969/j.issn.1673-1212.2009.04.009
- Jing WQ., Nan ZR., Wang SL., Zhao CC., Liu J., Liao Q., Wu WF., Zhou T. 2010. Fractionation and environmental assessment of heavy metals in the sludge from Lanzhou municipal wastewater treatment plants, China. *Journal of Agro-Environment Science* 6: 1211-1216.
- Li CP. 2013. HEAVY METALS CHARACTERIZATION OF ALTERNATIVE FUELS USED IN CEMENT KILNS *Environmental Engineering* 31(s1):573-576.

DOI:10.13205/j.hjgc.2013.s1.045

- Li H., Li CC., Liu WJ., Liu JG., Wang HT., Guo F., Wu YH. 2015. Treatment strategy of sewage Sludge in Kunming Urban Area. China water and wastewater 3: 95-98
- Li HY., Hu XD., Wu QH., Wu ZJ., Huang XX., Zhang FG., Leung YS., Fu J., Huang ZY., Xiong FK., Xiong F. 2015. Heavy metal concentration, emission flux and potential ecological risk assessment for agriculture in Guangzhou. Chinese Journal of Environmental Engineering 3 :1 409-1 416
- Li JT. 2006.Study of the utilization of Chengdu sewage sludge. Sichuan Normal University.10.7666/d.y928083
- Li Q. 2009. EFFECTS OF BIOSOLIDS ON THE ACCUMULATION AND TRANSFER OF TRACE ELEMENTS IN SOIL-WHEAT/MAIZE SYSTEM. Capital Normal University.
- Li Q.2012. Feasibility and Risk Assessment Study of Biosolids Agricultural application. Capital Normal University
- Li QQ. 2007. The Usage of Surfactant in recycling of sewage sludge. Hunan University. 10.7666/d.d031551
- Li R., Wu LH., Yang JB., Liu HY. 2011. Major nutrients and heavy metals of municipal sewage sludge in Guizhou Province. Journal of Agro-Environment Science 4: 787-796.
- Li TG., Wang LJ., Xu XJ., Zhan Q., Zhao J. Morphological Characteristics of Heavy Metals in Sewage Sludge and Their Potential Ecological Risk Assessment in Xi'An,(Shaanxi). Urban Environment & Urban Ecology, 2014, 27(4):6-10.
- Li WT. 2015. Developments of the speciation, removal and stabilization of heavy metals in municipal sludge. Chengdu University of Technology
- Li YQ., Wan CJ., Wei TJ., Guan DX., Huang H., Yu GH., Luo J. 2017. In situ analysis of heavy metal availability in dewatered sewage sludge based on DGT technique. Journal of Nanjing University (Natural Sciences) 2: 227-237. DOI:10.13232/j.cnkij.nju.2017.02.003
- Liang J., Fang HL., Zhu L., Hao GJ.2013. Accumulation and transfer of heavy metals in urban green-belt soils for the application of sewage sludge[J]. Environmental Science & Technology, (12IV):70-73.
- Lin KR, Wang DP., Qin LJ., Li S. 2016. Distribution characteristics of heavy metals in dewatered sludge from sewage treatment plants of town in Guangxi . Journal of Guangxi University.

- Liu C., Li H., Zhao YS., Wu WF., Wang HC. Nan ZR. 2015. Effect of sewage sludge amendments on the speciation distribution and redistribution of Cd in loess. *Acta Scientiae Circumstantiae* 10,3218-3224 DOI:10.13671/j.hjkxxb.2015.0110
- Liu H., Liu YE, Pang GL., Ma HZ., Xi DH., Xu XH. 2012. Heavy metals in municipal sludge: analysis and stabilization. *Environmental Science & Technology* 6:114-117. 10.3969/j.issn.1003-6504.2012.06.024
- Liu LF. 2007. Dynamic test of removal heavy metal from sludge by bioleaching progress. Taiyuan University of Technology.
- Liu WJ. 2014. Environmental security of heavy metals in sewage sludge compost applicated on the land of Kunming. Tsinghua University.
- Lu FJ. 2013. Characteristics and Potential Ecological Risks of Heavy Metals in Sewage Treatment Plant Sludge 4:139-142. *Environmental Science and Management* 4:139-142. 10.3969/j.issn.1673-1212.2013.04.032
- Lu Q. 2006. Study on the characteristics and disposal project of the sludge from municipal sewage treatment plant in Wuhan. Wuhan University of Technology. 10.7666/d.y1020852
- Lu SY. 2013. Discussion of urban sewage treatment plant sludge utilization and resources. Xi'an University of Architecture and Technology
- Lu Y., Yang G. 2013. Sludge components and use types of wastewater treatment factories in Kunming City. *Journal of Southern Agriculture* 10 :1681-1684. 10.3969/j.issn.2095-1191.2013.10.1681
- Lu ZL., Li JY., Jiang J., Xu RH. 2012. Amelioration effects of wastewater sludge biochars on red soil acidity and their environmental risk. *Environmental Science* 10 :3585-3591
- Luo YL., Zheng CX., Jia HT., Wang WQ., Wang WJ., Huang XZ. 2011. Study on distribution characteristics of heavy metals speciation in the sludge of Qidaowan wastewater treatment plant. *Environmental Engineering* 6: 82-85.
- Luo YL., Zheng CX., Wang MY., Wang Y. 2014. Heavy metals speciation of municipal sewage sludge in Urumqi and its agricultural use feasibility. 05:69-72. 10.13205/j.hjgc.201405017

Ma CS. 2011. Analysis of heavy metals in sludge from Qiaoxi sewage treatment plant in Shijiazhuang. Hebei Water Resources 12 :47-47. 10.3969/j.issn.1004-7700.2011.12.035

Ma HT. 2007. Study on the fraction distribution and leachability of heavy metals in municipal sludges. Hehai University. 10.7666/d.y1128692

Ma HT. 2007. Study on the fraction distribution and leachability of heavy metals in municipal sludges. Hehai University. 10.7666/d.y1128693

Ma XW., Weng HX., Zhang JJ. 2011. Regional characteristics and trend of heavy metals and nutrients of sewage sludge in China. China Environmental Science 8:1306~1313

Meng FY., jiang JQ., Zhao QL., Wang K., Wei LL. 2013. Soil salinization improved by dewatered sludge associated with physicochemical property changes of heavy metals. Journal of nature of Heilongjiang University 3: 368-375. 10.13482/j.issn1001-7011.2013.03.006

Meng GX., Zha TG., Zhag XX., Liu Z., Su GR. 2017. Heavy metal pollution characteristics and ecological risk assessment of the sludge from wastewater treatment plants in Beijing. Ecology and Environmental Sciences 09,1570-1576. 10.16258/j.cnki.1674-5906.2017.09.016

Niu JL., Liu L., Zheng BG. 2011. Study on the Characteristics and Composition Possibility of Urban Sewage Sludge in Zhengzhou City, Journal of Anhui Agricultural Sciences 15 :8985-8986. 10.3969/j.issn.0517-6611.2011.15.061

Pan Y. 2011. Experiment studies on the heavy metal after sludge composting with fly ash and leaching. Lanzhou University.

Qiao XL., Luo YM. Preliminary study on chemical composition and agricultural standards of some municipal sludge in China. Soil 4 205-209.

Shang HJ., Liu QW. 2018. The Research of Mercury Forms in Some Cities Urban Sludge in Zhejiang Province. Guangdong Chemical Industry 5 :20-21.

Shang HJ., Liu QW. 2018. The Research of Mercury Forms in Some Cities Urban Sludge in Zhejiang Province. Guangdong Chemical Industry 5: 20-21.

Song LL., Tie M., Zhang ZH., Hui XJ., Jing K., Chen ZL., Zhang Y.2012.Effects of applying sewage sludge on chemical form distribution and bioavailability of heavy metals in soil. Chinese Journal of Applied Ecology 10: 2701-2707.

Su H. 2015. Experimental Study on the Transferring Characteristics and Leaching Behavior of Heavy Metals during the Co-combustion of Coal and Different Sludges. Huazhong University of Science and Technology

Su L. 2015. The chemical analysis and toxicity test based on the ocean dumping of sewage sludge. Shanghai Ocean University.

- Sun F. 2007. Physicochemical properties of sludge and environmental risk of sludge disposal. Zhejiang University.
- Sun SJ. 2015. Study on the application of sludge disposal scheme based on the characteristics of sludge from Nanchang sewage treatment plant. Nanchang University
- Tie M., Song LL., Hui XJ., Zhang CH., Jing K., Chen ZL., Wang J. 2012. Study on chemical forms distribution characteristics of heavy metals in municipal sewage sludge. Environmental Protection Science 5) :36-40. 10.16803/j.cnki.issn.1004-6216.2012.05.009
- Wang CQ., Lu MX., Liang H., Yu Y., Gong XM., Wang P., Yuan H. Characteristics of the Wuhan Draining Water Sludge and Its Feasibility Used in Agriculture Hubei Agricultural Sciences 4: 451-455. DOI:10.14088/j.cnki.issn0439-8114.2006.04.021
- Wang FQ. 2016. Treatment of sewage sludge by earthworms and microorganisms. Hainan University.
- Wang HC. 2013. Changes of heavy metals during life cycle of municipal sludge and effects on phytoremediation of contaminated soil. Lanzhou University.
- Wang HC., Zeng ZZ., Zhang HF., Nan ZR. 2015. Study on variation of heavy metals speciation in sludge stabilization process. Environmental Engineering 10:81-84,112. 10.13205/j.hjgc.201510018
- Wang HT. 2006. Removal of the heavy metals from the urban sewage sludge by using the bioleaching process. Taiyuan University of Technology. 10.7666/d.y979461
- Wang J. 2016. Content and risks evaluation of heavy metals in sewage sludge of Guiyang municipal sewage treatment plants. Resources Economization & Environmental Protection 9:287-287. 10.3969/j.issn.1673-2251.2016.09.230
- Wang N., Liu QW., Zhi Y., Cheng L., Ma BJ., Mao YX. 2018. Spatial and Temporal Variation Patterns of Mercury in the Municipal Sewage Sludge of China. Environmental Science 5:2296-2305. DOI:10.13227/j.hjcx.201710130
- Wang S., Bao JG., Liu CL. 2010. The Study on Characteristics of Municipal Sewage Sludge and Analysis of the Prospects for Landscaping Use. Environmental Science & Technology s1: 238-241 1003-6504 (2010) 6E-0238-05
- Wang WH., Cheng J., Hong W., Liu JN. 2016. Research on the cooperative disposal of sludge in cement kiln. Petrochemical Industry Application 5 : 132-134. 10.3969/j.issn.1673-5285.2016.05.034

- Wang XL. 2016. Pollution characteristics and risk assessment of heavy metals in sewage sludge from municipal wastewater treatment plants in Shandong. *Environmental Pollution & Control* 8: 59-63+68.10.15985/j.cnki.1001-3865.2016.08.013
- Wang YF., Gao JF., Hou XF., Dong YW., Li JK., Liang ZQ. 2008. Research on heavy metal content and leaching—out toxicity determination and resourceful utilization of sludge 5: 576-578. 10.3969/j.issn.1671-3206.2008.05.035
- Wang YS., Liu HY., Li R., Yang JB., Jiang DM. 2014. Heavy metals component in sewage sludge and its potential ecological risk assessment for agriculture in Guizhou Province, China. *Resources and Environment in the Yangtze Basin* 3 :1110-1113.10.11870/cjlyzyyhj201403013
- Wang YS., Liu HY., Li R., Yang JB., Zhou J. 2015. Effects of Sewage Sludge Continuous Application on Zn, Cd Accumulation Characteristic in Corn-Wheat. *Journal of Guizhou University (Natural Science)* 5 129-135. 10.3969/j.issn.1000-5269.2012.05.029
- Wang YY. 2008. Impact on quality of the water spinach and heavy metal accumulation of soil of different applying sewage sludge amount. He nan Agricultural University. 10.7666/d.y1336492
- Wei XY., Guo ZH., Xiao XY. 2012. Environmental availability and ecological risks of heavy metals in sewage sludge. *Bulletin of Soil and Water Conservation* 4 :203-207. 10.13961/j.cnki.stbctb.2012.04.021
- Wen Z., Li J., Wang X., Zhang QQ. 2016. Fractionation and environmental assessment of heavy metals in sewage sludge from municipal wastewater treatment plants of Guizhou Province. *China Rural Water and Hydropower* 12:67-73
- Wu SW., Hu HR., Yang YD. 2011. Discussion on Characteristics and Land Application of Municipal Sludge of Kunming. *Journal of Anhui Agricultural Sciences* 15: 9379 – 9381. DOI:10.13989/j.cnki.0517-6611.2011.15.074
- Xie XL., Cai XY., Zhong YX., Liang PJ., Lei QY. 2014. STUDY ON THE CHANGE OF HEAVY METAL FORMS DURING COMPOSTING OF SEWAGE SLUDGE CONTAINING EXCESSIVE CU AND ZN. *Environmental Engineering* 32 s1) :319-324.
- Xu Q., Zhang GH. 2012. Research on Technology of Environmental Protection in Treating Municipal Sewage Sludge. *Sci-tech Innovation and Productivity*11: 69-71.

10.3969/j.issn.1674-9146.2012.11.069

Xu XH. 2008. Agronomic benefits and environmental impacts of sewage sludge application to soil. Chinese Academy of Agricultural Sciences. 10.7666/d.Y1422152

Yang X., Su YP., Wang JQ., Lin ZY. 2012. Analysis of sludge properties and land use prospects in Fuzhou sewage treatment plant. Straits Science 9 :3-5. 10.3969/j.issn.1673-8683.2012.09.001

Ye T. 2017. Evaluation on combined leaching removal of heavy metals by Saponin and Citric Acid from sewage sludge and risk assessment. Huazhong Agricultural University.

Yi X., Xu JJ, Wei M., Wang YK. 2013. Effects of applying municipal sludge on physiological characteristics and qualities of leaf lettuce. Agricultural Research In The Arid Areas 3 178-183. 10.3969/j.issn.1000-7601.2013.03.029

Yi XE. 2005. Study on the Agricultural Utilization of Sewage Sludge. Fuzhou Normal University. 10.7666/d.y769126

Yu CE. Technology of converting sludge compost and harm reduction into bio organic fertilizer. Nankai University. 10.7666/d.y2003123

Yuan HS., Liu YG., Li X., Ye F., Chen ZM., Zhang BB. 2006. Study on the removal efficiencies of heavy metals in acidified sewage sludge using electro remediation technique. Environmental Sanitation Engineering 2:5-8. 10.3969/j.issn.1005-8206.2006.02.002

Zeng XF., Yu XM., Wang ZW., Wei DB. 2009. Research on removal and recovery of heavy metals from municipal sludge. China Water & Wastewater 19:81-84.

Zhai LM., Xi B., Liu HB., Liu S. 2013. Effects of domestic sewage sludge on the accumulation and transfer of mercury in crop-soil system. China Environmental Science 11:2035-2039.

Zhang C., Cheng H., Yu YX., Wang LJ., Han JB., Tao P. 2013. Pollution characteristics of heavy metals in sludge from wastewater treatment plants and sludge disposal in Chinese coastal areas. Environmental science 4: 1345-1351. 10.13227/j.hjlx.2013.04.048

Zhang CS., Chen QL., Zhang KF., Li SG. 2008. Chemical Forms and Bioavailability of Heavy Metals in the Sludge of Datansha Wastewater Treatment Plant. Journal of Agro-Environment Science 3: 1259-1264. 10.3321/j.issn:1672-2043.2008.03.074

Zhang R., Xie YB., Hua RM., Li XD. 2011. Investigation of heavy metals contained in sewage sludge from municipal wastewater treatment plants from five cities and evaluation

- on their potential ecological risks in agricultural utilization. Journal of Anhui Agricultural University 2: 280-285. 10.13610/j.cnki.1672-352x.2012.02.014
- Zhang R., Xie YB., Hua RM. 2011. Study on heavy metals contained in sewage sludge from Hefei and around cities municipal waste-water treatment plant and evaluation on their potential ecological risks in agricultural utilization. Journal of Anhui Agricultural University 6: 128-133.
- Zhang Y. 2013. Research on Biological Characteristics, Physico-chemical Properties, Evolution of Heavy metals and Microbial Diversity during Sludge Composting. Southeastern Agriculture University.
- Zhang YM., Ren YF., Zhao YB. 2006. Initial research of producing concentrated compound fertilizer utilizing urban mud. Journal of Agricultural Sciences 1: 95-96. 10.3969/j.issn.1673-0747.2006.01.026
- Zhao GP., Ding Y., Shi RR., Liu LH. 2013. Properties of municipal sewage sludge in Nanchang area. Journal of Nanchang Hangkong University (Natural Sciences) 1:47-52. 10.3969/j.issn.1001-4926.2013.01.010
- Zhao J. 2014. Analysis of pollutant characteristics in Guiyang sewage treatment plant. Guizhou Normal University.
- Zhao LL. 2013. Secondary pollution of heavy metals in municipal sludge disposal process and the preliminary inquiry of plant enrichment. Shenyang Normal University.
- Zhao QH. 2008. Distribution characteristics and status of heavy metal in city wastewater treatment process. Shandong University.
- Zhao QH., Ma SP. 2008. Detection of heavy metal elements in sludge from waste water treatment plant by microwave digestion and ICP-AES. Chemical Analysis and Meterage 2: 42-44. 10.3969/j.issn.1008-6145.2008.02.014
- Zhao QL. 2011. Removal of heavy metals for agriculture application of dewatered sludge from wastewater treatment plant and the characteristics of sludge. Harbin Institute of Technology
- Zhao QL. 2012. Removal of heavy metals for agriculture application of dewatered sludge from wastewater treatment plant and the characteristics of sludge. Harbin Institute of Technology
- Zhao QW., Shi QB. 2006. Disposal and utilization technology of mud from waste water in Xining. Journal of Qinghai University (Natural Science) 3:26-28. 10.3969/j.issn.1006-

8996.2006.03.008

- Zhao WX., Ren AL., Guo B. 2009. Heavy Metal Content and Their Decreasing Trends in the Process of Activated Carbon Prepared from Sewage Sludge. Environmental Science & Technology 12: 60-62. doi:10.3969/j.issn.1003-6504.2009.12.014
- Zhao XL., Lu JW., Chen PL. Wang DH.2008. Content, speciation of heavy metal in sewage sludge and its environmental capacity for agricultural use in Chongqing. Transactions of the CSAE 11: 188—192. 10.3321/j.issn:1002-6819.2008.11.037
- Zheng XX. 2007. Concentrations and Chemical Fractions of Heavy Metals in Sewage Sludge of Jiangsu Province10.7666/d.Y1215314
- Zhou HB. 2014. Study on Effects of Inorganic Salts on Forms of Cu and Cd during Municipal Sewage Sludge Composting. Northeastern University.
- Zhu TL., Li M., Huang QY. 2010. Effects of Straw Ash and Sewage Sludge on Morphologic Changes of Cadmium in Cadmium Contaminated Soil. Journal of Huazhong Agricultural University 4 447-451.