Pollutant coefficients data of livestock industry at provincial level in China

ZHOU Tianmo[1,2], ZHU Yunqiang[1], FU Qiang[3], HU Zhuowei[2], YANG Fei[1]

(1. Institute of Geographic Sciences and Natural Resources Research, Beijing 100101, China;
2. Key Laboratory of Resources Environment and GIS, Capital Normal University, Beijing 100048, China;
3. Department of Resources and Environmental Sciences, Henan University of Economics and Law, Zhengzhou 450002, China)

Abstract: Based on a series of measures, such as unit transformation, livestock and poultry equivalent normalization, and errors correction etc., we produce pollutant generation coefficients of livestock industry dataset at provincial level in the mainland of China. This dataset includes six main species of livestock and poultry, which are dairy cattle, beef, pig, broiler, laying hen and draft cattle. In addition, this dataset can support more accurate computing and comparing researches on livestock and poultry pollutant production at provincial level.

Keywords: livestock and poultry; pollutant coefficient; provincial level; China
DOI: 10.11821/dlxb2014S010
Citation: ZHOU Tianmo, ZHU Yunqiang, FU Qiang, HU Zhuowei, YANG Fei. Pollutant coefficients data of livestock industry at provincial level in China. Global Change Research Data Publishing and Repository, 2014. DOI: 10.3974/geodb.2014.01.10.v1, http://www.geodoi.ac.cn/WebEn/doi.aspx?Id=10.3974/geodb.2014.01.10.v1

1 Introduction

Pollutant coefficient of the livestock industry is an essential component of livestock and poultry's pollutant production estimation. There are two types of pollutant generation coefficient at home and abroad as follows:

The first one is fixed coefficient at national level, which is primarily used to reflect the average status of livestock and poultry's pollutant production for per day or per year at national or regional level. Countries, such as Japan[1-2], Denmark[3], America[4] and the former Soviet Union[5], all have fixed coefficients for pollutant production.

Another one is pollutant coefficient at regional level such as six major regions, Northeast, North, East, Central South, Southeast and Northwest China, coefficient, and many disperse province and county coefficients in published papers[6-43].

However, there still lacks an open available systemic livestock industry's pollutant generation coefficient at provincial level that greatly influences the estimation accuracy of livestock and poultry's pollutant production. Meanwhile it is hard to reveal the spatial difference of different provinces if we adopt fixed one or several coefficients. Therefore,

Received: 2014-03-20; **Accepted:** 2014-06-20
Foundation: National Scientific Special Program of Public Welfare Industry for Environmental Protection, No.201009017
Author: ZHOU Tianmo (1989-), MS Candidate, E-mail: dx-ztm@163.com
Corresponding author: ZHU Yunqiang (1977-), Associate Professor and Director of Earth System Data Sharing and Services Studies, IGSNRR/CAS. E-mail: zhuyq@igsnrr.ac.cn

Table 1 Summary of the LivestockPolluGeneCoeffi_China metadata

Full name of dataset	Pollutant coefficients of livestock industry at provincial level in China
Short name of dataset	LivestockPolluGeneCoeffi_China
Corresponding author: Authors	ZHU Yunqiang (zhuyq@igsnrr.ac.cn) ZHOU Tianmo, State Key Laboratory of Resources and Environmental Information System, Institute of Geographic Sciences and Natural Resources Research; Key Laboratory of Resources Environment and GIS, Capital Normal University, dx-ztm@163.com ZHU Yunqiang, State Key Laboratory of Resources and Environmental Information System, Institute of Geographic Sciences and Natural Resources Research, zhuyq@igsnrr.ac.cn FU Qiang, Department of Resources and Environmental Sciences, Henan University of Economics and Law, hn_fq7998@163.com HU Zhuowei, Key Laboratory of Resources Environment and GIS, Capital Normal University, huzhuowei@gmail.com YANG Fei, State Key Laboratory of Resources and Environmental Information System, Institute of Geographic Sciences and Natural Resources Research, yangfei@lreis.ac.cn
Geographical region	The mainland of China
Data format	Excel, .xlsx Dataset size 16 KB
Data Publisher	Global Change Research Data Publishing and Repository, DOI:10.3974/
Data access and services platform	Global Change Research Data Publishing and Repository, http://www.geodoi.ac.cn/ National Data Sharing Infrastructure of Earth System Sciences of China, http://www.geodata.cn
Academic editors	LIU Chuang, SHI Ruixinag, WANG Zhengxing, HE Shujin
Data sharing policy	The authors of the dataset agree to publish the data here according to the Article I of Data Sharing Policy of the Global Change Data Publishing and Repository, which states that the dataset can be used freely for research, education, and decision making; any users for commercial uses should get formal permission from IGSNRR/CAS.

based on existing disperse coefficients published in various journals, we produce this dataset, the provincial livestock industry's pollutant generation coefficients of main livestock in China, by the process of unit transformation, livestock and poultry equivalent normalization, and errors correction etc.

2 Dataset description

The descriptions of the pollutant coefficients of livestock industry at provincial level in China (LivestockPolluGeneCoeffi_China for short) dataset are recorded. These information include the dataset full name, dataset short name, corresponding author, authors, geographical region of the dataset content, year of the dataset, number of the dataset tiles, dataset spatial and temporal resolution, dataset format and size, data publisher, data sharing platform and contact information, technical editors, foundation and the data sharing policy. Table 1 below summarizes the main metadata elements of the LivestockPolluGeneCoeffi_China dataset.

3 Methods

The dataset processing method references from the article of "Optimizing pollutant generation coefficients of livestock industry and mapping patterns of pollutant constitution in China" published in the Journal of Geographical Research[44].

3.1 Coefficient optimization

There are some problems in different provincial coefficients of published articles, such as the measurement methods are inconsistent, and livestock and poultry's species are not clear. The problems above result in hardly comparing pollutant production among different provinces. Therefore firstly according to the formula 1, we transform numerical unit of each provincial coefficient to uniform kg/day· head. For these coefficients, which do not include feeding period, we adopt the following fixed feeding days to transform them: 180 days for pigs, 55 days for meat poultries, and 365 days for dairy cattle, beef, laying hen and cattle.

$$g_{m,d} = g_{m,y} \div T_m, \quad g_{m,y} = Q_m \div Y_m \tag{1}$$

where $g_{m,d}$ is pollutant generation coefficient of each livestock and poultry in every day (kg/ day· head) while $g_{m,y}$ is pollutant generation coefficient of each livestock and poultry in every year.

In addition, for the problem of cattle's species of existing coefficients are almost obscure, we use the public criterion of 43-75kg/day· head to revise these data that are obviously lower than the above criterion according the formula 2.

$$1\ dairy\ cattle = 2\ beefs = 10\ pigs \tag{2}$$

There are 2 periods in pig's feeding, caring and fattening so we adopt piecewise calculation method as the following formula 3 to get pig's pollutant generation coefficient.

Pollutant generation coefficient of a pig = 1/3 coefficient of caring period + 2/3 coefficient of fattening period (3)

After the above processes, if there are several coefficients of the same livestock in the same province, we take the average value as the optimized coefficient.

3.2 Verification and correction

On the basis of optimized coefficients, using the existing coefficients of six major regions as references, we respectively calculate relative errors of each provincial coefficient by using formula 4. The result shows that 31 optimized coefficients' relative errors are higher than 20%. Therefore using formula 5, we further modify them to get the final daily pollutant generation coefficients of main livestock at provincial level in China.

$$\mu = \left(\hat{V}_{m,ij} - F_{m,i}\right)/F_{m,i} \tag{4}$$

$$G_{m,ij} = \hat{V}_{m,ij} + \left(\sum_{j=1}^{n_i} F_{m,i} - \sum_{j=1}^{n_i} \hat{V}_{m,ij}\right)/n_i, \quad |\mu| \geq 20\% \tag{5}$$

In formula 4, μ is relative error and $\hat{V}_{m,ij}$ is the average value of pollutant generation coefficients while $F_{m,i}$ is reference value of pollutant generation coefficients.

In formula 5, $G_{m,ij}$ is the corrected pollutant generation coefficients of each livestock and |μ| is absolute value of relative error. n_i is the number of provinces in the number i region, and i is the number of major region while j is the number of province in the major region.

4 Dataset composition

This dataset is comprised of six livestock' pollutant generation coefficients of each provinces in China. Six livestock are dairy cattle, beef, pig, broiler, laying hen and draft cattle. The spatial extent is 31 provinces except for Hong Kong, Macao and Taiwan in China.

Table 2 Pollutant generation coefficients of livestock at provincial level in China

Province (Municipality, Autonomous Region)	dairy cattle	beef	pig	broiler	laying hen	draft cattle
Beijing	42.393	24.432	4.288	0.107	0.16	25.345
Tianjin	48.013	25.369	3.85	0.12	0.165	25.345
Inner Mongolia	48.01	25.368	4.863	0.12	0.165	25.345
Hebei	42.02	21.555	3.215	0.12	0.165	25.345
Shanxi	42.02	21.555	3.215	0.12	0.165	25.345
Liaoning	45.15	22.623	4.665	0.14	0.133	25.285
Jilin	47.057	23.099	4.303	0.14	0.12	25.285
Heilongjiang	47.745	23.271	4.303	0.14	0.12	25.285
Shanghai	45.238	23.164	3.603	0.165	0.113	24.785
Jiangsu	46.478	23.474	3.547	0.197	0.123	24.785
Zhejiang	44.581	23	3.747	0.17	0.15	24.785
Anhui	42.475	22.474	2.77	0.22	0.113	24.785
Fujian	48.293	23.928	3.884	0.197	0.125	24.785
Shandong	41.467	22.222	2.77	0.22	0.125	24.785
Jiangxi	43.3	22.335	4.13	0.06	0.123	27.65
Henan	42.157	22.049	4.477	0.077	0.117	27.65
Hubei	51.267	26.218	4.093	0.06	0.12	27.65
Hunan	53.45	27.436	4.4	0.06	0.12	27.65
Guangdong	46.065	23.026	4.315	0.088	0.121	27.65
Guangxi	51.267	26.218	5.13	0.06	0.12	27.65
Hainan	46.9	23.235	3.49	0.06	0.12	27.65
Chongqing	44.983	23.897	5.135	0.06	0.12	24.785
Sichuan	48.317	26.119	4.803	0.06	0.12	24.785
Guizhou	51.238	27.455	5.063	0.06	0.12	24.785
Yunnan	53.793	29.052	3.947	0.067	0.13	24.785
Tibet	48.317	26.119	4.983	0.06	0.12	24.785
Gansu	39.247	23.348	5.03	0.18	0.095	22.335
Xinjiang	39.247	23.348	5.03	0.18	0.095	22.335
Shaanxi	42.723	23.22	5.098	0.153	0.113	22.335
Qinghai	39.247	23.348	5.03	0.18	0.095	22.335
Ningxia	36.935	22.963	5.098	0.17	0.103	22.335
Average	45.464	24.03	4.267	0.123	0.126	25.175

The detailed dataset is showed as Table 2.

5 Conclusion

The existing fixed coefficients at national or sub- region level are difficult to reflect spatial difference of pollutant production of each province and largely impact the precise of pollutant production. Thus, based on existing disperse coefficients published in various journals, after series of process of unit transformation, livestock and poultry equivalent normalization, and errors correction etc., we produce this dataset detailed in provincial level as described in this paper. This dataset can support more accurate national livestock pollutant production estimation and comparing research on livestock pollutant production at provincial level.

References

[1] Ban J H, Song G Y H. Agricultural Pollution Handbook. JPN: DIREN Library, 1974.

[2] Rural Culture Association. The Livestock Environmental Measures Book. JPN: Tokyo Rural Culture Association Press, 1995.
[3] Hanne D P, Kristensen V F. Standard Values for Farm Manure: A Revaluation of the Danish Standard Values
[4] Concerning the Nitrogen, Phosphorous and Potassium Content of Manure, DIAS report: No7. Animal Husbandry; 1998.
[5] ASAE Standards. Manure Production and Characteristics, 2004.
[6] Ministry of Agriculture of People's Republic of China. The First National Pollution Census Leading Group Office. Livestock and Poultry Breeding Generation and Discharge Coefficient Manual. http: //wenku.baidu.com/view/c1ee9509581b6bd97f19ea00.html, 2009-10-25.
[7] Huang S F, Chen C J, He J F. Animal husbandry pollution and its harness countermeasure in upper catchment of Huangpu river. Shanghai Environmental Sciences, 1994, 13(5): 4-8.
[8] Shen G X, Wang Y G, Yuan D W. Loading amounts of animal feces and their alarming values and classifications grades in Shanghai suburbs. Acta Agriculturae Shanghai, 1994, 10(Suppl.): 6-11.
[9] Department of Nature and Ecology Conservation of State Environmental Protection Administration of China. National Scale Livestock and Poultry Breeding Situation Investigation and Countermeasures. Beijing: China Environmental Science Press, 2002: 77-78.
[10] An L L. Poultry Environmental Hygiene. Beijing: Higher Education Press, 2004: 70, 84, 98, 102, 185-187, 305.
[11] Editorial Board of Agricultural Technology Economic Manual. Agricultural Technology Economic Manual. Beijing: Agriculture Press, 1983: 116.
[12] Dong Hongmin, Zhu Zhiping, Huang Hongkun et al. Pollutant generation coefficient and discharge coefficient in animal production. Transactions of the CSAE, 2011, 27(1): 303-308.
[13] Guo Jun, Hai Reti, Wang Fang. Pollution reduction of livestock farming in Nanchang. Environmental Science & Technology, 2011(S2): 88-92.
[14] Jing Donglin, Yan Youfu, Chen Xiping et al. Analysis on the total domestic animal excrement and farmland loading amounts in Panyu. Guangdong Agricultural Sciences, 2011, 28(23): 141-144.
[15] Wang Jinhu, Zhang Dehua, Chen Yiyun. Livestock waste pollution loading and its environmental impact in Xingyun Lake watershed. Shanghai Environmental Sciences, 2011, 30(1): 12-17.
[16] Lin Yuan, Ma Ji, Qin Fu. The structure distribution and prospect of China manure resource. Chinese Agricultural Science Bulletin, 2012, 28(32): 1-5.
[17] Li Fan, Bao Xianxun, Wang Wenjun et al. Animal manure components and production of the animal husbandry in Anhui Province. Journal of Anhui Agricultural Sciences, 2012, 40(12): 7359-7361.
[18] Yang Jinsheng, Yuan Xuezhu, Zhang Hongwei et al. Improved discharge coefficient method for calculating livestock and poultry pollution based on daily average breeding amount. Urban Environment & Urban Ecology, 2012, 25(2): 27-30.
[19] Zhou Wweiming, Li Min, Mao Hongrui et al. Pollution risk evaluation of livestock and poultry excrement in Yiwu city. Chinese Agricultural Science Bulletin, 2012, 28(23): 36-40.
[20] Luan Dongmei, Li Shiping, Ma Jun et al. Calculation of pollutants producing and discharging coefficients of heifers and lactating dairy cows in large-scale dairy farms. Transactions of the Chinese Society of Agricultural Engineering, 2012, 28(16): 185-189.
[21] Geng Wei, Hu Lin, Cui Jianyu et al. Biogas energy potential for livestock manure and gross control of animal feeding in regional level of China. Transactions of Chinese Society of Agricultural Engineering, 2013, 29(1): 171-179.
[22] Dong Keyu, Reclamation and environment pollution of wastes from livestock and poultry. Agro- Environmental Protection, 1998, 17(6): 281-283.
[23] Zhang Desheng, Sun Hui, Zhang Cuiju, Research of pollution from dimension breeding domestic animals and fowl in Heze city. Journal of Heze Normal College, 2001, 23(4): 38-40.
[24] Liu Peifang, Chen Zhenlou, Xu Shiyuan et al. Waste loading and treatment strategies on the excreta of domestic animals in the Yangtze River Delta. Chinese Journal of Mechanical Engineering, 2002, 11(5): 456-460.
[25] Xu Qian, Zhu Guizhen, Xiang Liyun. Pollution from large-scale livestock and poultry breeding farms in Beijing and its control. Rural Ecological Environment, 2002, 18(2): 24-28.
[26] Ma Lin, Wang Fanghao, Ma Wenqi et al. Assessments of the production of animal manures and its contribution to eutrophication in Northeast China in the middle- and- long- term period. Transactions of the Chinese Society of Agricultural Engineering, 2006, 22(8): 170-174.
[27] Chen Wei. Current situation of pollution and controlling countermeasures for livestock and poultry breeding in Yong'an city. China Environmental Management, 2003, 22(3): 39-40.
[28] Yang Guoyi, Chen Junjian, He Jiawen et al. Environment pollution and comprehensive control of wastes from

livestock and poultry in Guangdong province. Soil and Fertilizers, 2005, (2): 46-48.
[29] Shen Tizhong, Wang Yepeng, Lei Daiying et al. The farmland feces loading estimates and warming analysis in Wuhan circle area: Taking Tianmen city as a case. Hunan Agricultural Sciences, 2009, (2): 134-136.
[30] Peng Li, Gu Wenhai, Wei Shiqiang et al. Temporal-spatial distribution of poultry excrements in each district and county of Chongqing. Chinese Journal of Ecological Agriculture, 2006, 14(4): 213-216.
[31] Chen Chao, Huang Dongfeng, Qiu Xiaoxuan et al. Survey and evaluation of agricultural non-point source pollution and prevention and cure countermeasures in the upper middle of Minjiang Drainage Area. Journal of Agro-Environment Science, 2007, 26(Suppl.): 368-374.
[32] Pang Fengmei, Li Peng, Li Yujin et al. Annual livestock and poultry feces emission estimates and control measures in Tianjin. Agro-Environment & Development, 2008, (3): 82-85.
[33] Cheng Peng. Experimental study of excretion coefficient on typical dairy farm in Beijing [D]. Beijing: Graduate School of Chinese Academy of Agricultural Sciences, 2008.
[34] Peng Li. A study on the loading rationality and the temporal and spatial distribution of emissions of livestock and poultry manure in Chongqing [D]. Chongqing: Southwest University, 2009.
[35] Di Jifang. Research on the faeces pollution of livestock and poultry in Hohhot [D]. Huhhot: Inner Mongolia Agricultural University, 2009.
[36] Ding Wei, Eer Hehua, Wang Tianxin. Livestock and poultry feces emission and the judgement of its impact on environment in Ningxia irrigation region. Ningxia Journal of Agriculture and Forestry Science and Technology, 2009, (2): 54-56.
[37] Zhang Yuzhen, Liu Yijing, Duan Yong et al. Environmental risk analysis and the loading of livestock manure in Tingjiang River watershed. Area Research and Development, 2009, 28(3): 124-134.
[38] Wu Shenshu, Tan Meiying, Huang Huang et al. Loading capacity estimation and risk assessment of livestock manure in cultivated lands around Dongting Lake area. Chinese Journal of Eco-Agriculture, 2009, 17(6): 1245-1251.
[39] Wang Kaiying, Liu Jian, Chen Xiaoxia et al. Pollutant production and discharge from livestock and poultry industries and land carrying capacity in Zhejiang province. Chinese Journal of Applied Ecology, 2009, 20(12): 3043-3048.
[40] Zhu Honghao, Chang Zhizhou, Ye Xiaomei et al. Estimate of annual excretion in a large-scale cattle farm in Taihu district. Jiangsu Journal of Agricultural Sciences, 2010, 26(3): 517-521.
[41] Zhou Kai, Lei Zeyong, Wang Zhifang et al. Estimation of annual total livestock and poultry excrement in Henan province. Chinese Journal of Eco-Agriculture, 2010, 18(5): 1060-1065.
[42] He Zhiping, Zeng Kai, Li Zhengque et al. Measurement of pollutants producing and discharging coefficient on large-scale pig farms in Sichuan. China Biogas, 2010, 28(4): 10-14.
[43] Peng Li. Manure pollution survey and countermeasures of livestock and poultry in Chongqing [D]. Chongqing: Southwest University, 2004.
[44] Zhou Tianmo, Fu Qiang, Zhu Yunqiang et al. Optimizing pollutant generation coefficients of livestock industry and mapping patterns of pollutant constitution in China. Geographical Research, 2014, 33(4): 762-776.