Geochemical Survey Report on Chinese Farmland 2015

China Geological Survey, Ministry of Land and Resources

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From 1999 to 2014, under the leadership of Ministry of Land and Resources and with the support of Ministry of Finance, China Geological Survey had spent nearly 2 billion RMB in organizing over 100 thousand person-time in 77 units in China to implement the national geochemical survey on the farmland according to the uniform technical standards and methods, in partnership with people's governments at the provincial level and the local authorities of land and resources. The survey was carried out at the scale of 1:250,000, 1 sampling point for each 1km X 1km grid (i.e. 1,500 mu[1]); each sample was analyzed by 54 element indexes, with a total area of investigated land 1.507 million square kilometers, where 1.386 billion mu of farmland is under investigation, accounting for 68% of the total area of national farmland (2.031 billion mu). Meanwhile, we have finished assessment demonstration of 75 thousand square kilometers in the key regions at the scale of 1:50,000 and in local areas at the scale of 1:10,000.

Different from previous farmland quality grade assessment (physical element assessment) based on light temperature (climate) production potential, plow layer thickness, sloping and other physical elements, this survey conducted the assessment on geochemical situation for farmland according to beneficial and harmful elements contained in the soil. Over 30 million pieces of data are obtained through high-accuracy test for more than 600 thousand samples of soil, water, creatures, etc., and 54 element indexes,

[1] 1 mu= 0.067 hectare

by which we have also established a geochemical dynamic database at the scale of China and 31 provinces (regions, cities); formed a preliminary understanding and basic judgment on overall situation of geochemistry for Chinese farmland and found out a series of featured farmland resources abundant with beneficial micro elements.

I. 52.44 million mu of farmland abundant with selenium has been found through survey and measures were highly recommended for strict protection and scientific development and utilization.

Selenium is the necessary nutrition element for human body confirmed by World Health Organization and International Nutrition Organization. It will do harm to human body if it is insufficiently or excessively absorbed. We generally define the farmland with soil containing selenium between 0.4 mg/kg to 3.0mg/kg as the farmland abundant with selenium. According to assessment standard of heavy metal in Environment Quality of Place of Origin for Green Food (NY/T 391-2013) and selenium content in soil of investigated area, it is found from the survey that 52.44 million mu of green farmland abundant with selenium is mainly distributed in Fujian, Guangdong and Hainan, Hunan and Hubei area, southwest area, Hubei, Hunan, Anhui and Jiangxi District, Shanghai, Jiangsu and Zhejiang area, Shanxi and Henan area and northwest area (Figure 1 and Table 1). The farmland abundant with selenium is mainly controlled by sulfide mine deposit, black shale series, coal measure strata and other geological body

and certain type of soil. The stable source of selenium element in the soil is conducive to long-term development and utilization. Furthermore, a series of featured farmlands abundant with boron, molybdenum, zinc and other beneficial micro elements have been found in Shanxi, Liaoning, Fujian, Tianjin, Qinghai and other places.

Currently, the green farmland abundant with selenium has become a new growth point for development of featured and ecological agriculture. The people's governments in Hubei, Guangxi, Qinghai, Zhejiang, Fujian, Sichuan, Jiangxi, Hainan, Hunan and other provinces (regions) have taken the development of farmland abundant with selenium as an important work for strategy of "enhancing the competiveness of the province by agriculture". They have made great efforts to develop featured farmland abundant with selenium, zinc, etc., formed featured industrial chain of agricultural product and obtained significant economic and social benefits. Xintian County in Hunan has fully taken the advantage of farmland abundant with selenium to develop a demonstration base to grow agricultural product abundant with selenium in area up to 270 thousand mu; formed three major industrial parks abundant with selenium; cultivated famous brands of agricultural product abundant with selenium inside and outside the province and established 46 large-scale enterprises that manufacture agricultural product abundant with selenium. In 2014, the gross output value of industry abundant with selenium hit over 2 billion

yuan for the whole county, an increase of 40% compared to that in previous year, which realized over 1 billion yuan of profits, an increase of 35% compared to that in previous year. The staff number involved in the industry abundant with selenium has exceeded 100 thousand.

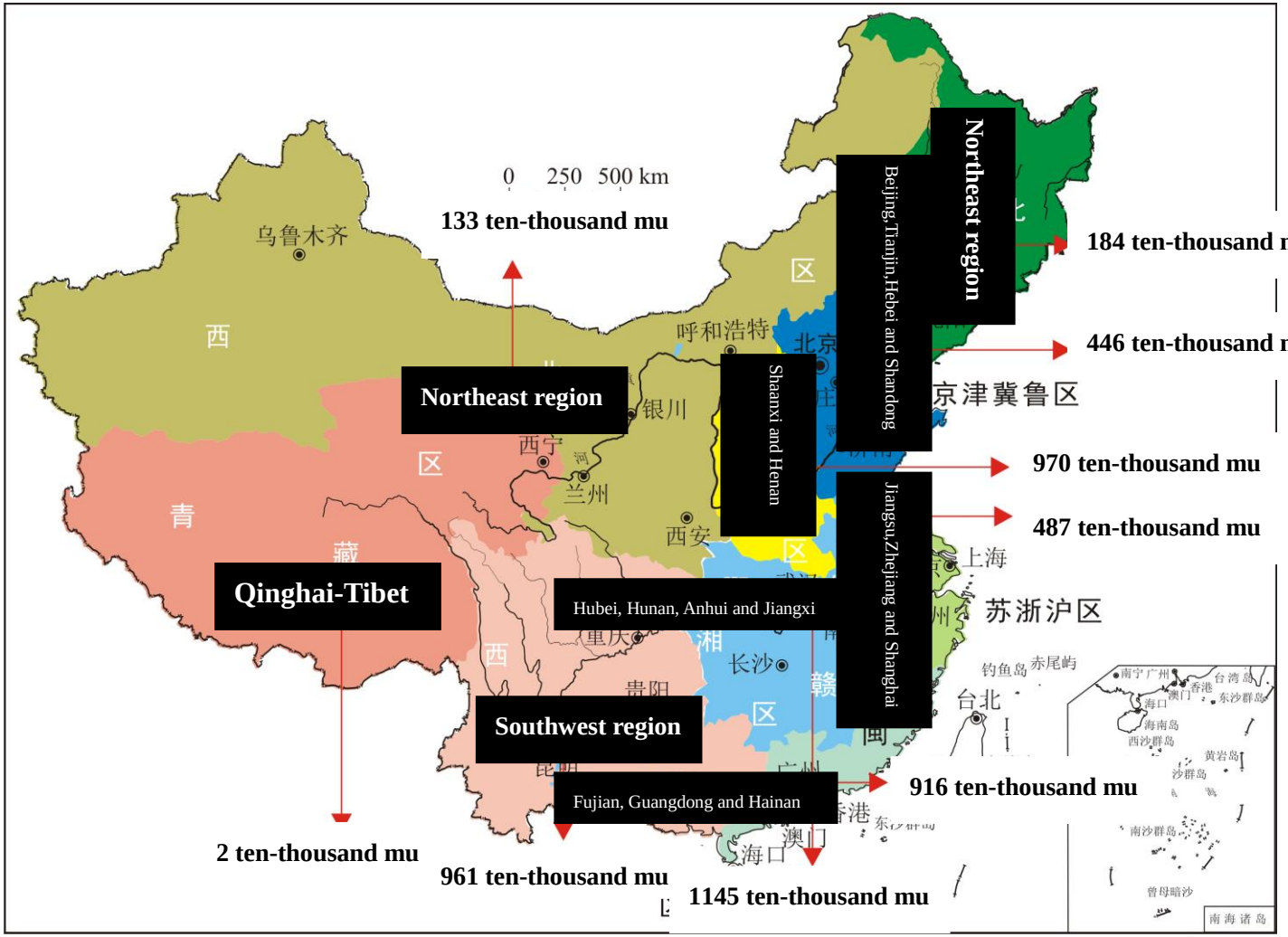

Figure 1 Distribution diagram of national green farmland abundant with selenium

Table 1

Distribution of national green farmland abundant with selenium

Local	Area of green farmland abundant with selenium (ten-thousand mu)	Proportion in investigated area of farmland （%）
China	**5,244**	**3.8**
Northeast region	184	3.5
Shaanxi and Henan	970	18.5
Beijing, Tianjin, Hebei and Shandong	446	8.5
Fujian, Guangdong and Hainan	916	17.5
Qinghai-Tibet	2	0.1
Northwest region	133	2.5
Southwest region	961	18.3
Hubei, Hunan, Anhui and Jiangxi	1,145	21.8
Jiangsu, Zhejiang and Shanghai	487	9.3

The rice, wheat and other bulk crops, as well as soy beans, vegetables, fruits and other cash crops grown in the regions abundant with selenium are found meeting the standard of crops abundant with selenium, precious and conducive to health for human. It is recommended for scientific preparing and implementing the development and utilization planning of farmland abundant with selenium, perfecting the system of development, utilization and protection, strengthening the quantity and quality dynamic monitor management and boosting the sustained utilization of farmland abundant with selenium.

II. 1.272 billion mu of farmland free of heavy metal pollution is found from the survey, and it is recommended to strictly prevent human activity from polluting the farmland.

The farmland free of heavy metal pollution refers to farmland not exceeding the secondary standard specified in *Soil Environment Quality Standard*（GB 15618-1995). According to the survey, we have found 1.272 billion mu of unpolluted farmland, accounting for 91.8% of a total area of investigated farmland, mainly distributed in Jiangsu, Zhejiang and Shanghai, northeast of China, Beijing, Tianjin, Hebei and Shandong, northwest of China, Shaanxi and Henan and Qinghai-Tibet area（Figure2 and Table 2）.

Table 2

Distribution of farmland not polluted by heavy metal in China

Local	Area of farmland without pollution (100 million mu)	Proportion in investigated area of farmland （%）
China	**12.72**	**91.8**
Northeast region	2.46	97.6
Shaanxi and Henan	1.86	99.1
Beijing, Tianjin, Hebei and Shandong	2.23	99.1
Fujian, Guangdong and Hainan	0.42	78.9
Qinghai-Tibet	0.04	98.2
Northwest region	1.02	98.4
Southwest region	1.15	77.7
Hubei, Hunan, Anhui and Jiangxi	2.01	82.1
Jiangsu, Zhejiang and Shanghai	1.50	91.2

It is recommended to implement strict protection policy for farmland free of heavy metal pollution and take it as the main objective of first being included in the permanent basic farmland. We shall also take necessary measures to actively prevent and control the possible pollution effect induced by industrial and agricultural production activity on the farmland, strengthen the pollution prevention and control and realize permanent utilization of farmland free of heavy metal pollution.

III. The report shows that, the medium to heavily polluted or the points exceeding the standard accounted for 2.5%, covering an area of 34.88 million mu. Different measures, including rehabilitation treatment, adjustment of growing structure or usage of land should be adopted accordingly.

It is indicated in the survey result that the medium to heavily polluted or the points exceeding the standard accounted for 2.5%, covering area of 34.88 million mu. The proportion of point of micro to light pollution or exceeding the standard accounts for 5.7%, covering an area of 78.99 million mu. The farmland polluted or exceeding the standard is mainly distributed in Hunan, Hubei, Anhui and Jiangxi area, Fujian, Guangdong and Hainan area, and southwest area.

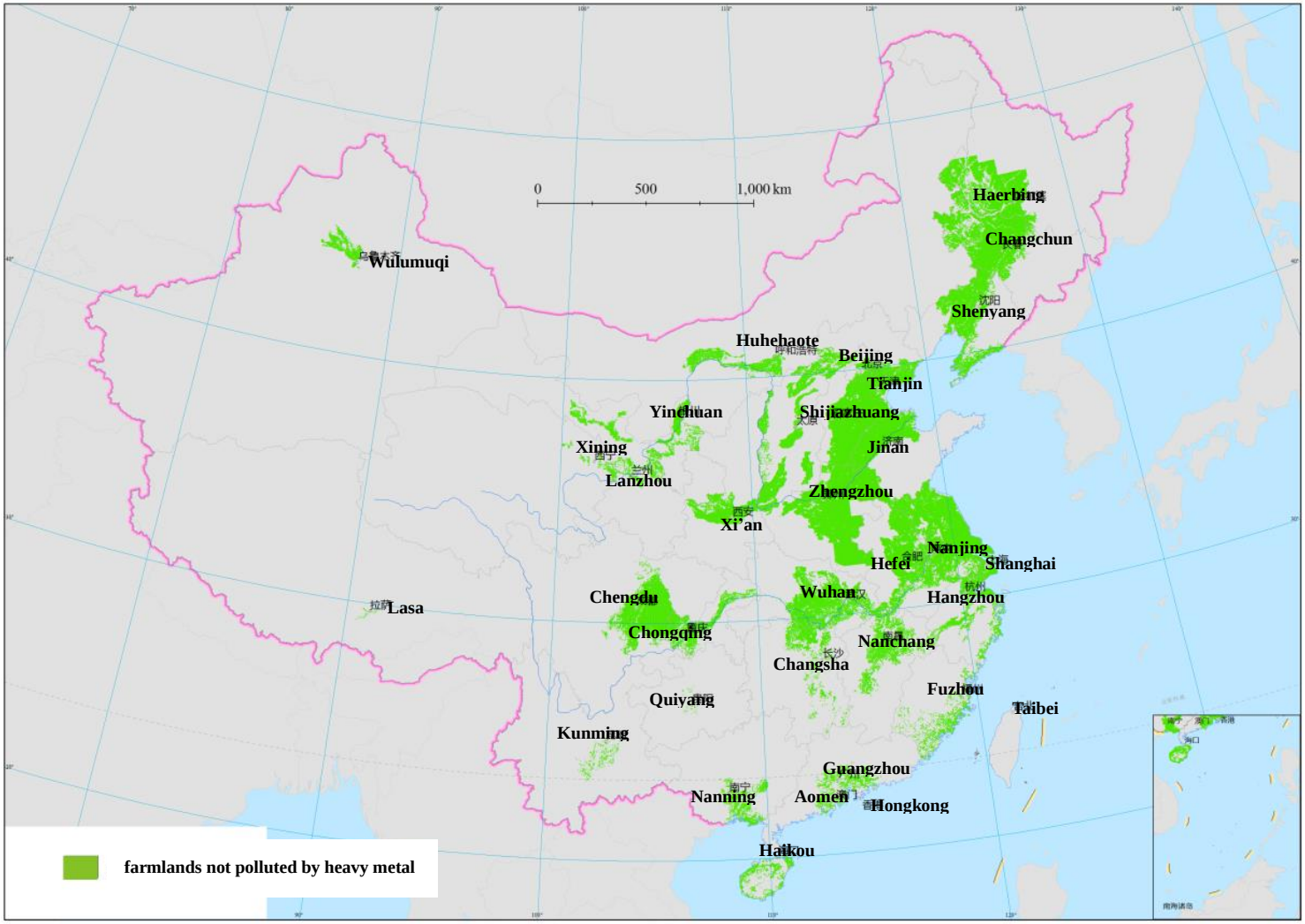

Figure 2 Distribution of farmlands not polluted by heavy metal in China

The high geological background, soil-forming process, secondary enrichment and human activity are the main reasons that cause farmland pollution or exceeding the standard.

The farmland with heavy metal contamination exceeding the standard in China is closely related to geological effect. The heavy metal in upstream regions of Xiangjiang River and karst region in southwest exceeding the standard over 80% is caused by regional high geological background, soil-forming and weathering effect. Human activity is an important reason inducing or intensifying the situation where the heavy metal exceeds the standard. The "three wastes" emitted by mining, smelting, electroplating, etc., the sewage irrigation from agricultural production, the improper use of fertilizer, livestock feeding and other human activities induce or intensify the heavy metal pollution in farmlands in local areas.

The harmfulness of heavy metal in the soil is related to content of heavy metal and its occurrence status, environmental conditions and other elements. In the regions where the heavy metal in the soil exceeds the standard due to high geological background, the activity of heavy metal in the soil is relatively low and hard to be absorbed by crops. In such regions, we shall prevent the human activities from changing the environmental conditions to avoid eruption of regional ecological risk.

It is recommended to strengthen the construction of laws and regulations about prevention and cure of heavy metal pollution, accelerate the

development of geological surveyon farmland, develop cause analysis and ecological risk assessment on polluted farmland and implement partition, categorization and hierarchical management. For light-polluted farmland, we shall take agricultural measures or properly adjust the growing structure to ensure safety of agricultural product. For mid- or heavy-polluted farmland, we shall strengthen the management and control measures for pollution source and implement the regulation, restoration and treatment of heavy metal pollution. The land use shall be adjusted for farmlands unable to be restored or treated.

IV. The organic matters in the black land in northeast China has obviously lowered, and the acidification in southern farmland and alkalization in northern farmland have intensified, so efficient measures need to be taken to prevent them from happening.

Compared to the data released by Chinese agricultural authority in 1980s, this survey shows the content of total nitrogen, available phosphorus, and available potassium in Chinese farmland has obviously increased, and the organic carbon generally sees an increasing tendency. But some regions still have farmlands with lowered organic matters, increasingly acidified or alkalized soil and other problems.

The survey shows in northeast area, Fujian, Guangdong and Hainan, northwest area and Qinghai-Tibet area, part of farmlands tend to have obviously lowered content of organic carbon; the content of organic carbon

in farmland in northeast region has lowered by 21.9%; 16.0% in Fujian, Guangdong and Hainan; 13.3% in Qinghai-Tibet area; 10.5% in northwest area; which has significantly reduced the fertility of the soil.

29.3% of surveyed soil was seen with increasing tendency of alkalization, with pH value increased by 0.64, mainly distributed in northern regions, which causes soil hardening, fertility reduced and is harmful for crops to absorb the nutrition.

21.6% of farmland was badly hit by acidification, with pH value reduced by 0.85, mainly distributed in Fujian, Guangdong and Hainan and Hubei, Hunan, Anhui and Jiangxi District with outstanding problem of heavy metal pollution. The acidification has reduced the farmland quality, increased the activity of heavy metal and intensified the risk of deterioration of farmland ecology and underground water quality.

It is recommended to take positive measures to reduce the exploitation and utilization of underground water in northern farmland, facilitate the survey and treatment efforts on soil and water loss, regulate the industrial and agricultural production activities possibly forming pollution source and reduce the effect of human activity to greatly make the situation of regional farmland better.

V. The survey has efficiently supported the national macro decision and land resources management, thus more actions need to be taken to further strengthen the conversion and application of survey results.

So far, this survey is a professional work with the most analysis elements, highest survey accuracy and strictest implementation standard finished by Chinese system organization. The obtained large number of elaborate system about national data provides basic data for drafting of *Chinese Law of Soil Pollution Prevention and Cure*, implementation of *"12th Five-Year Plan" Planning of Comprehensive Prevention and Cure of Heavy Metal Pollution*, preparation of *Gazette of National Soil Pollution Situation* and construction of *Quality Standard for Agricultural Environment* and other standard systems, as well as plays an important role in supporting the management of land quality for Ministry of Land And Resources. Zhejiang, Shandong, Shanghai, Tianjin, Jiangsu, Guangxi, Fujian, Anhui and other provinces (regions, cities) have strengthened geochemical surveyfor lands, and obtained excellent effect in service of permanent basic farmland definition, selection and construction of high-standard basic farmland, use, planning, adjustment and perfection of land, ranking and monitor of farmland quality and development of featured quality farmland.

It is recommended to fully take the advantage of geochemical surveyresults, facilitate the conversion and use of fruits, fully take the advantage of the basic effect of geological survey results on land resources management, modern agricultural development and ecological environment improvement.

VI. In macro perspective, this survey has preliminarily mastered the geochemical situation of the investigated farmland, and it is urgent to

launch a system combining geochemical survey, monitoring and warning functions with high accuracy to provide sopport for land use planning and meeting "three red lines" limit.

The survey is conducted mainly at the scale of 1: 250,000, and we also advanced survey demonstration work at the scale of 1: 50,000 and 1: 10,000, mainly to meet the macro planning of Chinese land resources to lay a solid foundation for investigation, monitoring and warning with higher accuracy. As far as the survey content concerned, we only considered 52 chemical elements, organic carbon and pH value index; in terms of the survey scope, the farmlands are not all covered and the inclusion of other types of land is insufficient either; regarding assessment degree, we haven’t been able to comprehensively delineate the source of heavy metal contaminating the soil as well as the relevant ecological risks. Survey results currently formed and remaining strategic and general preliminary understanding Nevertheless, the further results of this work is urgently required for people's governments at all levels and the local authorities of land and resources.

Therefore, it is recommended to facilitate the construction of linkage system connecting central and local efforts, focus on significant and urgent needs of land management, facilitate the geological investigation, improve the survey accuracy, enlarge the survey content, comprehensively finish survey on national farmland at the scale of 1:250,000, systematically carry out large-scale survey in key regions, establish national geochemical

monitoring network and warning system and constantly update the geochemical database to make the geological survey results better support the national legislation of land resources management, land use planning, "three red lines" limit, featured land resources development, resources protection of quality land, rehabilitation of polluted land ,etc..

Attached table:

Area of green farmland abundant with selenium and without pollution for all provinces (regions, cities) in China

provinces (regions, cities)	Area of green farmland abundant with selenium (ten-thousand mu)	Area of farmland without pollution (ten-thousand mu)
Total	**5244**	**127171**
Beijing	7	1016
Tianjin	38	1280
Hebei	355	11911
Shanxi	567	5842
Neimenggu	13	2366
Liaoning	124	6796
Jilin	7	9586
Heilongjiang	53	8252
Shanghai	6	736
Jiangsu	133	11615
Zhejiang	347	2654
Anhui	213	7552
Fujian	91	1481
Jiangxi	325	3339
Shandong	46	8139
Henan	403	12808
Hubei	350	7009
Hunan	256	2240
Guangdong	713	1571
Guangxi	755	1403
Hainan	112	1160
Chongqing	43	2719
Sichuan	142	7027
Guizhou	18	48
Yunnan	3	310
Xizang	0	37
Shaanxi	16	3164
Gansu	22	2009
Qinghai	2	400
Ningxia	11	1544
Xinjiang	71	1159