

Soil problems in China and its lessons for other developing countries

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Abstract. With the rapid growth of economy in China for more than 35 years since 1980, the soils in China experienced severe changes featured in high input of chemical fertilizers indeed of organic fertilizers to pursue high yield for the ever-growing population and the increase of life style and in high input of a large amount of metals especially cadmium from manure and atmospheric deposition. The shift of fertilizer application pattern and the high-yield output greatly change the soil quality, of which soil acidification is one of the main problems. Soil acidification and high cadmium input not only caused pollution on the soil but also contaminated the food. Cadmium with high percentage based on the strict soil quality standard (cadmium 0.3 mg/kg for soil, 0.2 mg/kg for rice grain). This paper will elucidate the soil pollution process in China during this 35 years and evaluate the soil and food problem properly and it may give a lesson for other developing countries when they are pave the way of modernization.

Keywords : *soil, cadmium pollution, acidification, food safety, China*

1. Introduction

China, a country with big population and limited land resources is highly dependent on soil for food production. Thanks to “green revolution”, food production in China has increased several folds now when compared in 1980s. However, large amount of fertilizer and pesticide application have greatly changed the soil properties; what is more, large amount of pollutants mainly from industrial emission have made the situation to worse, resulting in high rate of occurrence of cadmium and other metal tainted rice and pose a health threat to human in some



polluted areas.

2. Soil acidification due to fertilization during the 40 years

Farmland soil in China has been acidified due to large amount of fertilizer (especially N-fertilizer) input. Soil acidification is now a major problem in soils of intensive Chinese agricultural systems, It has been estimated that Soil pH declined in the range of 0.13-0.80 units from the 1980s to the 2000s in the major Chinese crop-production areas [1], which means the soil acidity has increased 6 times in farmland. Another study in Guangdong Province indicated all the soil has decline from an average of 5.70 to 5.44 (n=24671) in Pearl River Area [2].

Acid mine drainage (AMD) is another source of acids to deteriorate soil in some mining areas. A case in point is Dabaoshan mine, where the long-term irrigation of AMD has made the soil pH be 4.0 in a village 16 km away from the mining area [3].



Figure 1. Tailing of Dabashan mine with AMD

3. Large amount of metals enter farmland during these 40 years

Farmland soil in China featured in low cadmium with an average concentration of 0.097 mg/kg based on a national soil investigation in 1980s [4]. However large amount of metals has entered the farmland by ways of air deposition and livestock manure application. Study showed more than five, two and nine provinces emitted 100-500t of cadmium in 2000, 2005, 2010, respectively. The sector of cadmium source was mainly zinc smelting, followed by coal combustion, with the former to be 1681t, the later 303t, and total in 2086t in China in 2010 [5]. It was calculated that the amount of cadmium, arsenic and chromium that enter the farmland were 1417t, 5925t and 17010t, respectively. In the case of cadmium, major pollution source comes from livestock manure application (55%), followed by air deposition (35%), then by chemical fertilizer (8%, mainly from compound fertilizer 6%), and wastewater irrigation (2%). Only about 13% of entered cadmium was removed by harvest, run-off and

other ways and 87% kept left in the farmland. A net input of cadmium was 1239t with a concentration increase of 0.004 mg/kg [6]. Further calculation indicated after 50 years the cadmium concentration in farmland will exceed the current soil quality standard form cadmium (0.3mg/kg) if the pollution rate keeps unchanging. Fortunately, the pollution speed has been slowing down quickly since the 12th Five Year Plan (2011-2015) on Environmental Protection was taken.

4. High rate of occurrence of cadmium tainted rice in some polluted area

Rice is a plant easily contaminated by cadmium during its wet-dry production environment. During the flooded period, CdS is formed in highly reduced condition and Cd²⁺ activity is very low, however, CdS will be oxidized to sulfate and Cd²⁺ in aerobic condition and cadmium can be uptake quickly into rice plant and into grains especially in the reproductive stage.

Based on the aboved statement, it may be concluded that farmland soil in China is characterized with acidic condition and high anthropogenic source of metals. This combination makes metals have high activities for the “foreign” source of cadmium cannot be aging into forms with low activity.

As a country with rice is a staple food of the population, it can be understood if in some polluted areas such as in Hunan Province rice was contaminated with cadmium. Therefore, potential health risk is posed for the time being. Based on the current hygiene standard for cadmium (0.2mg/kg), it was estimated that about 10% of rice has been contaminated with cadmium in China, and about 50% of rice tainted in some heavily polluted areas as in Hunan province.

5. Countermeasures is now being taken to control the pollution and to remediate the polluted soils

After the release of the Bulletin of National Soil Pollution Survey in 2014 [7]. On May 31, 2015 the Action Plan on Prevention and Control of Soil Pollution [8]—10 chapters with 231 detailed measures dealing with monitoring, pollution prevention and remediation to be used in drafting laws and regulations was released by the State Council. The modification of out-of-dated soil heavy metal standards and the establishment of New Chinese Soil Pollution Law are under way. It is expected that 90 percent of contaminated farmland be made safe by 2020, with an increase to 95 percent by 2030.

6. Lessons for Other Developing Countries

The 40 years' economic reform did make China a big success in economics, however, the soil and the total environment was degraded to some extent. China failed to take the lesson from Japan where cadmium pollution in paddy soil results in *itaiitai* disease and paid more attention to the protection of soil environment. Even though the pollution in soil in China have not brought obvious health threat, but the story above did provide a good lesson for other developing countries when they pave the way of modernization.

References

- [1] Guo J H, Liu X J, Zhang Y, Shen J L, Han W X, Zhang W F, Christie P, Goulding K W T, Vitousek P M and Zhang F S 2010 Significant acidification in major Chinese

croplands *Science* **327**1008-1

- [2] Zhi-xing G, Jing W and Min C 2011 Spatiotemporal variation of soil pH in Guangdong Province of China in past 30 years *Chinese J. of Applied Ecology* **22** (2) 425–430 (in Chinese with English abstract)
- [3] Yan-ling X, Neng-chang C, Sheng-guang X 2009 Breeding rice cultivars with low accumulation of cadmium: cultivars versus types. *J. of Agro-Environment Science* **28** (7) 1346-1352 (in Chinese with English abstract)
- [4] China National Environmental Monitoring Center. Element background values of soils in China (In Chinese) Beijing: China Environmental Science Press 1990
- [5] Shao X, Cheng H, Li Q and Lin C 2013 Anthropogenic atmospheric emissions of cadmium in China *Atmospheric Environment* **79** 155-160
- [6] Luo L, Y Ma, S Zhang and D Wei 2009 An inventory of trace element inputs to agricultural soils in China *J. of Environmental Management* **90** 2524–2530
- [7] Bulletin of National Soil Pollution Survey http://www.zhb.gov.cn/gkml/hbb/qt/201404/t20140417_270670.htm
- [8] The Action Plan on Prevention and Control of Soil Pollution http://www.gov.cn/zhengce/content/2016-05/31/content_5078377.htm