

PAPER • OPEN ACCESS

Sustainable development of sludge disposal and resource utilization in Chinese farms

To cite this article: Y W Su *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **267** 062013

View the [article online](#) for updates and enhancements.

Sustainable development of sludge disposal and resource utilization in Chinese farms

Y W Su^{1,a}, X N He² and Z Q Qu³

¹School of Public Safety and Emergency Management. Wuhan University of Technology, Wuhan 430000, China.

²School of Information Engineering. Wuhan University of Technology, Wuhan 430000, China.

³School of Management. Wuhan University of Technology, Wuhan 430000, China.

^aVanny0214@126.com

Abstract. At present, China's sludge disposal is in the primary stage of development, and there are still having some significant defects in the terminal treatment of the sludge disposal link. The treatment methods are often extensive, such as incineration and landfill, and the application level of sludge recycling is very low. At the same time, China has large number of farms, which will produce a lot of animal waste every day. Traditional disposal methods such as burning and landfill are difficult to make the waste resource available. There is no denying the fact that there is immeasurable agricultural and economic value in the sludge and excrement, but it is not used properly at present. This paper will analyze the current situation, trend and prospect of sludge treatment, and further explore the new ways of urban sludge disposal and resource utilization in China, which may broaden the possibility of sustainable development of China.

1. The Background of the Research

1.1. The quality of land in China is declining

At present, the land area of soil erosion and desertification accounts for about 31% and 30% of the total land area, and the area of cultivated land degradation accounts for more than 40% of the total cultivated land. Every year, about 4 million mu of land is damaged due to natural disasters and production and construction activities^[1]. From the perspective of sludge disposal, China's land quality decline is mainly concentrated on the following two aspects.

1.1.1. Improper disposal of sludge. An important factor affecting land quality is the extensive disposal of sludge. Firstly, our country sludge harmless disposal method is relatively backward. Landfill is the main method of sludge treatment in China, and there is no differentiation of pollution sources. In addition, most of China's sewage treatment enterprises have inadequate disposal capacity and backward disposal means, and a large amount of sludge has not been standardized treatment, posing a serious threat to the ecological environment in the discharge process^[2]. Secondly, China's sludge treatment rate is low. According to statistics, in 2016, the national sludge treatment capacity was about 13 million tons, and the national sludge treatment rate only reached 33%^[3]. What's more, 67% of the



sludge was not disposed innocuously. When such a large volume of sludge is discharged into the sewer or back into the field, the pollution will eventually flow to the human body.

1.1.2. High content of harmful substances in sludge. Sludge is also a kind of extremely complex heterogeneous body, which is generally composed of water, organic fragments, bacteria, inorganic particles, colloid, and heavy metals. The composition of sludge from different sources is also different. Sludge enriched sewage in 30% to 50% of the pollutants, which also contains pathogenic bacteria, parasites (eggs), toxic organics, heavy metals, and even some antibiotic ingredients, as well as a large number of nutrients such as nitrogen, phosphorus, potassium and trace elements and other components. If not treated properly, waste water and sewage can contaminate groundwater, soil and spread disease. In addition, soil pollution has the characteristics of accumulation, concealment and irreversibility. Once the sludge is discharged arbitrarily without treatment, the quality of the land will be greatly reduced and it is difficult to recover ^[4].

1.2. Unreasonable use of domestic fertilizers

China is a large agricultural country, agricultural economy has always played an important role in the national economy. The sustainable development of agriculture is the foundation of China's continuous economic development and the necessary condition of social stability. However, the damage to the soil from too much fertilizer is growing. At present, the degradation of cultivated land in China is serious, which is mainly manifested by soil erosion, acidification and salinization. One of the main drivers of soil acidification is the overuse of fertilizers ^[5].

1.2.1. Excessive dependence on chemical fertilizers in agricultural production. According to statistics, the fertilizer utilization rate of China's three major grain crops, rice, corn and wheat, was 37.8% in 2017, 2.6 percentage points higher than that of 2015, and the overall use of fertilizer was too much. One of the outstanding problems is the high application per mu. China's average amount of chemical fertilizer per mu for crops is 21.9 kg, which is far higher than the world average (8 kg per mu), 2.6 times that of the United States and 2.5 times that of the European Union. The excessive use of chemical fertilizers, especially the excessive amount of nitrogen and phosphorus, increases the nitrogen and phosphorus content of surface water, which has a great impact on the environment. On the one hand, the eutrophication of water is becoming more and more serious; on the other hand, the nitrogen element in nitrogen fertilizer will volatilize to NH₃, causing pollution; Additionally, copper and chromium in phosphate fertilizer will also cause pollution to the land. In the long run, it's even worse for human health. Apply fertilizer especially in the grain that nitrogen fertilizer is overmuch and vegetable, the content of nitrate is high, long-term edible can make the person's working ability drops, serious can cause the happening of cancer, leukemia.

1.2.2. Difficulties to popularize organic fertilizers. At present, one of the common problems in the use of organic fertilizers is that the organic fertilizers with good effects cannot be widely promoted and only used by a few people. The current situation has the following reasons: first, farmers' ideas and habits. Since the 1970s and 1980s, with the development of chemical fertilizer industry, more and more farmers have accepted chemical fertilizers. Farmers are familiar with the rules of planting and fertilization. If they use commodity organic fertilizers, they need to find the rules again, which has a high time cost. Second, the amount of organic fertilizer than fertilizer, high cost. To grow rice, for example, it takes 60 kilograms of fertilizer per mu, but to achieve the same growth, it takes about 200 kilograms of ordinary organic fertilizer, or even tons of fertilizer. Third, high cost limits the promotion and application of commercial organic fertilizers. Due to the long maturity time, a large amount of labour is invested in the process of turning over the heap, drying, adjusting the moisture and nutrient content, crushing, packaging and other operations, resulting in high production cost of organic fertilizer. In the railway transportation, the transportation cost of organic fertilizer is 2 times of that of chemical fertilizer ^[6].

2. Present difficulties in sustainable use of sludge disposal

2.1. Measures for sludge disposal of farms

At present, the commonly used polyacrylamide flocculant is called PAM. It is used for sludge treatment flocculation. Taking pig farms with low utilization rate of sludge resources as an example, most pig farms adopt "blisters manure" treatment mode for livestock and poultry manure. Through the physical method to filter the waste of large particles, water and a lot of micro and small solid waste, by adding polyacrylamide flocculant flocculating particles, and then use centrifuge, belt machine or plate frame machine further dewatering mud pressure, after flocculation sludge high temperature aerobic composting fermentation. Through composting sludge and some organic matter (e.g. straw), the moisture content of sludge can be reduced and the organic matter in sludge can be cured.

2.2. Problems in the use of traditional flocculants

Traditional polyacrylamide flocculant is a kind of chemical flocculant of water-soluble polymer. Because PAM's character can cover both sludge and water, even if straw and other auxiliary materials or bacterial species are added in the later fermentation process, the sludge cannot be truly fermented. The internal porosity of sludge separated by traditional PAM flocculant is very low, which is not conducive to the oxygen exchange in the fermentation process, resulting in a very long fermentation cycle. The final product has the residue of soil hardening, and the fermented sludge cannot be used as a resource. Because the sludge is always in anaerobic state, it is not suitable for the survival of bacteria, so it leads to the death of a large number of bacteria. The drying cycle of PAM is longer than normal. Thus the greater the amount of organic matter in the sludge will be converted into ammonia, hydrogen sulfide, alkane and other gases, and the continuous stench will also seriously affect the surrounding environment.

3. Sustainable ways of sludge resourceful utilization

3.1. Resourceful treatment of farm sludge

In recent years, China's intensive animal husbandry industry has maintained steady development, producing nearly 200 million tons of meat, eggs and milk annually, but at the same time, it also produces nearly 4 billion tons of livestock and poultry manure every year, and its chemical oxygen demand reaches 12.68 million tons, accounting for 96% of the total agricultural emissions, which is an important cause of agricultural non-point source pollution. China's various organic fertilizer resources are equivalent to over 74 million tons of nutrients, but the actual utilization rate is less than 40%, especially the large amount of livestock and poultry manure produced by large-scale breeding can not be effectively used. Promoting the resource utilization of livestock and poultry manure will greatly promote the promotion and application of organic fertilizers. Compared with the municipal sludge generated from aquaculture wastewater sludge with high content of organic and inorganic nutrients, stable raw material ingredient, low degree of heavy metal pollution and through materials mixed with and microbial fermentation processing two process, it can be completely control within the national standard, and is regarded as an important point of sludge land use.

According to the survey, about 55% of the sludge in China will be discarded and treated in a relatively backward way, which will cause environmental pollution and waste of resources. However, in fact, there is still great agricultural value and economic value in the sludge.

Pig manure will turn into sludge if not treated. However, under the effect of leavening agent, pig manure can decompose macromolecules that are not easily absorbed by plants through microbial fermentation, enhance the fertilizer efficiency, decompose and release insoluble phosphorus and potassium nutrients, protect the environment to a certain extent, and thoroughly kill insect eggs, bacteria and other harmful substances in the feces. If flocculation, composting, fermentation and other methods are used as fertilizer, it is a way to make efficient use of existing resources and achieve the sustainable development goal, which can create three to seven times the value.

From the previous review, we can see that the use of PAM, the traditional chemical polymer flocculant, is the biggest obstacle in the process of sludge reclamation in the sludge treatment of farms. My team is currently developing a new type of biological flocculant, which has physical and chemical characteristics completely different from traditional PAM. The biological flocculant is mainly composed of plant protein and animal protein, which will not form a coating on the sludge, and has the characteristics of natural degradation, no secondary pollution, and no reverse flocculation. Biological flocculation after modification of the sludge dewatering process after the above 70 °C fermentation temperature, can effectively kill pathogenic bacteria in the sludge, the harmful composition in grass weed and insect larvae, such as sludge, through biological fermentation process to make the sludge in the part of the heavy metal chelating stable metal salts, to fundamental change sludge properties. The finished humus contains a large number of beneficial bacteria which are helpful for plant growth, higher nitrogen, phosphorus and potassium, improve porosity, and ensure the quality of organic fertilizer fermentation.

3.2. Customized services of organic manure utilization from farm sludge

The problem of fertilizer industry in China is very obvious. The quality classification of organic fertilizer industry in China is still fuzzy, and the product homogenization tendency is serious. Organic fertilizer national standard is issued in 2002, lag sex is serious. Many enterprises reduce the cost of cutting corners without rotting equipment or strict high temperature fermentation, resulting in the content of various components of organic fertilizer products to meet consumer demand. Therefore, under the condition of high-quality humus produced by sludge recycling disposal, how to make better use of humus resources in soil improvement is a problem that we need to further solve.

Providing customized services and the fine processing of organic fertilizer, can maximize the use of resources. The possible useless material resources will be used to bring maximum benefits. Different crops need different proportions of nutrient elements, and different companies and individuals need fertilizers in the production. By adding different auxiliary materials and microbial agents into the products, and adjusting the proportion of each component of humus soil, the added value of products can be further improved. Through customized organic fertilizer production, the products can be applied to the fields of flower pot, organic fertilizer and soil remediation, etc.

3.3. The mine repair

At the same time, organic fertilizer also has a huge value space in the new green economy such as mining and rehabilitation. Vegetation removal, soil degradation and pollution, soil erosion, and the loss and pollution of water resources are fatal blows to the maintenance of biodiversity in mining areas, which seriously threaten the survival of plants and animals and thus cause damage to biodiversity.

The key to ecological damage caused by mining is land degradation, that is, the change of soil factors, that is, the deterioration of soil physical and chemical properties, nutrient loss and the increase of toxic and harmful substances in the soil. Therefore, soil improvement is one of the most important links in the ecological restoration of abandoned mines. However, due to the lack of nitrogen, phosphorus, potassium and other elements necessary for plant growth in abandoned mines, the use of organic fertilizer to improve soil is a prerequisite for vegetation restoration. Application of humus resources to soil improvement in abandoned mines can not only improve soil fertility, but also promote the formation of soil aggregate structure and improve soil water retention. However, the amount of organic fertilizer needed for mine restoration is huge, and the corresponding organic components need to be added according to the specific conditions of the mountain to achieve the purpose of restoration. Therefore, it is feasible and of great social value to combine customized means and utilize the quantity of sludge from farms to meet this demand.

4. Conclusion

After treatment, the sludge can be transformed into valuable resources for subsequent utilization. This not only solves the problem of waste disposal, but also develops a new resource, which meets the requirement of sustainable development.

Promoting the resource utilization of livestock and poultry manure will greatly promote the promotion and application of organic fertilizer. On one end is the urgent need to solve the sludge flocculated from the breeding sewage of 100 million tons, and on the other end is the gap in 4 times of the organic fertilizer market. These two problems can promote each other and solve them cooperatively, so that the composting and fermentation industry of livestock and poultry manure will create greater economic benefits.

If a large number of fertilizers, easy to make vegetables in the content of nitrate exceeds the standard, and nitrite and amine substances formed by the combination of N-nitroso compound is a strong carcinogen. Therefore, it is also necessary to introduce cheap, high-quality, nutritious and efficient organic fertilizers into the cultivation to reduce the health risks of residents.

Acknowledgements

This research was financially supported by Wuhan University of Technology National College Student Innovation and Entrepreneurship Training Program “Sludge treatment under degradation by novel biological flocculant” (201810497248).

References

- [1] Shi M 2008 Discussion on Land Quality Protection in Regional Development - A Case Study of The Yangtze River Delta Region. *Shanghai land resources* **39(04)** p 58-61.
- [2] Leiyu F L and Yinguang C. Dilemma of sewage sludge treatment and disposal in China[J]. *Environment Science and Technology* 2015 **49(8)** 4781-4782.
- [3] Yu J H and Wang K J. Investigation and analysis on the treatment and disposal of sewage sludge in China [J]. *Journal of Residuals Science and Technology* 2010 **7(1)** p 21- 27.
- [4] Another 100 Billion Environmental Protection Market Segments Forming Sludge Treatment in the Blue Sea Period.
<http://www.hbzhan.com/News/detail/121756.html>
- [5] Too Much Fertilizer Makes the Land More and More Sour [J], *friends of farmers* **2015(5)** p 17.
- [6] Xiang J Three Major Problems in the Promotion of Commercial Organic Fertilizers [J]. *Rural area, agriculture, farmers* (B version) **2015(12)** p 27-28