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Comparative analysis of soil pollution management policies in China and the United States: Towards sustainable environmental strategies

Bolin Wang

Alliance Manchester Business School, The University of Manchester, Manchester, United Kingdom, M13 9PL

wangbolin2021@gmail.com

Abstract. Soil pollution is a significant worldwide issue that has adverse effects on food security, public health, and environmental sustainability. The paper aims to examine additional research on assessing the extent of soil contamination, identifying its origins, and evaluating the efficacy of regulatory and technical solutions in addressing this issue. This study examines the soil pollution regulations of China and compares them to those of the United States. It purposes to identify areas where both countries are moving towards sustainable soil management by reducing sources of pollution. This study will utilize a literature analysis to examine the historical background, effectiveness, and diverse factors associated with economic development and environmental conservation programs. Both countries have built risk-based control systems that adhere to the "polluter pays" principle and comply with internationally recognized standards. The paper identifies the difficulties in putting the regulations into practice and suggests that future research should focus on doing comparative assessments with other nations, evaluating the effectiveness of the implementation process, and exploring technical advancements for soil remediation. This comparative analysis highlights the significance of soil pollution reduction and efficient management strategies, since they hold global significance.

Keywords: Soil pollution, Policy analysis, Sustainability, China, United States

1. Introduction

Soil pollution arises from the accumulation of detrimental substances, including industrial chemicals, agricultural inputs like insecticides or pesticides, fertilizers, waste disposal byproducts, and other similar materials. Put simply, the deterioration of soil health hampers the efficiency of agriculture and compromises food safety, resulting in a reduction in biodiversity caused by inadequate ecosystem functioning [1-3]. Soil pollution is a significant obstacle to achieving Sustainable Development Goals, such as the eradication of poverty and the elimination of hunger [4].

The cases in China and the United States focus on specific scenarios that highlight the significance of studying soil contamination in these nations due to their substantial global effect, both in terms of economy and environment. The soil contamination dynamics in the two countries vary in several aspects. However, their industrial activities, agricultural practices, and focused environmental regulations expose them to similar issues in battling environmental degradation. In order to assess the advancement of

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research in this particular area, it is necessary to examine the different policies and techniques implemented by China and America to combat soil contamination. Nevertheless, this research underscores the delicate nature of the interaction between economic expansion, agricultural output, and environmental preservation.

The research method employed in this paper is the literature review, which involves a methodical examination of scholarly articles, policy documents, and reports related to policies aimed at reducing soil pollution and the expected strategies for soil management principles. This approach enables a comprehensive assessment of the effectiveness of existing policies and identifies areas that necessitate additional research and policy development. The importance of this research lies in its contribution to a wide domain within environmental science and policy, thereby expanding our understanding. This study, which compares and analyzes soil pollution management measures in China and America, can provide valuable guidance for policy-making agencies, environmental groups, and international organizations. This emphasizes the importance of efficient techniques in soil management, appropriate regulatory strategies, and potential prospects for both bilateral and international collaboration in tackling the worldwide problem of soil contamination. This study enhances the existing academic knowledge and also contributes to the development of policies that can generate sustainable consequences for the environment.

2. Overview of Soil Pollution

The total extent of soil pollution on a global level is detrimental to food security, water safety, as well as ecosystem quality. This is especially problematic in regions of China, including South Fujian Province, known as the Golden Triangle area [5]. There, in a 2018 survey, to evaluate risks of trace metals to ecology and human health, 456 stations were sampled in the soil from 28 districts. According to the Hazard Index (HI) values, 3.7% of soils had dangerously elevated levels of toxic metals that could harm children. Additionally, the total carcinogenic risk (TCR) values revealed that an additional 23.3% of soils were unsafe, posing both noncarcinogenic and carcinogenic risks to children due to trace metals [5]. To mitigate these consequences, one can opt for replacing chemical fertilizers with manure, utilizing controlled-release fertilizers, and integrating urease inhibitors to minimize pollution [5].

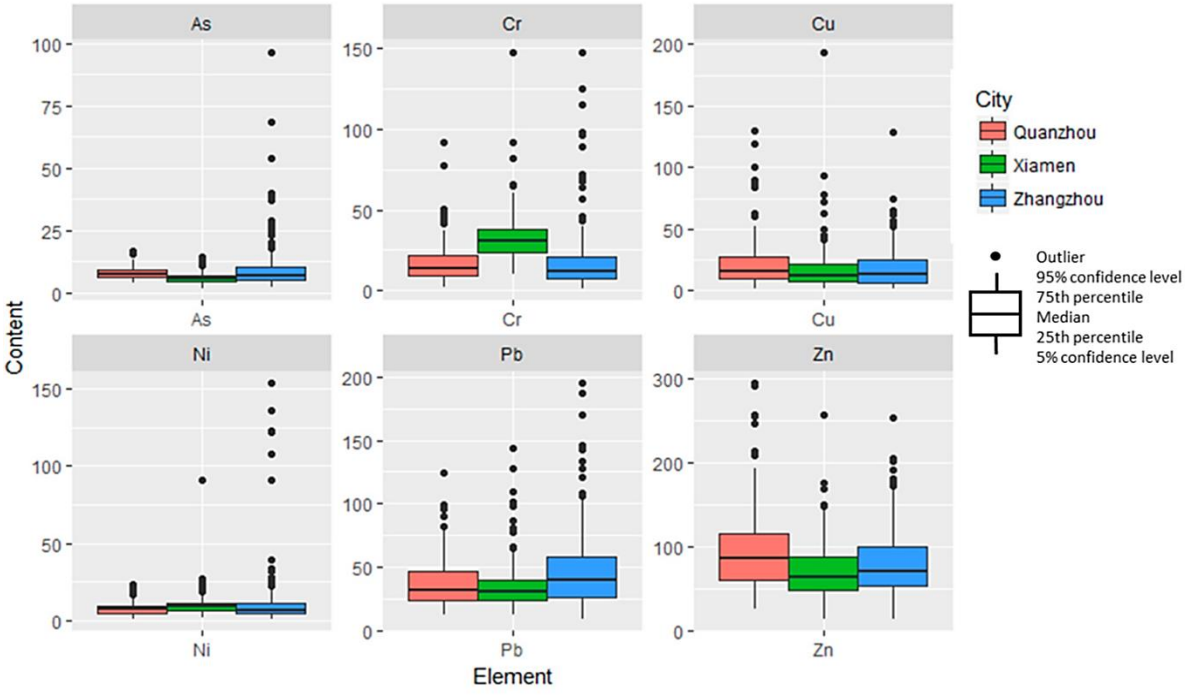

Figure 1. Heavy metals' concentration in soils of the Golden Triangle region [5]

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Soil contamination is additionally a result of agricultural practices and policies in the United States, where nitrogen and phosphorus pollution that arises from crop production are among the major concerns. These pollutants are of significant significance. Trade disputes between countries, like the ones between China and the U.S., can exacerbate environmental issues by negatively impacting soil quality domestically and causing worldwide repercussions in terms of changes to agricultural practices and international trade. A study suggests that the redirection of goods and services to different regions of the world as a result of the halt in trade between the United States and China will lead to a global increase in emissions ranging from 0.3% to 1.8%. The impact of this phenomenon on soil fertility extends beyond local boundaries and has implications at the worldwide level. It not only alters the land system but also affects the trade balance [6]. The intricate nature of soil contamination management in both nations emphasizes the necessity for comprehensive and methodical approaches to environmental preservation and sustainable agriculture tactics.

3. Soil Pollution Policies in China

China's strategy on soil pollution control has undergone a great change over the past few decades due to increased environmental challenges that arise from fast industrialization and urbanization. Soil pollution has a lower historical priority than air and water pollution, with few laws to govern the issue until soil contamination was found beyond question [5]. The change of the situation happened with the release into circulation in 2014 of a national general survey on soil pollution by the Ministry of Environmental Protection (now – the Ministry of Ecology and Environment) and the Ministry of Land and Resources (now – the Ministry of Natural Resources). The survey revealed that 16.1% of soil samples exceeded the permissible thresholds for soil environmental quality. The primary pollutants found in these samples were cadmium, mercury, arsenic, and lead. Consequently, the government implemented a more focused and specific approach to address soil pollution [7].

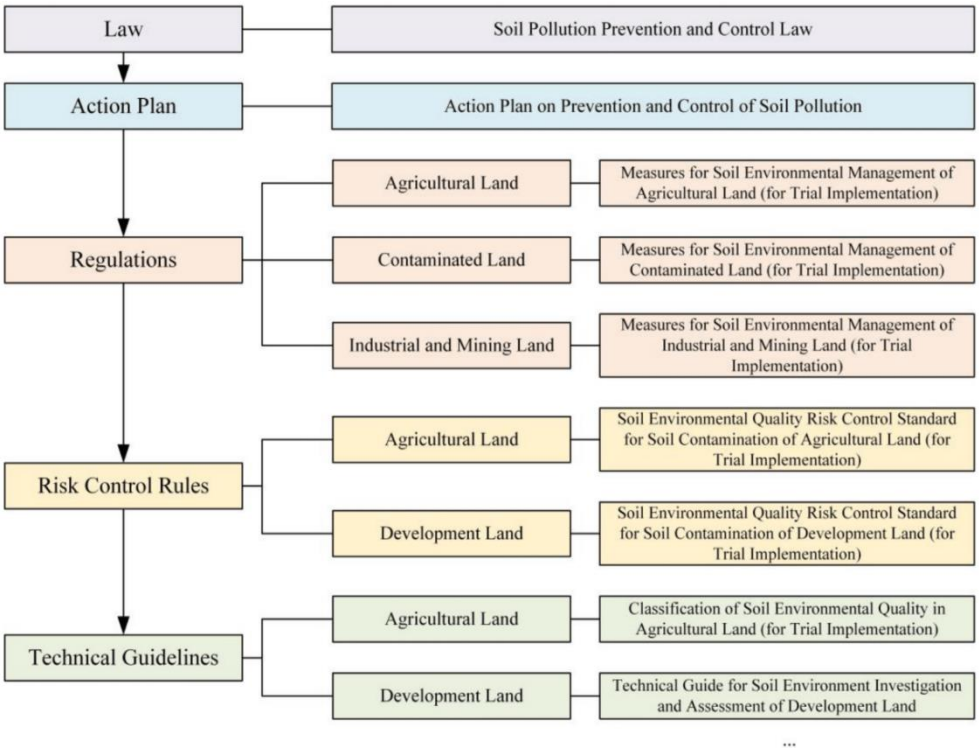

Figure 2. The policy management system for soil pollution policies in China

Recently, a systematic policy regulation measure targeting soil pollution has been put in place in China. For example, the Chinese Soil Pollution Prevention and Control Law serves as a foundation for

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China's legislative framework for soil pollution control by providing comprehensive mechanisms of soil pollution remediation. However, there are still some issues regarding the imperfections of remediation standards and lack of public participation [7]. Current policies in China are set against a risk-based control system that classifies arable land on the basis of pollution levels and defines specific rules for hazard mitigation on both agricultural farm and development land. This system is consistent with those of the developed nations as it incorporates ideas such as 'polluter pays' and requests for more initiated research work. China's approaches to soil pollution management are expected to shift in the future and pay more attention towards improving legal frameworks, remediation technologies unnecessary for both the general public and stakeholders, as well as effective strategies for the intricate problem of soil pollution. It has been recommended that a 10-step cycle be implemented, which consists of preparing soil pollution surveys, enacting regulations to prevent land contamination, funding management for the development and use of a classification system applicable in agriculture lands, and scientific research on technology advancement [7]. Moreover, the 14th Five-Year Plan (2021-2025) includes a set of policies to tackle soil and groundwater pollution control as a key priority for environmental governance [8].

4. Soil Pollution Policies in the United States

Over the time, soil pollution management in the United States has been developed as an integrated strategy towards prevention and control. One of the most important regulatory frameworks is the Pollution Prevention Act 1990, which does not focus on recycling, energy recovery, treatment, and disposal, but rather on source reduction with the aim of making sure that there are no new waste and pollution streams being generated [9]. The existing regulatory frameworks consist of separate statutes and executive decrees that oversee strategies for pollution avoidance in different industries. The Environmental Protection Agency (EPA) is responsible for the formulation and implementation of initiatives that aim to promote source reduction. These steps entail allocating incentives to states to incentivize enterprises to adopt the practices and establishing a database for sharing information on source reduction. Hence, the EPA offers Source Reduction Assistance (SRA) funds to finance research, inquiry, experimentation, surveys, teaching, and training related to source reduction. These grants specifically target projects that promote the implementation of efficient practices, techniques, and training in pollution prevention (P2) methods. The aim is to achieve tangible enhancements in human and environmental well-being by reducing the utilization of dangerous substances, minimizing resource consumption (such as water and energy), reducing expenses for companies, non-profit organizations, or communities, and mitigating legal responsibilities [9].

As the future unfolds, it is highly likely that policy proposals and directions will still focus on soil and water quality by appreciating their connectedness as environmental elements. Defining landowners' responsibilities and rights is viewed as a significant step in achieving soil resource sustainability. As such, it can be said that U.S. policies seek to change the role of discharge from untreated or treated wastewater by including them in a list of pollution sources and codifying landowners' obligation to soil and water quality as detailed above so that the main responsibility for protecting the environment is no longer on government officials but also individuals who should practice active management to protect these vital natural resources. In terms of soil governance, it is prominent to mention the Rights of Soil Model Law that was produced by the Center for Democratic and Environmental Rights (CDER). The act of law gives a soil ecosystem its rights and obliges landowners to develop methods aimed at maintaining soil health. The law acknowledges that soils have the right to "exist, flourish, and maintain [their] health" in a legal sense [10]. Apart from aligning to the international considerations on environmental sustainability, this approach also shows the need for holistic soil management strategies that shall cater for immediate as well long-term environmental concerns.

5. Comparative Analysis

The comparative analysis of soil pollution policies pursued in China and the USA reveals distinct characteristics unique to each country, as well as shared concepts. The predominant approach to land

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remediation in China relies on conventional technology. However, the United States places greater emphasis on technological innovation, particularly in the fields of biological and chemical cleanup. This approach frequently employs organisms, such as bacteria or plants, that degrade, eliminate, or immobilize contaminants in the soil [11]. The budget allocation for soil pollution control in the United States is comparatively higher in terms of cost [12]. In contrast, China's capital expenditure is negligible, despite the estimated cost of cleaning the poisoned soil in China being around 1.3 trillion U.S. dollars [13]. Notwithstanding the high expenses, the Chinese government has been making substantial expenditures in clean energy, which also encompasses efforts to combat soil contamination [12].

In the United States, environmental conservation is a significant issue, and the public is frequently more focused on concerns related to soil pollution [14]. Nevertheless, there is still insufficient public awareness regarding soil contamination mitigation in China [15]. While China has made significant progress in establishing a comprehensive soil management system, it is recommended that future policy revisions consider public participation [15].

6. Conclusion

The paper examines the soil pollution management strategies in China and the U.S., highlighting the transition from remediation-focused methods to comprehensive risk-based management systems that prioritize sustainability and the reduction of pollution sources. An essential aspect for the future entails doing a comprehensive evaluation of the effectiveness of these policies and their tangible impact on soil quality and public welfare. Moreover, contemplating how technology provides soil remediation is essential to ensuring that the methods employed to manage soil contamination are both productive and successful. The data obtained from these studies could be pivotal in developing environmentally sustainable and resilient policies to mitigate global soil contamination and protect environmental well-being.

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