Proceedings of the 4th International Conference on Business and Policy Studies
DOI: 10.54254/2754-1169/133/2025.19639

Social Participation and Potential Exploitation of Comprehensive Utilisation of Saline and Alkaline Land in China

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Abstract: Saline-alkaline land is widely distributed in China, and the management techniques and methods have been very mature and perfected, forming comprehensive benefits in ecological, economic and social aspects and greatly avoiding its negative impacts. It is of rich practical significance to improve, manage and thus exploit the resources and potential of saline-alkaline land. Combining the literature of scholars at home and abroad, we conduct a literature review of saline-alkali land governance in China, mainly focusing on the following aspects: studying the social participation model of saline-alkali land governance in China, analysing the subjects involved in saline-alkali land governance and clarifying the shortcomings of the existing model, analysing the role of the government in terms of the evolution of the policy and the classification of the policy, summarising the classification and distribution of saline-alkali land in China, and exploring the potential of saline-alkali land in terms of the utilisation of the resources. Summarise the classification and distribution of saline-alkaline land in China, and explore the potential of saline-alkaline land from the perspective of resource use.

Keywords: saline land management, social participation, potential exploitation.

1. Introduction

The Classification of Land Use Status (GB/T21010-2017) states that saline and alkaline land is characterised by a large amount of salt on its surface and the ability to grow natural, salt-resistant vegetation in these areas. Therefore, they are classified as light, medium and heavy by measuring their dissolved oxygen content, exchangeable sodium content and other indicators. The higher the degree of salinity, the lower the seedling rate and the less likely it is to be exploited. Therefore, a moderate amount of plants can be planted on light or medium saline land, which can improve the situation of saline land to a certain extent; while on heavy saline land, the soil must be improved and treated first before planting.

The formation of saline-alkaline land is significantly affected by the influence of a variety of external environmental conditions, such as geomorphology, temperature and humidity, rainfall, vegetation cover, soil fertility, plant community mix, soil erosion, changes in the amount of plant activity, soil deposition, soil erosion, soil improvement, and changes in soil fertility. The current

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increase in the area of secondary saline-alkaline land is having a negative impact on the local ecosystem and threatening the food security of the region. In fact, because saline-alkaline lands are often in environments with gentle topography, their soil structure is harder and easier to be ploughed, so that appropriate improvement of saline-alkaline lands, whether primary or newly developed, can significantly enhance their agricultural benefits as well as the stability and loading capacity of their biomes. The People's Republic of China has the third largest saline soil in the world, which covers 21 provinces (autonomous regions and prefectures), including Heilongjiang, Jilin, Liaoning, Henan, Hebei, Tianjin, Shandong and Jiangsu. Saline and alkaline land management in China has a very broad prospect, bringing comprehensive benefits in ecological, economic and social aspects.

Since the early 20th century, a large number of theoretical and practical researches have been carried out by experts at home and abroad centred on saline-alkaline land management [1]. China is vigorously developing and researching saline-alkaline land management technologies, focusing on semi-arid and semi-arid zones and semi-humid and semi-arid climatic zones. The treatment methods for these zones include saving freshwater resources, using underground saline water resources, and cultivating salt-tolerant plants. In particular, in the spring, brackish groundwater and sea ice water can be used for irrigation. Globally, salinisation in arid and semi-arid regions is a serious problem, and Australia has responded to this challenge by carrying out irrigation activities for barley, wheat, Canadian canola, and alfalfa in the Murray Darling River Basin [2]; Pakistan has adopted partial pool irrigation for salinity drenching with the aim of saving water resources, salinity drenching, and controlling the groundwater table [3]; and Kazakhstan has utilised vertical tube wells, irrigation and drainage techniques of drainage netting and drip irrigation to reduce the rise of groundwater table [4].

The causes, resource characteristics, technologies and methods of saline-alkaline land have been widely studied, and the root causes of soil salinisation in most areas have been deeply explored, but the reasonable treatment methods and models have not been determined, and they are costly and cannot bring matching benefits. In this paper, we start from the perspective of saline-alkaline land management mode, pay attention to the social participation of saline-alkaline land management, and explore the potential of saline-alkaline land according to different types. It enriches the current research literature related to saline-alkaline land and provides insights for the comprehensive utilisation of national saline-alkaline land governance.

2. Social participation in the comprehensive use of saline land in China

2.1. Subjects of comprehensive utilisation of saline land

Saline and alkaline land governance requires the joint participation of multiple subjects, such as the government, enterprises, schools, scientific research institutions, farmers and other subjects, to coordinate the mutual relationship, regulate the allocation of resources, and achieve the maximisation of benefits. Currently, saline-alkali land management varies from region to region, and the forms of participation of different subjects are different. In different provinces, the synergistic modes of enterprises, research institutes and the government have their own characteristics, such as Dongying, Shandong Province, which is dominated by market-based promotion, and Yancheng, Jiangsu Province, which is dominated by the government and state-owned enterprises. However, the role of the government in saline land management still remains in the introduction of policies and provision of funds, lacking further government support and continuous guarantee. Some scholars have introduced the stakeholder theory to explore in depth the interrelationships among the government, enterprises and farmers in the process of saline-alkali land management and assess its sustainability through data collected in various ways, including field visits, research and government interviews. Although China has been working on saline-alkali land treatment since the 1950s, establishing several experimental areas and initiating a large number of scientific research projects, the comprehensive

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planning of saline-alkali land treatment at the national level is still flawed due to the insufficient guidance of macro-management decision-making and institutional safeguards. Due to the limited governance funds, the effect of improving saline-alkaline land cannot reach the expectation [5]. Government-led promotion is the decisive factor to carry out good saline-alkali land improvement, followed by social participation and technology integration [6].

In the long run, enterprises, research institutes and other governance bodies are weak, and the leading role of the government is indispensable.

2.2. Role of the government

The government mainly plays the role of introducing policies, documents and regulations in the management of saline and alkaline land, which can be mainly divided into five major types: financial subsidies, technical support, guidance, resource exploration and master planning.

2.2.1. Financial subsidies

In 2022, the General Office of China's Ministry of Agriculture and Rural Affairs (MARD) introduced an initiative aimed at promoting financial resources invested by the government to be used to improve the infrastructure of agriculture and rural areas, especially to enhance the maintenance of the farming environment. The initiative focuses on preventing soil erosion, improving farmland infrastructure, constructing good farming environments, solving saline and flooding problems, and encouraging various types of renewable energy sources, such as hydroelectric, wind, and solar energy, to be used to improve the ecological environment of the black soil.2023 In 2023, the Ministry of Finance (MOF) and the Ministry of Agriculture (MOA) jointly enacted the ‘Measures for Management of Funds for the Construction and Utilisation of Cultivated Land’, which provides funding for soil fertility protection and improvement at all levels of government across the country. work, which covers the improvement and reclamation of saline soils, as well as financial inputs for other sustainable soil improvement projects.

2.2.2. Technical support

In 2018, the National Saline Soil Industry Technology Innovation Strategic Alliance came into being, which brings together forces from various parties, including the Academy of Sciences, large enterprises, industry associations, and financial institutions, with the aim of creating a comprehensive platform for comprehensive innovation in saline soil control, and realising strategic planning, technological innovation, and resource integration.In 2019, the Academy of Sciences enacted the ‘Programme for the Construction and Development of National Field Observatories (2019- 2025), based on the observatories in the Huanghuaihai Plain, and committed to carry out saline soil modification to improve the quality of crops and contribute positively to the sustainability and safety of agriculture in the Bohai Sea.In 2022, in order to better implement the modernisation of agriculture, we will vigorously develop the inefficient farming methods under improvement and actively explore effective saline soil management technologies, as well as more advanced high-quality farmland construction as a way to ensure our nation's food security. By 2023, in order to more strongly support and promote grassroots agricultural development, the Chinese government has issued a policy aimed at strengthening agricultural technology promotion and has included it in key development projects in 13 provinces. The policy will address the growth of important crops and how to effectively deal with the challenges of saline soils, and will encourage effective communication between all levels of government and relevant administrative authorities to work together to develop a comprehensive, effective and sustainable agricultural extension service model.

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2.2.3. Guidance

In May 2014, China's Development and Reform Commission (DRC), the Ministry of Science and Technology (MOST) and 10 other units issued the 'Several Opinions on the Directive on Strengthening Comprehensive Management of Saline Soil' to take action in a more targeted manner, including: comprehensive inputs into policy, technology, economics, law, society, culture, and environmental protection, as well as the construction of a sound long-term monitoring and evaluation system, with a view to effectively controlling and improving the saline soil environment.2023 The second meeting of the Central Finance and Economy Commission issued the 'Guiding Opinions on Promoting the Comprehensive Utilisation of Saline and Alkaline Soil', which, based on President Xi's speech in Hebei in May, clearly stated the importance of 'promoting the comprehensive utilisation of saline and alkaline soils is a strategic issue that should be given an important position', and made efforts to explore the resource status of saline and alkaline soils in depth, as well as to improve the relevant master plans and specific implementation systems. It also endeavours to deeply explore the resource condition of saline-alkaline land and improve the relevant overall planning and specific implementation measures.

2.2.4. Resource Exploration

In 2004, the Ministry of Land and Resources issued a document entitled 'Several Proposals for Land Development and Integration' to develop and use unused farmable land such as mudflats, saline and alkaline land, barren grassland, and bare land in accordance with the Land Use Master Plan and the Land Development and Integration Plan. In the year since 2022, the Third National Soil Census has been promoted with high quality and efficiency, making full use of the census data to form traditional results such as soil types, soil attribute maps and textual reports, mapping out obstacles to agricultural land to serve for soil reclamation and fertilisation in accordance with local conditions, and results such as evaluation of suitability of soil for agricultural use, evaluation of arable land quality, and evaluation of optimal layout of soil specialties, which provides an important basis for the comprehensive utilisation of saline and alkaline land. It has also formed results such as evaluation of soil suitability for agricultural use, evaluation of arable land quality, evaluation of optimised layout of speciality products, etc., providing an important basis for comprehensive use of saline land.

2.2.5. Overall planning

In 2016, in order to promote agricultural modernisation, the government issued the Agricultural Modernisation Plan (2016-2020) to ensure sustainable agricultural development.In 2023, the Agricultural Modernisation Construction Plan will focus on investing in the development of non-cultivated land modernised facility agricultural parks in order to improve the environmental quality of the north-western part of the country, the Huanghuaihai region as well as the Bohai Rim region. In addition, in 2024, the State Council will make land space planning for Inner Mongolia Autonomous Region and Jilin Province to support the comprehensive use of saline land.

3. Potential exploitation of saline and alkaline land in China

China has a vast geographical area and diversified climates, and saline and alkaline soils are distributed in 21 provinces (autonomous regions and municipalities directly under the central government), but there are significant differences between them, not only in terms of the size of the area, but also in terms of the composition of salts and the causes of saline and alkaline soils. In the production practice and scientific experiment of saline and alkaline land management in China, adhering to the principle of 'adapting to local conditions and comprehensive management' and the

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policy of 'combining utilisation and improvement', the resources of saline and alkaline land in many areas have been exploited and tapped.

3.1. Resource development of saline-alkaline land

Natural resources refer to the substances and energies with important ecological value and economic significance embedded in nature, which can not only satisfy the current needs, but also provide human beings with a better living environment. As a land resource, saline soil naturally possesses the characteristics and potentials of resources, and has diverse values after human development. Through the comprehensive analysis of saline soil and saline plants, we can better explore the potential value and provide effective economic and social benefits.

3.1.1. Saline Soil Resources

China's saline soil is an important soil resource, which has a wide distribution range and a wide variety. Different types of land have their own development potential.

3.1.2. Saline Plant Resources

Saline plants are often described as those possessing good salt and alkali tolerance characteristics, adapted to extreme altitude and soil conditions. Their presence has resulted in a rich diversity of species and populations, and they are therefore regarded as an important natural asset. It is estimated that China has 450 diverse species of saline plants, and as many as 200 species are widely used in various fields, which not only provide a variety of nutrients, but also can be made into a variety of delicious dishes, such as food grains, animal and poultry meat, medicinal herbs, and cellulose.

3.1.3. Ecological and Tourism Resources

Saline soil has rich natural scenery, which is not only a natural condition, but also a civilisation monument, which contains rich biodiversity, including a large number of saline plants, which not only play a vital role in protecting and restoring the local natural environment, but also provide beautiful scenery.

3.2. Classification and zoning to tap the potential

3.2.1. Northwest Inland Saline Zone

The northwestern inland areas of Xinjiang have accumulated a large amount of salts on the surface due to drought and low evaporation. These salts usually form salt crusts and salt crusts, making the area of saline and alkaline land in this region more than 20 million acres. In order to reduce the salts in the soil, the people of Xinjiang must perform seven salt washes when reclaiming saline land to ensure soil fertility. In this way, the saline land in Xinjiang can be sustainably irrigated to avoid land abandonment. With the spread of water-saving irrigation techniques, the availability of freshwater resources has been greatly reduced, making the development of saline soils in the region severely limited. In addition, water leaking from irrigation in inland saline areas cannot be discharged into the sea, but only into the lowlands of the region, increasing the mineralisation of the water, resulting in salinisation of non-saline soils and the formation of secondary saline soils.

Therefore, it is not desirable to continue to use irrigation for salt washing. We should make full use of the potential of saline soils to maintain their unique ecological environment and actively develop and reclaim them on the basis of ensuring water conservation and conservation farming.

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3.2.2. Middle semi-arid saline-alkaline zone of the Yellow River

The geological characteristics of this region are very special, and its main salinity is derived from sodium carbonate. The geographical location of this region is at the junction of a tropical and subtropical zone, and the surrounding area is very humid, with a climate that is very suitable for growing crops. As a result of these factors, much of the agricultural land in the Ningxia region is in a state of lack of watering and drainage, which makes it difficult for groundwater to flow and allows various chemicals and particles contained in the groundwater to precipitate to the surface.

Although the semi-arid saline area in the Yellow River covers a large area, the area along the Yellow River is facing the dilemma of fragile ecosystems, and the development and reclamation needs to be accompanied by corresponding environmental protection measures.

3.2.3. Arid and Semi-arid Depression Saline Area in Huanghuaihai Plain

Due to the joint influence of various factors such as geomorphology and meteorology, the salinity of this area becomes very complex, and the cyclic transformation of salinity is also very obvious, which is manifested in the seasonal accumulation and removal of salinity. According to the stratigraphic sequence of the mineral assemblage, the enrichment of carbonates and carbonates occurs mainly in the alluvial fans, at the top of the plains, and also to a lesser extent -sulphates, and ultimately, the deposits of all these salts flow into the river valleys of the coastal plains. When the salts are arranged in different zones, the mineral content of the groundwater gradually increases.

The area of saline-alkaline land in the Yellow and Huaihai Plains is more than 20 million mu, and in order to give full play to its ecological and economic values, it is necessary to adopt a variety of biotechnological and chemical technologies with a view to maximising its potential.

3.2.4. Semi-humid and semi-arid low-lying saline-alkaline areas in Northeast China

The three northeastern provinces have a total of about 47.95 million mu of saline-alkaline land. As a result of the climate, a semi-humid and semi-arid saline-alkaline zone has been formed in this area, in which alkaline soils are most common. The high pH value and the large proportion of clay particles prevent effective penetration of water in the top layer of the soil, resulting in a strongly alkaline soil. During the rainy season, waterlogging can lead to a lack of oxygen in the soil, thus hindering the growth of crops; while during the dry season, the surface can crust over, which can hinder the germination of crops, and worse still, large cracks in the dry soil may even lead to the breakage of the plant's root system.

In order to solve this problem, we need to carry out clearing as well as soil modification when we carry out reclamation. First of all, we need to add some appropriate chemical fertilisers to the clearing process. These fertilisers can transform the originally toxic substances into safe salts, and also enhance the soil's infiltration capacity. In this way, we can better remove the silted salt and thus get better cleaning results.

Higher harvests can be obtained by planting rice because they are more resistant to anoxic environments. In addition, if adequate irrigation is given and clean water is ensured, as well as good drainage facilities are set up, this alkaline soil can be brought out of its salty nature quickly, thus leading to less pollution.

In order to solve the problem of semi-humid and semi-arid saline soils in the Northeast, we recommend the adoption of improved techniques to enhance rice harvesting. This will result in richer, more consistent, and superior rice, and will bring great benefits to agriculture. However, we need to be particularly careful when carrying out agricultural activities to avoid diverting irrigation runoff into untreated and filtered soils, especially those that are prone to salinisation or clayey soils.

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3.2.5. Coastal semi-humid saline areas

The saline-alkaline land distributed along China's coastline covers a number of provinces, including Jiangsu, Shandong, Hebei, and Liaoning, with about 15 million mu, which belongs to the coastal semi-humid saline-alkaline zone. As the distance from the coast increases, the characteristics of the saline soils in the area change. The farther away from the sea, the earlier the seawater disappears, and the water table is higher, which results in a reduction of the salt content in the soil and groundwater in the area. The type of salt in the semi-humid coastal region is mainly sodium chloride, and the soil here has a higher salt content. This region receives abundant rainfall, an average of 600 millimetres per year. If we can establish an effective drainage system to regulate groundwater pressure to a 'critical depth' (the depth at which highly mineralised water cannot rise through the land capillaries to accumulate by evaporation from the ground), then we can use natural precipitation to remove the salt from the land and protect agricultural land from damage.

The semi-humid saline areas of the coastal region have been utilised to a greater extent in recent years in the adoption of chemical methods, although their combined value has yet to be explored.

China's saline soil covers a wide range of areas, therefore, through scientific control, rational exploitation and in-depth utilisation, it can give full play to the diversity of this soil, including fertile soil, lush vegetation, excellent water quality and complete ecosystems, which provide more opportunities for China's agriculture, cities, forestry and animal husbandry, and at the same time promote the sustainable development of the local economy, society as well as nature.

4. Conclusion

First, there are fewer studies on the socio-economic field. A large number of studies are limited to saline land management techniques and methods, the causes of land salinisation, favouring the natural science field even if it is a literature review, but also limited to these topics, the humanities and social sciences field of concern is very little, less mention of saline land management, the government, enterprises, research institutes, farmers and other subjects of the relationship and the role of the Government, especially ignoring the important role of the Government.

Second, the research method is limited to quantitative methods. Many scholars focus on the effect of a particular technology in terms of numbers and quantities, and rarely analyse it from the qualitative level, lacking the exploration of qualitative methods.

Third, the history of saline-alkali land management is rarely analysed. According to the found written materials, China has been managing saline-alkaline land as early as the pre-Qin period, although it is relatively primitive and traditional, it played a great role at that time, and many technologies even continue to this day, but the existing literature ignores the timeline of saline-alkaline land management and improvement, and is unable to summarise the changes and wisdom of China's saline-alkaline land management from the perspective of the history of the longitudinal.

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