Soil Salinization and Reclamation Result Assessment on Chongming Island Shanghai

Yilin Wang[1], Yiming Cao[1]

[1]*Easyday Education, Shanghai, China*

Abstract: *This in-depth investigation examines soil salinization on Shanghai's Chongming Island and evaluates the results of reclamation initiatives. We carefully examined the island, chose eight different sampling locations, obtained soil samples, and took exact measurements. After being dried and suspended in water at a 1:5 ratio, soil samples were tested for pH; electrical conductivity of samples was also tested after standing precipitation. The continuous problem of soil salinization on Chongming Island, which is primarily related to seawater intrusion, is clearly confirmed by our findings.*

Keywords: *Soil salinization, Chongming Island, seawater intrusion, reclamation, soil quality assessment, sustainable development*

1. Introduction

1.1 Background Information of Chongming Island

Due to its extensive natural diversity, Chongming Island—also known as the "Green Island"—holds special geographic and historical value. At the meeting point of the Yangtze River and the East China Sea, this island is now under the municipal governance of Shanghai and Nantong of Jiangsu Province. Fluvial deposition over many years, fueled by the steady buildup of sediments in the Changjiang Estuary from more than 1000 years ago, is what is responsible for its development [1]. The largest estuary alluvial island in the world, Chongming Island, has emerged as a result of this dynamic process.

In the past, Chongming Island has led the way in agricultural and environmental activities. The earliest reclamation initiatives started in Tang dynasty [1], eventually opening the path for agricultural and fertilizing activities. The landscape we see now was shaped by the rapid changes in the Yangtze River's estuarine location, particularly in 1050 AD, and by the historical presence of salt fields.

The coastline development of Chongming Island has changed dramatically over time and has gone through three distinct stages. Traditional land use before to 1950 was predominantly defined by agriculture, fishing, and salt manufacture. Industrialization and quick land reclamation between 1950 and 2001 drastically altered the island's landscape. Coastal areas are shoals are decreasing because of human activities [2]. In recent years, the local government has put more emphasis on wetland protection and ecological reestablishment. It's important to note, though, that this change has ecologists worried that current ecological restoration techniques may ignore the island's original ecosystem, particularly the predominance of reeds that have been replaced by alien grasses. Bin Zhao et. al. pointed out in their 2004 paper that careful conservation should be of higher importance than uncontrolled reclamations [3]. Our research uses sampling and data analysis to develop a thorough understanding of the soil quality of Chongming Island in order to address these ecological challenges.

1.2 Causes of Soil Salinization

Chongming Island faces a serious problem with soil salinization, which is caused by a number of interrelated issues [4] [5].

- **Waterlogging:** The lack of deeply rooted vegetation, along with a rising water table, has produced conditions where saline water seeps into the fields but finds it difficult to drain away.
- **Seawater Intrusion:** The island is vulnerable to seawater intrusion, which is made worse by elements including rising sea levels, submergence incidents, and the impact of sea air.
- **Anthropological justifications:** Human activities can exacerbate soil salinization, underscoring

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the necessity of employing sustainable land management techniques.

1.3 Rationale for the Study

This research endeavor stems from Chongming Island's ambitious goal of becoming an ecological haven, with an emphasis on reclaiming and rehabilitating saline-alkali lands. To effectively guide and inform this transformative journey, it is imperative to comprehensively assess the current state of soil salinization and the efficacy of ongoing governance measures. Furthermore, unlocking the potential of wasteland reclamation for agriculture and economic development is a priority that underscores the significance of this research.

2. Methodology

In order to conduct an exhaustive study, we carefully applied a methodology that takes into account a number of important factors, including:

2.1 Selecting a sampling point

To ensure diversity and representativeness over Chongming Island and the Shanghai region surrounding the river, the sampling points were carefully chosen. These points were carefully selected to record a wide range of salinity levels and soil conditions, giving a comprehensive picture of the island's soil health. We included sample points that are clearly influenced by sea water, and also samples that are more prone to the impact of Yangtze River. Inland locations are also sampled to see how human activities have changed soil quality.

2.2 Processing and Sampling

Each chosen site's soil samples were meticulously gathered using strict techniques to prevent contamination and maintain sample integrity. The soil samples were then completely dried under the sun. The next essential step involves combining the dried soil with water in a precise 1:5 ratio to create soil suspensions [6].

2.3 Measurement Techniques

We measured important soil parameters as part of our thorough evaluation. To determine the acidity or alkalinity of the resulting soil suspensions, the pH of the samples was carefully monitored. We measured the electrical conductivity (EC), a crucial predictor of soil salinity levels, after a time of settling.

In terms of pH testing, the procedures are as follows:

1) Weigh 5g field moist soil into 2 extraction cups.

2) Place lids on cups.

3) Add 25 ml of deionized water shown in Figure 1.

4) Gently swirl cups to create soil suspension solution.

5) Standardize pH meter using a solution with pH value of 7.

6) Gently swirl the soil slurry while taking measurement.

7) Record pH to the nearest 0.01, the result is shown in Figure 2.

8) Clean the pH pen with standard neutral solution and recheck standard buffer concentrations after every measurement. Recalibrate meter as needed.

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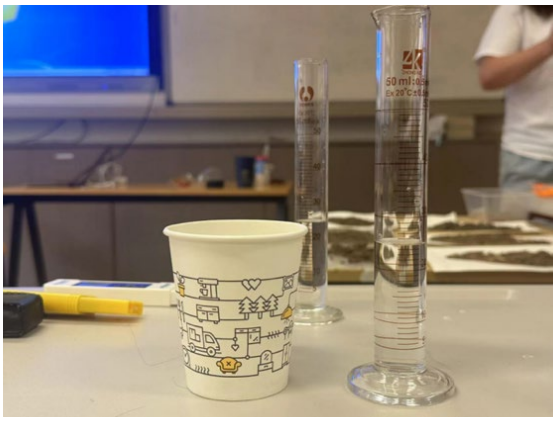

Figure 1: 25ml of water was added to 5 grams of dried soil

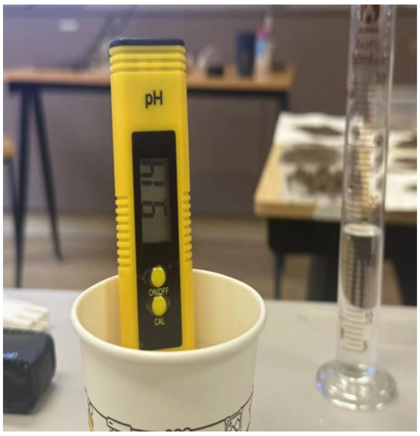

Figure 2: pH measurement is read from the instrument after mixing and stirring

EC is measured after letting the solution stand and precipitate for three hours shown in Figure 3. The measuring procedures are as follows

Figure 3: Samples are then allowed for standing precipitation

Figure 4: Electric conductivity is measured

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1) Caliber EC meter with a solution that has 0 conductivity.

2) Measure the EC of the solution using an EC meter shown in Figure 4.

3) Rinse and dry the EC pen after every measurement. Re-caliber as needed.

2.4 Soil quality classification

Soil samples were classified into different categories using following criteria. Both Table 1 and Table 2 as following are adapted for the method used in this study.

Table 1: Salinity classes in in electrical conductivity for EC 1:5 samples

Salinity Classification	**$EC_{1:5}$ range for loams**
Non-saline	0-0.18
Slightly saline	0.19-0.36
Moderately saline	0.37-0.72
Highly saline	0.73-1.45
Severely saline	1.46-2.90
Extremely saline	2.90

* Table adapted from Department of Primary Industries and Regional Development, 2022 [6].

Table 2: Soil pH range and interpretations

pH	**Classification**	**Interpretation**
pH<5.5	Extremely to strongly acid	Soil deficient in Ca and Mg. Poor root growth. Phosphorus deficiency is likely.
pH 5.5-6.5	Moderately to slightly acid	Soil is low in carbonate. Satisfactory for many crops.
pH 6.5-7.5	Neutral	Ideal range for most crops
pH 7.5-8.4	Slightly to moderately alkaline	Free carbonate present in soil. Typically, P and micronutrients less available.
pH > 8.4	Strongly to very strongly alkaline	Sodic soil. Poor condition. Low infiltration and percolation. Possible root deterioration and organic matter dissolution.

* Table adapted from Soil Survey Division Staff, 1993 [7] and HACH Co, 1993 [8]

3. Results

3.1 Sampling Point Field Information

Our research entailed a detailed analysis of each sampling point, offering valuable insights into local soil conditions. These findings contribute to our understanding of Chongming Island's diverse soil profiles:

● Sample 1 (Binjiang Wetland Park) shown in Figure 5: Notable surface vegetation, moist soil, and brown topsoil collectively signify favorable soil quality, possibly indicating prior treatment.

● Sample 2 (Aquaculture Farm Road) shown in Figure 6: A light surface texture, dry soil, and gray-white topsoil suggest soil quality of an average standard.

Figure 5: Field picture of Sample 1

Figure 6: Field picture of Sample 2

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Figure 7: Field picture of sample 3

● Sample 3 (Dongtan Road) shown in Figure 7: Severe surface hardening, dry soil, and gray-white topsoil underscore poor soil quality at this location.

● Sample 4 (Dongtan Wetland Park Parking Lot) shown in Figure 8: Surface moss layer, dry soil, and grayish-brown topsoil imply average soil quality.

● Sample 5 (Mouth of the Yangtze River Tidal Flat) shown in Figure 9: Presence of surface vegetation, wet soil, and brown topsoil indicate relatively fertile soil conditions.

Figure 8: Field picture of sample 4

Figure 9: Field picture of sample 5

Figure 10: Field picture of sample 6

● Sample 6 (Yingzhou Park) shown in Figure 10: Abundant surface greenery, moist soil, and brown topsoil reflect optimistic soil quality.

● Sample 7 (Bajiang Road Wastelands) shown in Figure 11: Sparse surface grass, dry soil, and gray topsoil point to poor soil quality.

● Sample 8 (Siyao South Gate Roadside) shown in Figure 12: Occasional surface vegetation, dry soil, and gray topsoil suggest soil quality might be poor.

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Figure 11: Field picture of sample 7

Figure 12: Field picture of sample 8

3.2 Soil Sample Measurement Results (pH and Electrical Conductivity)

Our comprehensive measurement results, as detailed in the following Table 3, offer a critical insight into the pH and electrical conductivity of each soil sample:

Table 3: Measuring Results

Sample	**pH**	**Electrical Conductivity**
Sample 1	9.14	0.092
Sample 2	9.04	0.088
Sample 3	9.76	0.650
Sample 4	8.45	1.426
Sample 5	9.17	0.234
Sample 6	8.81	0.072
Sample 7	8.61	0.102
Sample 8	8.84	0.094

Table 4: Soil classification

Sample	**pH**	**Electrical Conductivity**
Sample 1	Strongly to very strongly alkaline	Non-saline
Sample 2	Strongly to very strongly alkaline	Non-saline
Sample 3	Strongly to very strongly alkaline	Moderately saline
Sample 4	Strongly to very strongly alkaline	Highly saline
Sample 5	Strongly to very strongly alkaline	Slightly saline
Sample 6	Strongly to very strongly alkaline	Non-saline
Sample 7	Strongly to very strongly alkaline	Non-saline
Sample 8	Strongly to very strongly alkaline	Non-saline

These pH and electrical conductivity values serve as critical indicators of soil health and salinity, allowing for a comprehensive evaluation of Chongming Island's soil condition. Soil classifications based on Table 1 and Table 2 are listed in Table 4.

4. Discussion

4.1 Governance and Ongoing Measures

Although there are now governance initiatives in place to reduce soil salinization on Chongming Island [9], it is clear that continued attention and persistent action are essential. There are still issues, especially in the areas around Chongming East Beach where ongoing reclamation efforts have not improved the soil quality.

4.2 Seawater Intrusion: The Main Offender

The outcomes of Sample 5, which was collected along the coast, highlight how seawater intrusion affects soil alkalinity levels. The electrical conductivity levels are still within the normal range despite the higher pH levels. This shows that seawater intrusion is a key factor in the salinization of the soil in Chongming, offering a serious obstacle to efforts to restore the soil.

4.3 Soil Quality Variations

It is noteworthy that there are significant variances in soil quality around the island. While some locations, like the Binjiang Wetland Park, show ideal soil characteristics for prospective reclamation, others, like the Dongtan Road and Bajiang Road Wastelands, provide substantial obstacles because of the low soil quality. The difficulty of soil salinization on Chongming Island is highlighted by this discrepancy.

4.4 Strategies for Soil Improvement

To address the issue of saline-alkali land, a multifaceted approach is imperative. Our research suggests the following strategies for improving saline-alkali land in Chongming [10]:

● **Physical Improvement Methods:** These may include ground leveling, timely soil loosening, film planting, and innovative techniques like saltwater freezing irrigation.

● **Chemical Improvement Methods:** The application of carefully measured quantities of soil amendments to enhance the physical and chemical properties of saline soil. Organic matter, such as leaf rot soil, pine needles, wood chips, bark, chicken manure, peat, and vinegar residue, can be considered for soil improvement. Additionally, chemical amendments can be employed to mitigate soil salinity and adjust pH levels effectively.

● **Biological Improvement Methods:** The introduction of salt-tolerant green plants, such as melilotus, cyanine, and alfalfa, can significantly contribute to soil rehabilitation. These plants not only loosen the soil but also reduce compaction, enhance soil permeability and water retention, and mitigate salt accumulation in surface soil layers.

4.5 Limitations of Sampling and Methods

● **Limited Samples:** Although the research included a wide range of sampling locations, it is possible that greater sample size and diversity could yield even more thorough findings.

● **Evaluation of Prior Soil Treatment:** In certain instances, it was difficult to know for sure whether the soil at particular sites had previously been treated, which could have an impact on the outcomes.

● **Limited sampling range:** The research was primarily concerned with the region of Chongming Island that is managed by Shanghai, while further study may be expanded to include the island's regions that fall within the purview of Nantong City.

● **Limited testing:** Heavy mental concentration in the soils in Chongming island is another main issue hazarding the soil quality [11] [12]. In our study, we did not run any test on heavy metal. It is highly possible that for soils suitable pH and EC are plagued by heavy metal, rendering which impossible for agriculture production and unsuitable for human activity.

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5. Conclusion

Our in-depth investigation and analysis highlight the significant difficulties caused by soil salinization on Chongming Island. Our eight sampling locations revealed a range of soil quality, from highly alkaline to highly saline, which together points to an average soil quality. While soil touched by seawater is noticeably more salinized than soil primarily influenced by Yangtze River water, both have varying degrees of salinity. This body of knowledge about soil salinity supports the idea that the soil on the island is often unsuitable for conventional farming.

We advise concentrating on growing important alkaline-resistant crops and enhancing them with suitable fertilizers in order to navigate the challenging terrain of soil reclamation and promote sustainable development on Chongming Island. Furthermore, it is crucial to develop a comprehensive strategy that incorporates physical, chemical, and biological soil restoration techniques.

In conclusion, this study provides a solid platform for future efforts addressing the problems caused by soil salinization on Chongming Island. We can work together to safeguard the island's ecological vitality and sustainable prosperity by comprehending the nuances of soil health and salinity.

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