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Types And Spatial Distribution Of Surface Soil Salinization In The South Coast Of Laizhou Bay

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Abstract:
Due to the salinization phenomenon in the typical research area on the south coast of Laizhou Bay, coupled with the unreasonable changes in land use patterns in recent years, the degree of salinization in the research area is intensifying, and the surface soil is most closely related to human activities. It is also the most affected. This paper studies the differentiation law of surface soil salt segregation in typical plots on the south coast of Laizhou Bay. The surface soil salt segregation shows medium and strong spatial variation; cluster analysis shows that Cl^-, Na^+ are the first type, Ca^{2+}, SO_4^{2-} can be divided into the second category, K^+, Mg^{2+}, HCO_3^- is the third category; the main types of salinization are chloride type, sulfate type and their derivatives, and the degree of salinization is moderate salinization; the analysis of the source of salt ions shows that seawater intrusion is the main source, Different crops and irrational agricultural irrigation have exacerbated the degree of salinization.

Key words *: Laizhou Bay; soil salinization; surface soil; spatial distribution*

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Soil salinization is a land degradation phenomenon formed under the comprehensive influence of climate, hydrology, terrain and other natural factors as well as artificial and unreasonable development and utilization. It is a major land risk that has attracted the attention of the world today. Soil salinization not only reduces soil fertility and reduces agricultural production, but also destroys ecological and environmental resources, posing a serious threat to sustainable development [1] . Saline soil is one of the medium and low-yield soils, and soil salinization has become one of the important challenges for my country to strictly abide by the red line of 1.8 billion mu of cultivated land. It is of great significance to understand and master the composition, structure and spatial differentiation characteristics of salt ions in soil for the prevention and control of salinization. In soil, the migration and transformation of salt ions produces the distribution law of the surface layer, which determines the type, distribution and change trend of soil salinization. Therefore, the study of the differentiation law of soil salt ions is the basis for monitoring, evaluating and early warning of salinization . basic work.

GIS has a strong spatial data management function, but lacks the spatial analysis ability for some problems; geostatistics has a strong spatial analysis function, but its spatial data management function is weak; the combination of the two can learn from each other and can fully Give full play to their respective advantages [2] . Xu Jiyan et al . [3] believe that geostatistics is one of the most effective methods for analyzing the spatial distribution characteristics and variation patterns of soil properties. Liu Wenquan et al. [4] used classical statistics and geostatistics methods to study the spatial differentiation rules of salt molecules in the soil profile on the

southern coast of Laizhou Bay. Ma Gongbo et al. [5] made a preliminary evaluation of the degree of salinization in the southern shore of Laizhou Bay and obtained the spatial distribution rules of salt ions. Fan Xiaomei et al. [6] selected factors such as groundwater level, salinity, elevation, vegetation coverage, and distance from the sea as the main research objects among the factors affecting salinization. Wang Dan et al. [7] studied the migration speed and distribution characteristics of various salt ions under farmland drip irrigation conditions. At present, domestic studies mainly focus on the Huang-Huai-Hai Plain and the inland areas of Northwest China, and there are few studies on the salinity characteristics and spatial variation of estuary areas and tidal flat soils [8] . This article will be based on the combination of classical statistical methods and geostatistical methods, considering the impact of geological structure changes on groundwater and seawater intrusion from a macro perspective, and considering the impact of microtopography and different vegetation on different ion absorption conditions from a micro perspective. Taking the typical block on the south coast of Laizhou Bay as the research area, the optimal interpolation model was fitted in GS+9.0, and the spatial differentiation of salt ions was obtained through the spatial interpolation module in ArcGIS10.1, and finally combined with the geological structure and vegetation in the area Variables such as coverage, land use patterns, micro -landforms , and groundwater were used to analyze the dominant factors affecting the content of salt ions.

I. Overview of the study area

south side of the Bohai Sea. It includes three districts and cities: Shouguang, Hanting and Hanting. The elevation is about 9 meters, and there are three rivers, Mi River, Bailang River and Wei River , flowing into Laizhou Bay from south to north . The study area is simultaneously affected by the Pacific monsoon and the Eurasian cold wind, resulting in a warm temperate monsoon-type semi-humid continental climate with an annual average temperature of 13-16°C and an average annual precipitation of about 750mm. The wet season is distinct, and the precipitation in the rainy season accounts for 70%-80% of the annual precipitation. The soil types in the region are mainly saline soil and fluvo-aquic soil. The planting types are mainly wheat and corn in the southern area, and cotton is the main planting type in the northern area affected by the soil salinity.

II. Materials and methods

Sample collection

On the basis of a comprehensive survey of the study area on the south coast of Laizhou Bay, combined with the land use map, soil type map and geological map of the study area, according to the principles of accessibility, typical representation and the exclusion of human interference, ArcGIS10.1 software was used in the digital Arrange the sampling points on the base map , arrange the sampling points reasonably, and determine the sampling work in each sampling experimental research area; during the field sampling process, make appropriate adjustments according to the actual environment around the preset sampling points, and use GPS to determine the sampling The actual coordinate positions of the points were obtained in June 2016 in the northern area of Weifang. Each sample point was taken with a wooden shovel to remove the 0 -20cmsurface soil, and the gravel, weeds and other sundries in the soil were removed. The five-point sampling method uniformly mixes the five soils and puts them into polyethylene sampling bags.

Analytical testing

In the laboratory, remove plant residues, invasive bodies and other sundries in the collected soil samples, grind and sieve them (the diameter of the sieve is 1mm), put them in a tray and spread them out for natural air-drying. For all soil samples, a 1:5 soil-water ratio extract solution was prepared and its conductivity was measured; the total salt content of the soil was measured by the gravimetric method; the total dissolved solids (TDS) was

measured by a YSL EC300 conductivity meter (produced by YSL Company in the United States) ; K, Na were measured by flame photometry; Ca, Mg were measured by EDTA complexometric titration; Cl was measured by AgNO3 titration; SO42- was measured by EDTA indirect titration [4]; HCO3- was measured by automatic potentiometric titrator (core module (Metrohm exchange unit); the total salt content (total soluble salt) is obtained by adding the sum of the salt ions obtained. For detailed measurement and experimental procedures, please refer to "Soil Agricultural Chemical Analysis Methods" [9] .

Research Methods

Use IBM SPSS Statistics 17 to conduct statistical analysis and cluster analysis of basic characteristics such as mean, median, range, standard deviation, coefficient of variation, kurtosis and skewness on the salt segregation data obtained in the laboratory. In the process of obtaining the salt segregation subspace distribution, Using GS+ software to calculate the variation function, fit the optimal interpolation model parameters, and perform kriging interpolation in the ArcGiS10.1 geostatistical module to draw K^+, Na^+, Ca^{2+} in the 0 - 20cmsurface soil , Mg^{2+}, Cl^-, SO_4^{2-}, HCO_3^-, and the spatial characteristic distribution map of total salt content.

III. Results and Analysis

Basic statistical characteristics of salt ions

K^+, Na^+, Ca^{2+} in the study area , Mg^{2+}, Cl^-, SO_4^{2-}, HCO_3^- and total salt are 10.76 , 82.09 , 70.14 , 14.05 , 73.10 , 66.54 , 276.74 and 816 mg/kg^{-1} respectively . The coefficient of variation (coefficient of variation, CV) can characterize the degree of dispersion of the data, Data of different dimensions can be compared; Wilding divides the coefficient of variation into high variation (CV>100%), medium variation (10%<CV<100%) and low variation (CV<10%) [10, 11 , 12]. The soil salt ions in the study area have strong spatial variability except for HCO 3 -, which is mainly due to the combined effect of multiple factors such as different soil textures, micro-topography, land use and irrigation methods in the study area . K and Na, which indicate that the distribution of salt ions is relatively concentrated and exists in the form of compounds, and there is a certain degree of salinization [13] . From the distribution curves of different types of soil salinity, it can be seen that the distribution of soil salinity in the natural state is closer to the normal distribution, and the kurtosis and skewness of the soil salinity distribution curves of secondary saline soil have increased significantly. In terms of the differences in the salinity distribution of different types of saline soil, the difference in the salinity distribution of the surface soil is much greater than that of the bottom soil. It can be seen that the change of land use mainly affects the surface soil, making the distribution of salinity more uneven[6]]. It can be seen from Table 1 that the ion with the maximum value in June 2016 was Cl^-, and the ion with the minimum value was K^+. The soaked soil is greatly affected by seawater immersion and groundwater . The order of salt ion content is $Cl^- > Na^+ > HCO_3^- > SO_4^{2-} > Ca^{2+} > Mg^{2+} > K^+$, mainly Cl^- and Na^+, which shows that the salinization of the region It mainly exists in the form of compound NaCl.

Table 1 Descriptive statistics of soil salt ions and total salt content in the study area/mg/kg^{-1}

	median value	minimum value	maximum	average	standard deviation	coefficient of variation %	kurtosis	Skewness
K^+	10.76	2.7	479.95	30.8	68.29	221.7	26.78	5.03
Na^+	82.09	17.46	12274.62	360.07	1306.6	362.9	66.19	7.76
Ca^{2+}	70.14	22.09	2053.12	117.37	220.06	187.5	57.05	7.03
Mg^{2+}	14.05	4.59	1068.86	38.82	134.64	346.8	47.82	6.84

Cl^-	73.10	7.31	22753.65	483.01	2412.5	499.5	68.98	7.95
SO_4^{2-}	66.54	11.6	5747.17	237.81	678.02	285.1	43.12	6.15
HCO_3^-	276.74	138.37	657.25	309.91	94.22	30.4	1.38	1.01
TS	816	0.04	4.02	0.174	0.44	252.9	57.51	7.13

Note: TS is the total amount of salt

Correlation and cluster analysis of salt molecules

The type of soil salinization depends on the content and proportion of ions in soil salt. Studying the migration relationship between ions in soil salt can provide a scientific basis for the prevention, improvement and efficient use of salinized soil. In the multivariate correlation analysis, the simple correlation analysis often reflects the superficial rather than the essential connection due to the influence of other factors. Therefore, partial correlation analysis is required to reflect the real relationship between ions[14] .

There is a significant correlation between each salt segregation, Na^+ and Cl^-, SO_4^{2-} and Ca^{2+}, Mg^{2+} and Cl^- have a very significant positive correlation, Ca^{2+} and Na^+, Cl^- are related to other ions, which means that the concentration of Na^+ increases, and Cl^- will also increase, which is also consistent with the previous analysis results; HCO_3^- and Mg^{2+}, Cl^- show a significant Negative correlation; the distribution characteristics and migration speed of each salt ion are different under irrigation conditions, Na^+, Mg^{2+}, SO_4^{2-} are mainly distributed in the periphery of the wet body after being washed by irrigation water, HCO_3^-, Cl^- are mainly distributed in the interior of the wet body. The samples in this study were taken from the 0 -20cmtopsoil, and the agricultural irrigation based on seawater inversion led to a strong correlation between salt ions.

Cluster analysis is to divide the data variables into several categories according to the inherent nature of the data according to certain standards. Cl^- and Na^+ are the first category, Ca^{2+}, SO_4^{2-} can be divided into the second category, and K^+, Mg^{2+}, HCO_3^- is the third category; the results of clustering also strongly verified the source and distribution of Na^+, Mg^{2+}, SO_4^{2-} and Cl^-, Na^+, Ca^{2+}, SO_4^{2-}, Analysis of compound forms. The salinity manifestations combined by the same class of salt ions have the same source, which is of great significance for the prevention and treatment of salinization.

Table 2 Correlation coefficient matrix of surface soil salt molecules on the south coast of Laizhou Bay

	K^+	Na^+	Ca^{2+}	Mg^{2+}	Cl- –	SO_4^{2-}	HCO_3^-
K^+	1.000						
Na^+	0.677 **	1.000					
Ca^{2+}	0.755 * *	0.262 ** _	1.000				
Mg^{2+}	0.793**	0.881**	0.383**	1.000			
Cl^-	0.674**	0.994**	0.244**	0.906**	1.000		
SO_4^{2-}	0.864**	0.520**	0.927**	0.590**	0.492 ** _	1.000	
HCO_3^-	0.033 _	0.001 _	0.066 * _	- 0.104 **	- 0.063 * _	0.137 **	1.000

**The correlation coefficient is significant at the 0.01 level*The correlation coefficient is significant at the 0.05 level

Analysis of the spatial distribution characteristics of salt ions

On the basis of variogram fitting, ordinary Kriging interpolation was performed on the soil heavy metal

content in the study area. Kriging interpolation results smoothed the data of soil salinity, which made the large value decrease and the small value increase, thus reducing the variation of soil salinity. sudden change [16]. The basic distribution law of salt segregation is layered and patchy distribution, gradually decreasing from the northwest coastal area to the south and showing a belt-like distribution , and the central area is relatively low-lying and sea-salt water intrusion leads to higher surface salt content and is patchy Distribution; from the perspective of salt ions, except for the anion HCO_3^-, which represents the highest alkaline content, both Cl^- and Na^+ have the highest content. In June, when winter wheat is harvested , the salt ions in the study area are less affected by human influence, so the law of gradual increase from northeast to southwest is more obvious; K^+ has the opposite distribution law, because K^+ and Na^+ are two elements that compete with each other, and salt-tolerant crops often increase the salt resistance of crops by selectively absorbing K^+ and increasing the ratio of K^+ / Na^+ [17] , vegetables are mainly produced near Mihe River , and the potassium content is higher than that of dry land and irrigated land [18] . The Ca^{2+} area is high in the north and low in the south, and there are point-shaped abnormally high points in some areas. Most of these abnormal points appear near the river. In the farmland area, the Mg 2+ content distribution around the river is also higher than that in other areas . , which is mainly affected by farmland irrigation, because the Ca^{2+} and Mg^{2+} adsorbed by soil colloids are easily replaced by Na^+ and enter the soil solution, and migrate to the edge of the wet body along with the water. Ca^{2+}, which are easy to flow with water , Mg^{2+} and SO_4^{2-} form aggregation at the edge of the surface moist body, and abnormally high points appear [19] . Cl^- is high in the northern coast and low in the south, similar to the distribution trend of Na^+. The content of Cl - is low near Shouguang in the Mihe River Basin , and higher in the Bailang River and Weihe River Basins in the central and eastern part. This is related to the planting traditions of the two regions. The absorption and conversion ability of Cl^- and Na^+ is strong; HCO_3^- is high in the central part and low in the north and south. Seawater intrusion is the main factor leading to this phenomenon. Na^+, Cl^-, SO_4^{2-} three ions are similar in spatial distribution, showing a trend of being higher in the middle, followed by the north, lower in the south, and gradually decreasing from the northeast coast to the southwest inland. The influence of lateral seepage of underground seawater intrusion results in higher contents of three ions in this area [4] . Looking at the overall distribution map of total salinity, the region is dominated by moderate salinization, with the highest concentration in the central region and the northern coast, and relatively low concentration in the southern region. The main reason is that from the bay to the inland, salt ions It is bound to show a decreasing overall trend; K^+, Ca^{2+}, Mg^{2+}, Na^+, Cl^-, SO_4^{2-} In terms of the spatial distribution of the six types of salt ions, climate and vegetation cover will play a certain role in the content of the surface soil, but the impact of seawater intrusion and micro-topography will play a leading role.

On the basis of variogram fitting, Kriging interpolation was carried out in ArcGIS 10.1 to obtain the spatial distribution of salt ions, which accurately and intuitively reflected the spatial differentiation and change of salt ions in the typical research area on the south coast of Laizhou Bay. The main control factors of the occurrence and development of salinization provide a reference basis for future treatment and prevention measures of salinization in the region.

IV. Conclusion

(1) Due to strong human disturbance in the typical study area on the south coast of Laizhou Bay, the coefficient of variation shows a high degree of spatial variation, which is mainly the result of the combined effects of micro-topography, land use, and irrigation methods.

(2) After cluster analysis, it is concluded that Cl^-, Na^+, Ca^{2+}, and SO_4^{2-} belong to the first category, and Na^+, Mg^{2+}, SO_4^{2-} belong to the second category. In Houzhen and Daotian Town , Beiluo Town , there are also some poles with abnormally high salt ions. The reason is that the micro-domain characteristics of saline soil change significantly in summer, mainly due to natural factors such as rainwater leaching, micro-topography,

different plant communities, and different farming systems. , farming habits, management methods and other human factors.

trend of salt ions is high in the north and low in the south, and gradually decreases from the northeast coastal area to the southwest inland, and the lateral intrusion of seawater in the middle of the Bailang River leads to higher salinity than other areas. The salty-fresh water interface in this area continues to move inland, resulting in intensified soil salinization and reverse succession of vegetation. At the same time, driven by economic benefits, land use patterns have undergone major changes. The interaction between land use/cover change and saltwater intrusion aggravates the degradation of the ecosystem and induces the expansion of saltwater intrusion. Seawater intrusion is the main reason, and agricultural irrigation and other production methods are the incentives, which together show the distribution of salt ions in the typical area of the south coast of Laizhou Bay.

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