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USE OF GEOINFORMATION TECHNOLOGIES IN DETERMINING SOIL SALINITY

Abstract: In this article, soil salinity was analyzed using geoinformation technologies based on the soil data of the Karakalpakstan district of the Republic of Karakalpakstan in 2017, 2020, and 2023. Based on the research results, soil salinity was classified and mapped. Such studies help to assess the salinity of the soil and to determine operationally in which areas their change is high.

Keywords: electrical conductivity, interpolation, GIS, digitization.

Introduction

Soil salinity is the main problem affecting crop productivity in the use of irrigated land. The area of irrigated land in the Republic of Karakalpakstan is 514.6 thousand hectares, which is 3.09% of the total land area of the Republic, and 15.78% of the land intended for agriculture (2022). This requires organizing rational use of land under the conditions of limited resources, identifying negative changes in it in time, and developing measures.

Geoinformation technologies play a crucial role in determining soil salinity through data collection, analysis, and visualization. Geographic Information Systems (GIS) software allows the integration of different spatial data layers, including soil type, topography, land use, and climate, to analyze the distribution and extent of soil salinity. By overlaying these layers and using spatial analysis tools, GIS can help identify correlations related to soil salinity.

Data and research methods

Research object. In the article, the Karaozak district of the Republic of Karakalpakstan was taken as the object of research (Fig. 1). Its area is 587.1 thousand ha, including 32.1 thousand ha of irrigated land. The Earth's surface is mostly flat. The northeastern part of the district is occupied by the dunes of the Beltov Mountains, and the large area in the southern part is occupied by the Tashkuduq dunes. On the southern edge is the Sultan Uvais Mountain (the highest point is Karachingil, 485 m). The climate is strictly continental, with hot summers and cold winters. The average temperature in January is from 5° to 8°. The lowest temperature is 35°, in July 26-28°. The highest temperature is 42° in July. The cold-free period is 195-200 days. Annual precipitation is 110 mm, mainly in winter and spring. District farms receive water from the Yesimozak, Karaozak, and Central canals of the Kuvanish-Jarma canal. Amudarya flows from its southern edge. The soils are grassy, sandy, meadow, meadow-swamp, and saline soils. There are large portable and semi-portable dunes in the southern part.

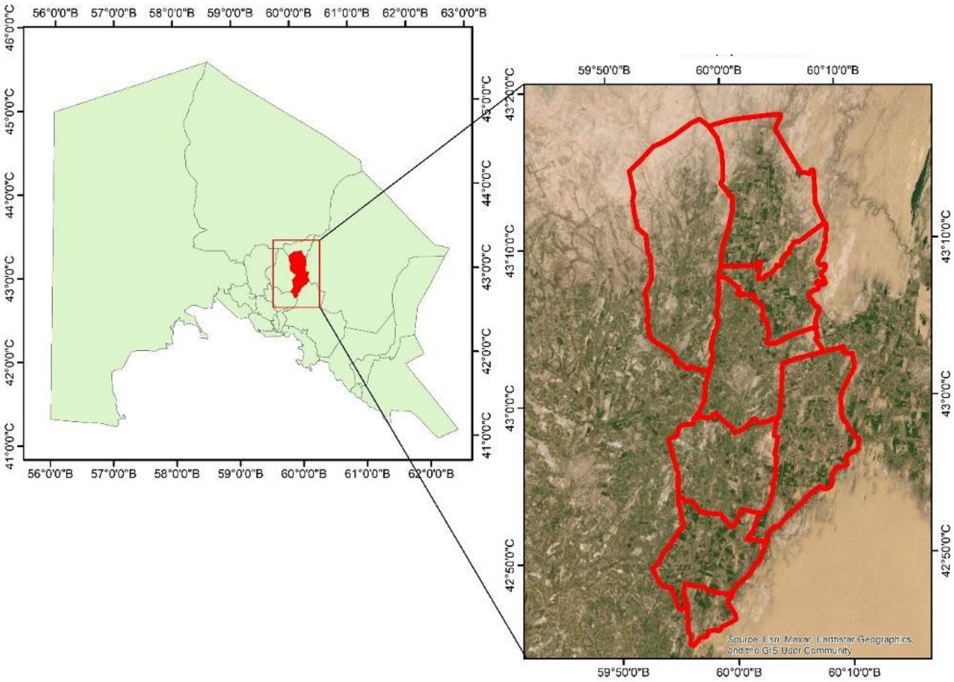

Fig 1. Location map of the research object.

Collected data. In the assessment of soil salinity, the data of soil electrical conductivity (EC) in 2017, 2020, and 2023, determined in laboratory conditions by the reclamation expedition under the Ministry of Water Management of the Republic of Karakalpakstan, were collected and digitized. (Fig. 2).

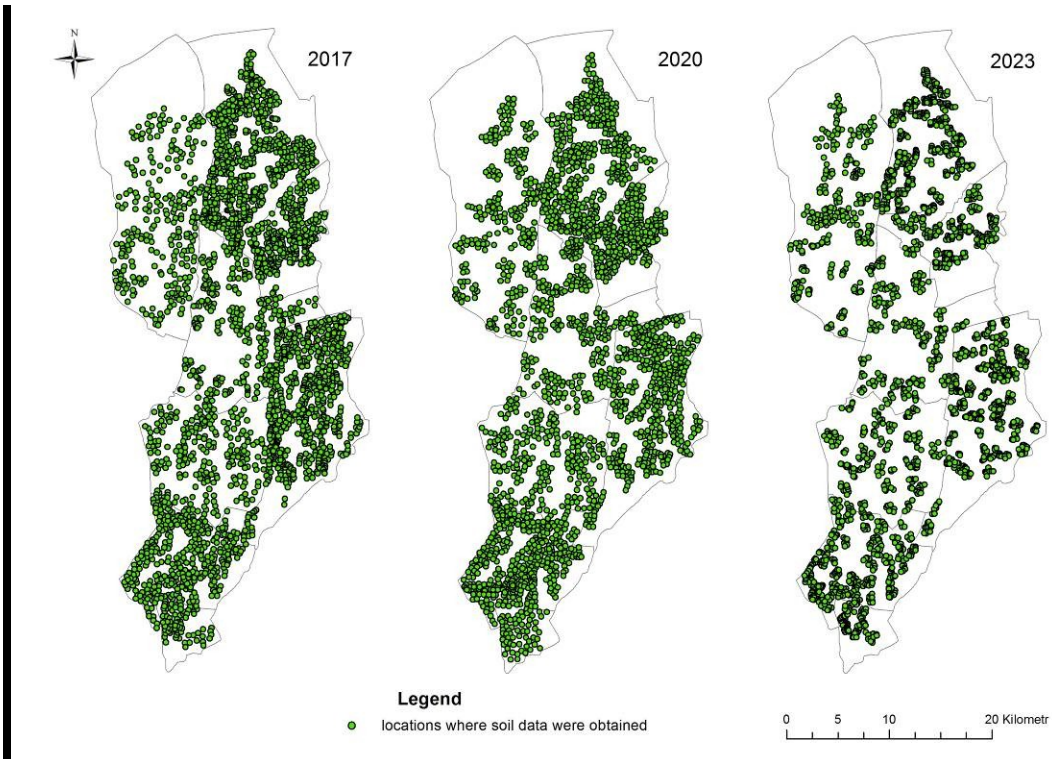

Fig 2. Digitized database view.

In the fall of 2017, the total electrical conductivity of the soil was obtained from 2752 points, while in 2020, 2260, and in 2023, data was collected and processed from 2273 points. The obtained data were classified using the classification developed by the Food and Agriculture Organization of the United Nations (FAO).

Table 1. Classification of soil according to electrical conductivity.

Salinity class	None salted	Medium salted	Salted	Highly salted	Very high salted
EC, ds/m	<2	2-4	4-8	8-16	>16

In the data of 2017, the lowest indicator was 0.44 ds/m, while this indicator was 0.58 and 0.44 ds/m in 2020 and 2023, respectively. It is possible to see that the highest indicators have changed significantly. That is, 9.57 ds/m in 2017; and 16.87 ds/m in 2020; in 2023, it will be 47.04 ds/m.

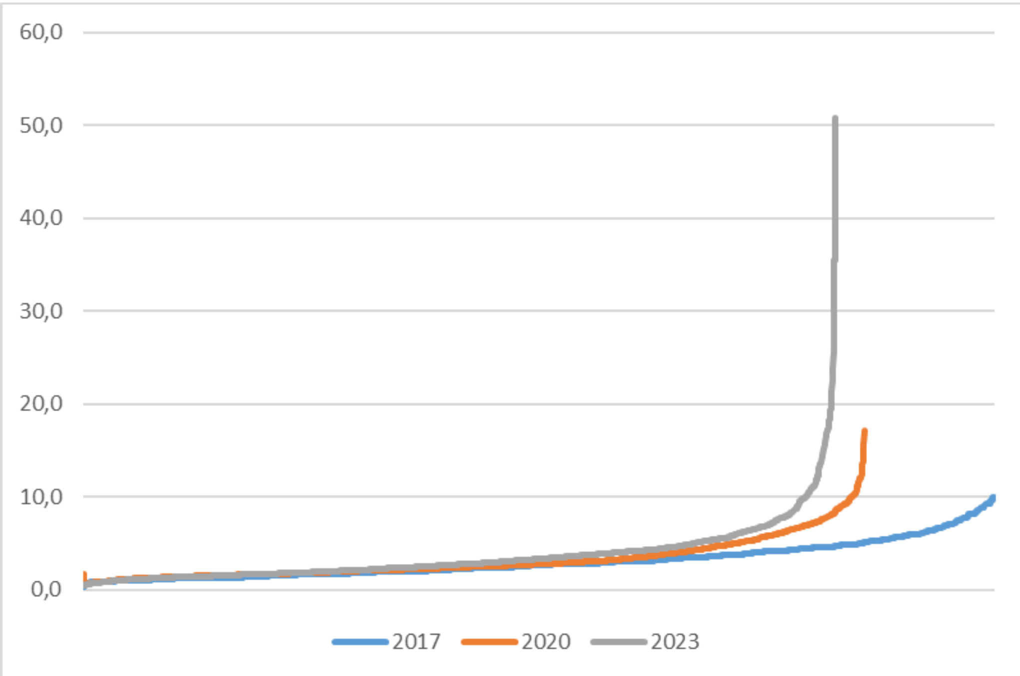

Fig 3. Soil EC changes in 2017, 2020, and 202.

The collected data was analyzed based on the interpolation method in ArcGIS 10.8 software, and the changes over the years were visualized. The extracted data were converted from raster data to vector data, and the salinity areas were calculated by class.

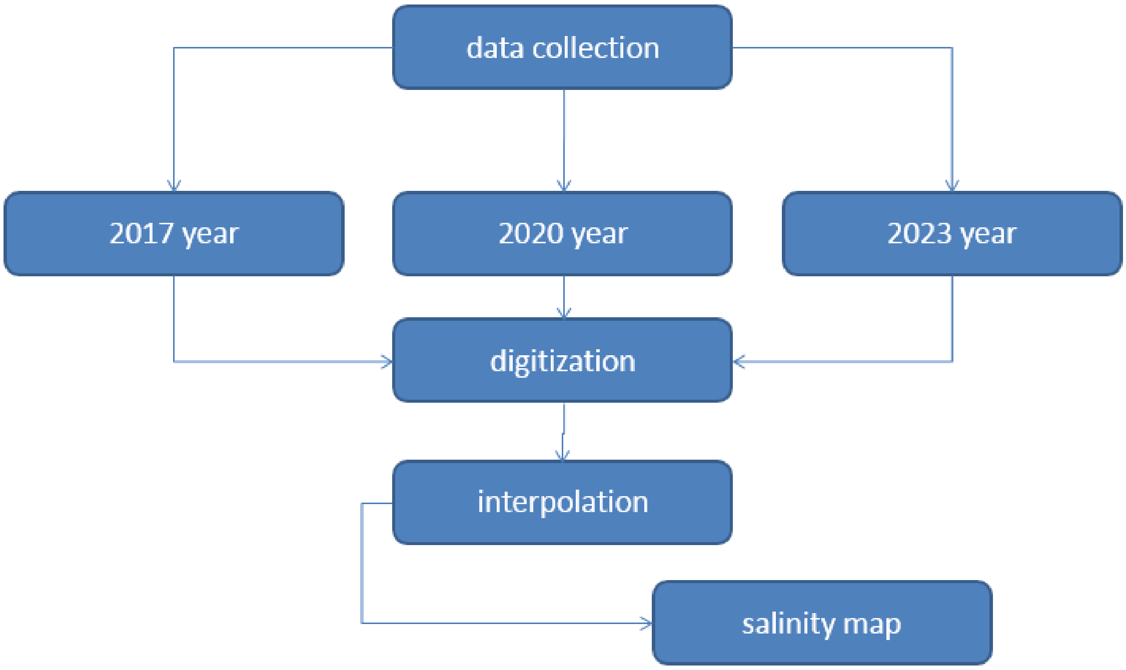

Fig 4. Research methodology.

Results

Based on the results of the research, the dynamics of soil salinity in Karaozak district over the past 6 years were studied and mapped using geoinformation methods. If in 2017 there was no very high level of salinity (>16 ds/m) in the total area of the district, we can observe that by 2023 such areas will be 0.1% (Table. 2).

Table 2.

Percentages of salinity classes by district in 2017-2023 (%).

Salinity class	2017	2020	2023
Non-saline	28,7875	15,9547	13,4066
Slightly	58,2328	63,9383	58,4665
Moderately	12,8797	19,5572	26,1183
Very	0,10004	0,54898	1,89916
Extremely	0	0,0008	0,1095
Total	100%	100%	100%

Fig 5. Dynamics of salinity.

The class with the most changes was determined in the non-salted (class 1) and salted (class 3) classes. In 2017, the non-saline land was 28.78%, and in 2020, it was 15.95%; by 2023, it was found to be reduced by 13%.

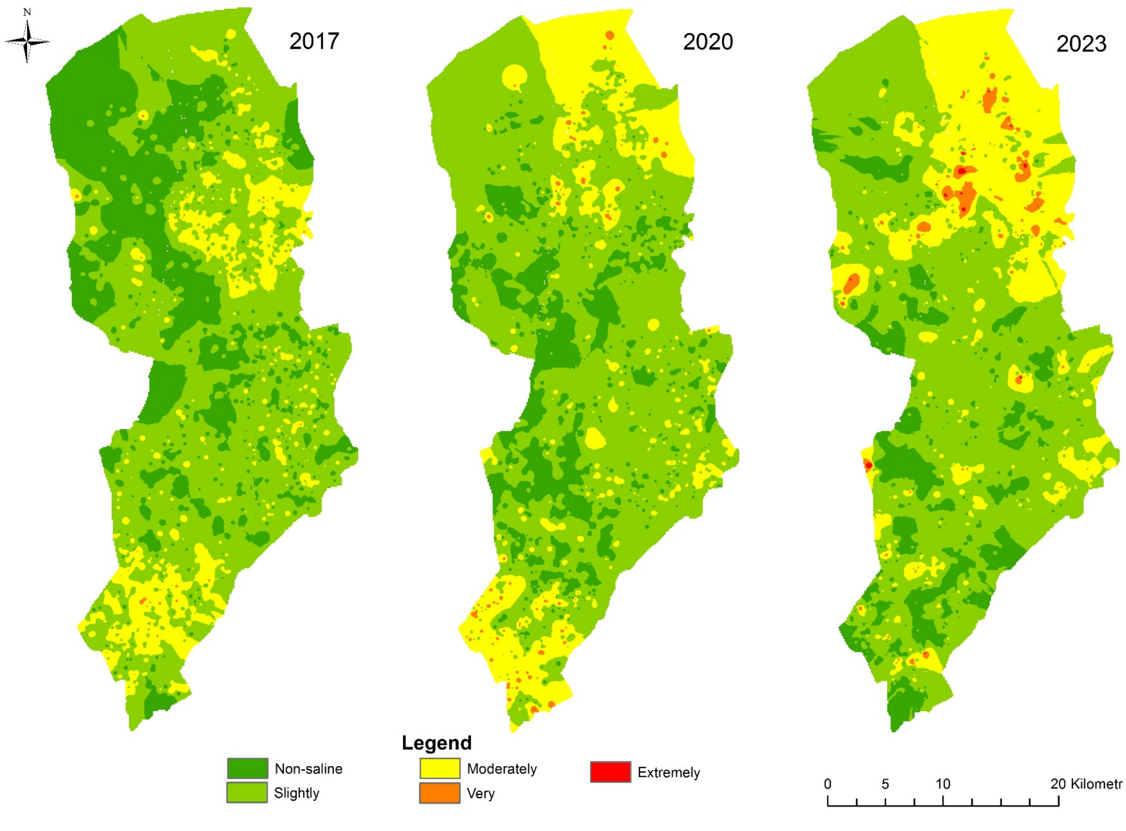

Fig 6. 2017, 2020, and 2023 salinity map of Karaozak district.

In the ArcGIS program, the research object was mapped over the years and placed side by side for visual comparison of the changes, which greatly helps in assessing which area the changes were strong and defining the area of future measures.

Conclusion

In short, the use of Geoinformation technologies in the determination and mapping of soil salinity allows operational identification and assessment of changes in the ground, and monitoring. In this paper, we started by building a database of soil samples, which, if correlated with remotely sensed spectral data, will help identify changes that are difficult to perceive in the future and negative impacts. Plays a major role in preventing secrets. Such studies are also of great importance in forecasting the correct implementation of agriculture.

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