

RESEARCH ON DYNAMIC EVOLUTION OF SOIL SALINIZATION IN TIANJIN COSTAL AREA USING REMOTE SENSING

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ABSTRACT

Soil Salinization is one of the most devastating land degradation in agriculture and environment all around the world. The salinization classification map composed of four stages of salinity can be generated using remote sensing technology. In this paper we propose a semi-supervised procedure for dynamic evolution monitoring of soil salinization in Tianjin costal area based on the use of Landsat data. The trends and extents of soil salinization for a period from 1989 to 2009 are investigated every 10 years. Compared with traditional 2-D spectral space of NIR-R bands, the results reveals that highly saline soils can be easily differentiated in NDVI-Brightness 2-D spectral space, which is a powerful tool for exploring salinization information in Landsat data. Mapping and monitoring soil salinization changes in arid and semi-arid regions by means of remote sensing is effective for producing detailed and accurate land degradation information.

Index Terms – Soil salinization, Tianjin costal area, Dynamic evolution monitoring, Spectral space

1. INTRODUCTION

Land degradation, which is a decline in land quality caused by human activities or natural disaster, has become a global issue [1]. Moreover, the soil salinization is one of the most challenging land degradation in agriculture and environment all over the world [1-7]. Saline soils can be detected on multispectral and hyperspectral remote sensing imagery because the soil surface is often affected when salinization happens. In visual image interpretation, the presence of saline soils is inferred from indicators like salt crust, poor vegetation, typical landforms and drainage condition. The study of dynamic evolution of soil salinization is quite a valuable topic.

2. DATA

The Landsat 5 TM multispectral images of three years (1989, 2001 and 2009) are used in our research, to analysis the dynamic evolution of soil salinization in study area for every 10 years, the study area locates in Tianjin costal area of China as shown in Fig. 1, where spreads large amounts of saline soils.

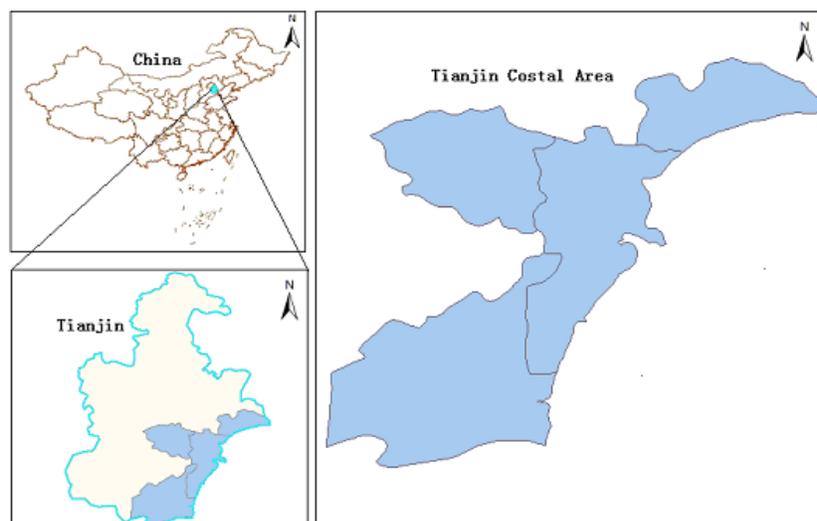


Fig. 1. Map of study area

3. NDVI – BRIGHTNESS SPECTRAL SPACE

Training samples of supervised classification are selected by interactive visual interpretation in 2-D spectral space. It reaches ideal classification results between different kinds

of landuse types, compared with traditional NIR-R 2-D spectral space scatter distribution, through Tasseled Cap Transformation [5], the 2-D space of NDVI-Brightness scatter points distribute like a trident as shown in Fig. 2(a).

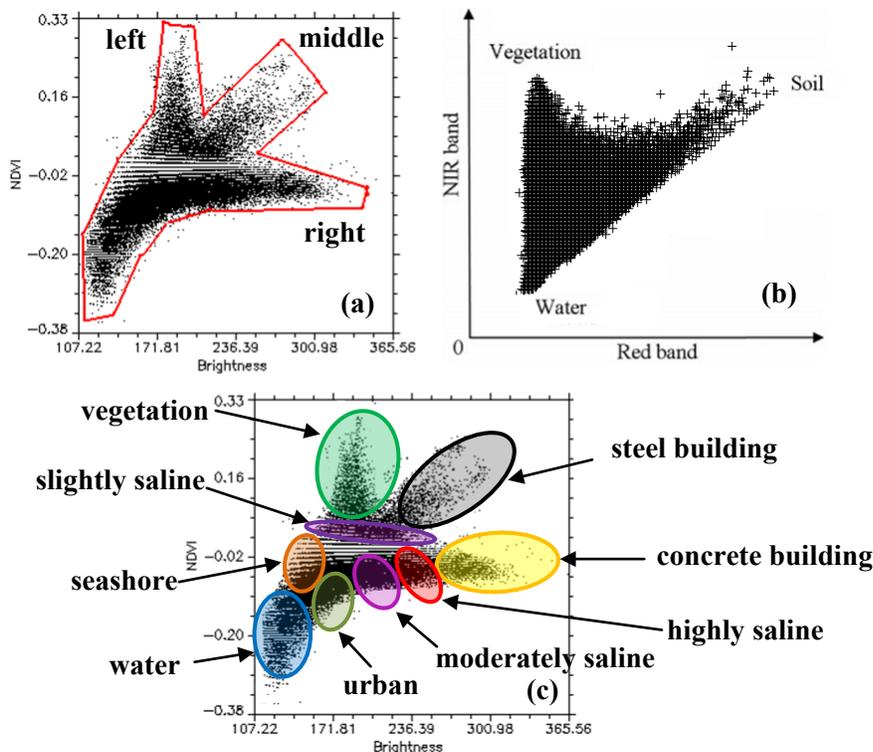


Fig. 2. (a): NDVI-Brightness space scatter plots; (b): NIR-R scatter plots; (c): interpretation results

As shown in Fig. 2(c), different part of the trident-like scatter plot represents different classes on ground. The left fork stands for vegetation, the middle fork for buildings made of steel like warehouse, gymnasium, etc. The right fork represents concrete structures like airport runway, the waist part of the trident stand for three stages of saline soils

and the root part represents water, between the waist and root parts are urban area and seashore.

As we can see, airport and highly saline soils are both with high reflectance, which makes it hard to distinguish them, but they can be easily differentiated in NDVI-Brightness space through Tasseled Cap Transformation.

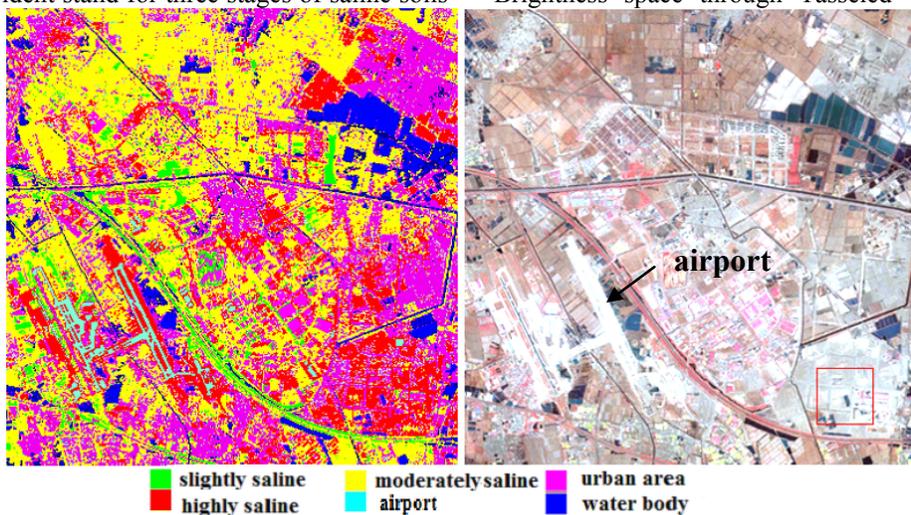


Fig. 3. NDVI-Brightness space interactive (Left: interpretation result, Right: False color composite)

Spectra Angle Mapping (SAM) is selected as supervised classification method for soil salinization investigation in study area, the overall accuracy reaches over 90%, and the Kappa coefficient comes to around 0.91. The total amount

of Tianjin costal area is 1406.9 km² in 2009, accounting for 46.2% of city of Tianjin, among them slightly and moderately saline soils take up 31.3%, highly saline soils for 12.3%, and extremely saline soils account for 2.3%.

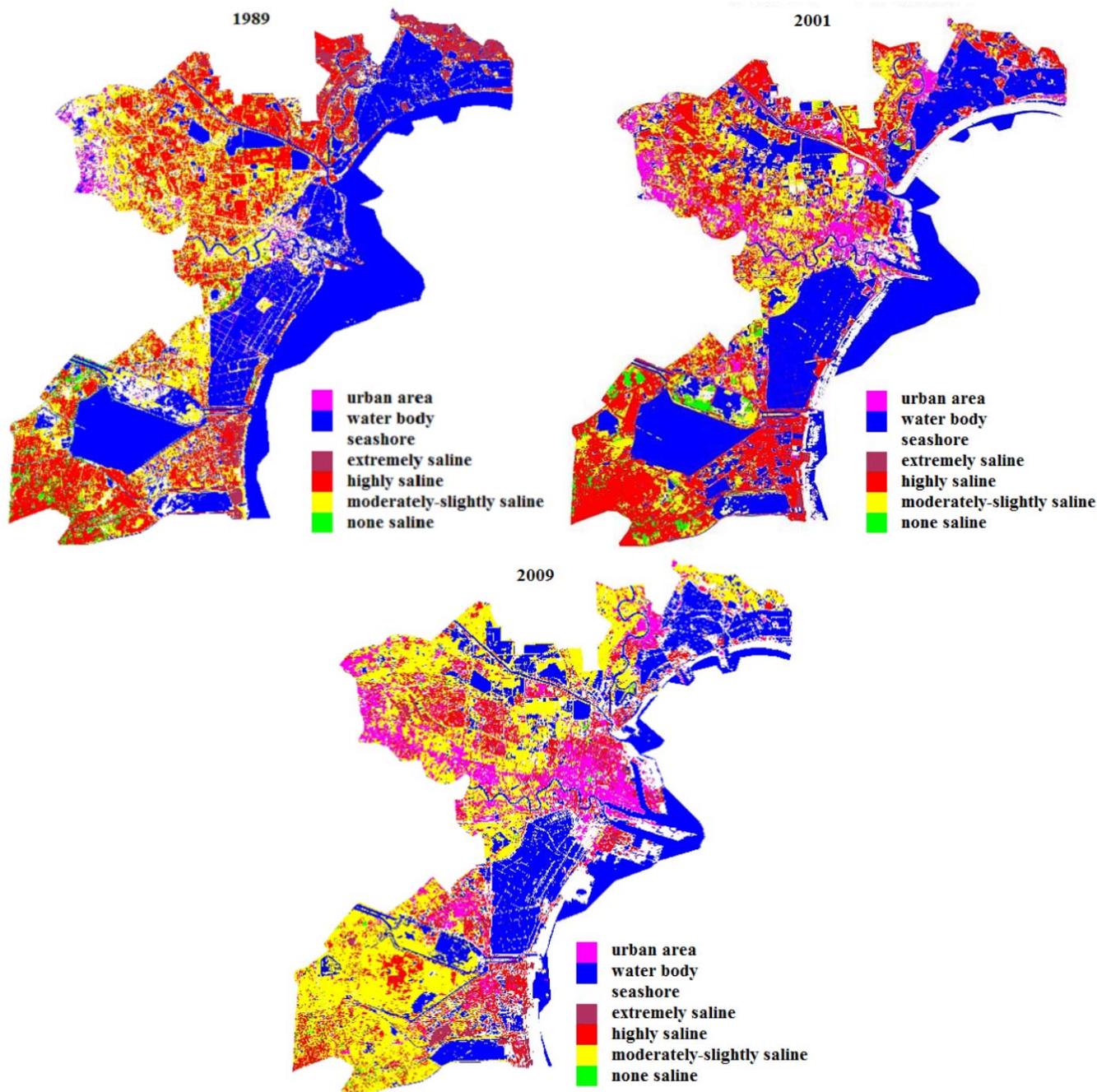


Fig. 4. Salinization evolution dynamic of 1989, 2001, 2009

The classification results are shown in Fig. 4 and Tab. 1. Under the joint influence of natural factor and anthropogenic factor, various class of saline soil formed different evolution regularity towards different directions from the year 1989 to 2009. The area of slightly and

moderately saline soils keeps increasing, and highly saline soils and extremely saline soils continue decreasing. Along with economic development and human-reduced social progress, urban land expanded steadily and the water area reduced continuously. Through the landscape index analysis,

we found that landscape of study area continuously segments and merges together, the patch fragmentation index and patch fragmental dimension increase, gradually

show a trend of generating more inlaid fragmented patches, which tend to be more and more heterogeneous and fragmented.

Tab. 1. Classification results of study area

category	1989		2001		2009	
	percent	area (km ²)	percent	area (km ²)	percent	area (km ²)
urban area	2.6%	79.7	5.1%	154	10.1%	308.4
water body	38.8%	1180.6	34.8%	1059.7	25.9%	787.4
seashore	13.3%	405.9	18.3%	556.5	17.5%	531.4
extremely saline	3.6%	108.1	2.7%	81.1	2.6%	80.6
highly saline	22.5%	685.7	17.9%	543.9	12.3%	373.2
moderately-slightly saline	17.4%	530	20.5%	624.4	31.3%	953.1
none saline	1.8%	54.9	0.8%	25.2	0.4%	10.8
total saline	43.5%	1323.8	41.0%	1249.4	46.2%	1406.9

4. CONCLUSIONS AND FUTURE WORK

In summary, soil salinization and its dynamic evolution is analyzed in Tianjin costal area in this paper, using remote sensing change detection techniques during a period from 1989 to 2009. Compared with traditional 2-D spectral space scatter distribution produced by NIR-R bands, by means of Tasseled Cap Transformation, scatter points distribute like a tridents in the 2-D space formed by NDVI-Brightness bands, in which highly saline soils can be easily differentiated in NDVI-Brightness space.

5. ACKNOWLEDGEMENTS

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