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Soil Types Extraction Based on MODIS Image

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Abstract

In the 1990s, the emergence of MODIS has caused to try new something in soil. This paper explores the soil extraction of secondary classification and accuracy based on computer supervised classification with MOIDIS data, topographic map and soil map data in fuyu country, heilongjiang province. The research indicates it's effective for using MODIS to extract soil speies classification and the extraction of homogeneous dividation can be realized and cultivates high accuracy, which indicates that MODIS spectral differences on soil target faint dividation have certain inversion ability and soil information extraction can be attained certain value of the classification results based on the spectral characteristics and auxiliary knowledge. It is a useful supplement for black soils secondary classification based on MODIS data and it is an effective means for black soil monitoring and protection.

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Keywords: MODIS, soil, soil species, information extraction

1. Introduction

The soil is a natural resources to humans. Along with the rapid population growth and the development of social economy, soil degradation has become the focus problem. Since 1970's, remote sensing technology has become an important means of resources environment and disaster dynamic monitoring. Affected by spectral resolution and visual interpreting project information of remote sensing data, the soil extraction technology was restricted in generalized survey in large scale and soil classification was limited to the unit of soil type. In the 1990s, the emergence of MODIS (moderate-resolution imaging spectral radiometer) has caused to try new something of remote sensing in soil detection [1-6]. Based on soil spectrum remote sensing information, such as albedos, vegetation index, soil classification, we have obtained certain achievements, but the applicability and its effect is still lack [7-9], especially for black soil. It is a useful try to explore the possibility and the accuracy of soil secondary classification based on

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MODIS image and it is important for dynamic monitoring and depth of remote sensing research based on MODIS images in soil.

2. Data acquisition and preprocessing

2.1. General research area

Fuyu county in Heilongjiang province, located at latitude 47 ° 18'24 "-48 º 1'48", longitude 124 ° 0'24 "-125 º 2'06", which is taken as a typical region of black soils. Because of cane and landform influence, it formed the zonal soil and the azonal soil. The zonal soils include chernozem, black soil and the azonal soils include meadow soil, wind sand soil, flood soil, etc. Among them, the largest area is chernozem which is for 43.27%, followed by meadow soil which is for 41.45%.

2.2. MODIS data preparation

According to the characteristics and the needs for soil extraction based on MODIS image, choose the image of 1-7 visible and infrared wavelengths MOD09Q1 and MOD09A1 data products in 2007 spring on May 25 - June 1. Data preprocessing include geographical correction, projection transformation and image cutting. This paper adopts double standards onical projection and WGS84 coordinate system and produces coordinate 250 meters resolution image data (refer with:fig.1).

2.3. Process of soil data and terrain data

Terrain is one of the important factors in soil formation. Fuyu landform varies considerably in tiny region. In order to improve the accuracy of classification and reduce the influence of the same ground feature with different spectrums or different ground features with the same spectrum on soil classification, the research generates a image with DTM (Digital Terrain Model) and 1:100000 soil map and rectifies it with the proceeded image.

3. Soil species information extraction

3.1. Soil sampling and classification system

Soil species is the basic unit of Soil genesis taxonomy. The same soil specie develops in the same cane, thus they have the similar development degree and profile levels arrangement, such as the main levels of permutation order, thickness, texture, structure, color, organic matter content and PH value and so on. Nonetheless, the difference among soil species is still probably cannot be accurately reflected by spectral radiant. It is necessary to establish soil extraction classification system according to the characteristics of remote sensing information. Based on the genetic soil database of 1:100000 and their mean spectrum curves extracted from remote sensing, soil specie can be extracted based on MODIS image, which is the soil secondary category. Jeffries-Matusita distance is the criterion to soil classification. According to J- M distance and spectrum characteristic analysis, poor soil classification training samples will be merged or adjusted. Being adjusted for the basic dividation, the last soil specie is for 21 types,including water, middle sticky bottom black soil, middle sticky bottom chernozem of carbonate, etc(refer with table 1)..

3.2. The evaluation of classification based on probability matrix template

Possibility matrix is the error matrix of evaluation classification accuracy. Research indicates that the overall percentage in classification error above 85% and template precision is more reasonable. The possibility of matrix evaluation results template of Fuyu refer with table1.

Table 1 The soil classification types and possibility matrix values

type	water	middle sticky bottom black soil	middle sticky bottom carbonate chernozem	thin sand loam carbonate chernozem	thin meadow chernozem	sand soil meadows soil	thin sticky bottom carbonate meadows soil
value%	76.48%	98.72%	92.4%	81.54%	57.24%	55%	91.35%
type	sand loam carbonate meadows soil	thin sue reach evapo-salinization meadows soil	high sue reach evapo-salinization meadows soil	thin sticky bottom carbonate gley meadows soil	shallow bits sue of alkaline substances meadow solonetz	brown hillock grass sand soil	brown flat born grass sand soil
value%	25.86%	96.45%	92.86%	71.62%	96.97%	81.4%	95.83%
type	gray hillock lime sand soil	thin layer lime meadows boggy soil	sand clip gravel bottom stuck meadows flood soil	meadows soil	thin layers of sand soil mass sticky bottom chernozem	sticky bottom carbonate chernozem	settlement area
value%	70.00%	91.38%	100%	89.75%	62.66%	71.51%	67.35%

3.3. Soil species information extraction

It is an important link for classification of remote sensing. The current remote sensing information extraction and recognition have formed some methods, such as the statistical pattern recognition method, syntax method, fuzzy method and neural network etc. For different characteristics of the various methods of research object, the significantly applicability is different [7,9]. According to remote sensing information extraction of practical application and maneuverability, this paper uses maximum likelihood and computer supervised classification method to ensure the accuracy of soil secondary category (refer with fig.2).

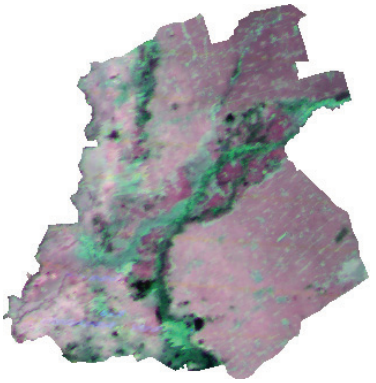

Fig.1 The projection transformation image

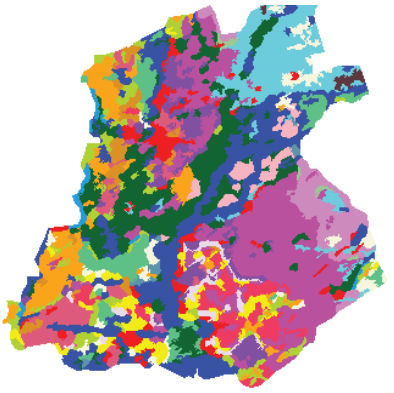

Fig.2 The soil classification figure

4. The accuracy testing and analysis of soil classification

Classification accuracy refers to the correctly degree of classification. At present the most widely measuring accuracy is Error Matrix by Congalton proposed, which the main classification precision indexes are production accuracy, user's precision, overall accuracy, leakage points error, wrong points error, etc. Because overall accuracy based on Error Matrix only use the diagonal elements and don't use the whole elements of Error Matrix, the comprehensive measure is still insufficient. Using Kappa coefficient index and choosing the sampling plan for validation sample data to produce confusing matrix to analysis maximum likelihood classifier, getting the classification overall accuracy and Kappa statistical values for 73.9% and 0.75(refer with table 2).

Results show that the overall classification dividation of the19 species is good. User precision and production accuracy of nine soil species is 90% above, such as middle sticky bottom black soil, thin sticky bottom carbonate meadows soil, brown flat born grass sand soil, etc. Dividation classification accuracy between middle sticky bottom black soil and sticky bottom carbonate chernozem is 80% -90%. Partial thin layer soil classification accuracy is for 60%-70%, such as thin sticky bottom carbonate meadows soil and thin sticky bottom carbonate gley meadows soil, etc. Because these soil species have the similar spectral features to its accurate distinguish difficulty bigger, the accuracy of classification is lower. Due to arenaceous qualitative characteristics and mixed pixels to spectral radiant of sandy loam quality thin layers soil species for its, their classification accuracy is low.

5. Conclusion

The research indicates it's an effective method to use MODIS to extract soil species. Information extraction of homogeneous dividation can be realized and cultivates high accuracy, which indicates that MODIS spectral differences on soil target faint dividation has certain inversion ability and soil information extraction based on the spectral characteristics and auxiliary knowledge type can be attained certain value of the classification results. This is a useful supplement for black soil secondary classification based on MODIS data, which provides a new clue for soil remote sensing resources detection

Table 2 The accuracy of maximum likelihood soil classification

type	user precision accuracy %	production accuracy %
water	81.23	76.48
middle sticky bottom black soil	98.72	98.72
middle sticky bottom carbonate chernozem	81.15	92.40
carbonate chernozem	76.83	81.54
thin meadow chernozem	54.33	57.24
sand soil meadows soil	69.34	55.00
thin sticky bottom carbonate meadows soil	94.78	91.35
sand loam carbonate meadows soil	30.21	25.86
thin sue reach evapo salinization meadows soil	97.00	96.45
high sue reach evapo-salinization meadows soil	90.67	92.86
thin sticky bottom carbonate gley meadows soil	68.94	71.62
shallow bits sue of alkaline substances meadow solonetz	95.58	96.97
brown hillock grass sand soil	82.30	81.40
brown flat born grass sand soil	96.99	95.83
gray hillock lime sand soil	72.27	70.00
thin layer lime meadows boggy soil	98.42	91.38
sand clip gravel bottom stuck meadows flood soil	98.64	100
meadows soil	94.61	89.75
thin layers of sand soil mass sticky bottom chernozem	74.91	71.62
sticky bottom carbonate chernozem	83.15	71.56
settlement area	76.27	67.35

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