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based on Landsat 8 Remote sensing image of the northern region of Changchun

Inversion of soil organic matter content

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Abstract: with Landsat 8 Remote sensing image to data source , using flaash atmospheric Correction Model Atmospheric correction of remote sensing images ,Combining field soil sampling Organic matter Assay Data , using stepwise regression analysis , quantitative inversion of soil organic matter content in the study area . results show , Soil organic matter content with Landsat 8 Remote sensing image reflectivity has strong negative correlation in near infrared band , An appropriate mathematical transformation of the reflectivity can effectively increase the correlation with the organic matter , The stepwise regression model established by this method , Its decision factor r2 =0. 925, Total root Variance Flmse =0. 171, describes the inverse The model has higher precision and stability . based on the above inversion model , Combining remote sensing image classification results , inversion of soil organic matter content in the study area , knot to show , content of soil organic matter in the study area showed a tendency of East High west , East , The content of soil organic matter in the South is generally higher than that of 3, and West , North Region Soil organic matter content is generally lower than 2%.

Keyword: Landsat8 OLI; organic matter ; Quantitative inversion ; multispectral Remote Sensing ; northeast of Changchun

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organic matter in soil (SOM) content is an important indicator of soil fertility. , Measuring the content of organic matter in soil is an important way to judge soil fertility . 1. The has a the content of the soil is very small. (is generally less than ten%), But a lot of research investigate proof , Organic matter in soil and parent material of soil , water content , Iron oxide Content and so on affect the spectral characteristics of the soil 2. Traditional soil organic content space prediction using spatial interpolation of sampling points to map the spatial distribution of organic matter Chart , This method has certain feasibility , but difficult to take into account a variety of soil factors to Spatial variability of organic matter content , cannot get objective soil organic matter Space distribution results .

Remote Sensing technology has a short data acquisition time , covers a wide range of , Informative Rich , Low production cost benefits , In recent years, many scholars at home and abroad have launched a benefit correlation Study on soil organic matter content with remote sensing technology , and a

certain research Results . in the selection of information sources , focused on multispectral

remote sense 3 and hyperspectral remote sensing [4-5] 2 way ; in the data processing and analysis method side face , main qualitative category [6-7] and quantitative inversion 8 2 way . Summary before people use hyperspectral remote sensing technology for soil research results can be seen :using the Spectrum The hyperspectral data obtained by the instrument can only be performed in fields or laboratories , Research Results practicality is not strong ; Inversion of soil organic matter based on hyperspectral remote sensing image , nitrogen et \ The study of has few attempts to , and higher acquisition cost of hyperspectral remote sensing image data , Strong correlation between bands , hard to get universal application ; use category methods only soil qualitative classification mapping , Difficulty in quantifying soil composition Analysis Purpose .

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This study takes the 2013 Year 2 the launch of the month Landsat 8 Land Imager (OLI) multispectral Remote sensing image to data source , test with field soil samplesdata , quantitative inversion, Nong ' an county, Changchun City, Jilin province , Dehui soil [Organic content , for regional soil quality monitoring , Sustainable use of land resources provide data support . The research area is located in the Dongbei Pingyuan black soil area and the saline-alkali soil area . take zone , East is the largest black soil region in China , is an important food production base in China On , Western White City and Songyuan West area is China's largest soda salt sodic area . so , monitoring soil organic matter content in the study area , can be a pre- Anti-soil degradation , Strengthening regional agricultural production management and sustainable land use for scientific basis .

1. Research Overview

Nongan County and Dehui in North Changchun , Central Hinterland of the Songliao plain , 124°36 ' ~126°24 ' E , 43°56 ' ~44°52 ' N , separates the Songhua River from the Yushu , Shulan County across, West vs Qianan County , Changling County borders , South and Jiutai , Changchun City phase even , North and Fuyu County adjacent ,temperate sub-humid monsoon climate , averages down Water ~500 mm , Average elevation ~200 m , Annual frost-free period 114 D , years of average temperature 4. 8Zhang , soil types are mainly black and Chernozem , Local soil has meadow soil , alluvial soil , Sand soil, etc. .

2. Research Methods

2.1 soil sampling and handling

2015 Year 5 Month 22- Day Soil sampling in the study area , Sampling points are evenly distributed in the study area , sampling process considering soil type and intersection Pass convenience , Get soil samples four (sampling route map 1), sampling point The overwrites the black soil area of the research area with the Chernozem area. soil sampling using the 4 Point Blending method Collection soil samples , Sample Depth is topsoil 0 cm , each tu ca 1 kg , to load soil samples into a sealed bag save . sampling with handheld GPS (GPS) receiver record sampling point space location , for To determine the point-to-point relationship between the sampling point and remote sensing image . to increase organic matter in soil samples

test accuracy of content , Dry soil samples in a lab , Grind , and remove the dirt with one potassium dichromate - organic compounds in sulfuric acid solution oxide samplessample

stones , plant roots , impurities such as animal residues , and the sample is passed 2 mm quality , excess potassium dichromate using ferrous sulfate titration , based on potassium dichromate consumption sieve . Determination of soil organic matter content using potassium dichromate - sulfuric acid , in the heating bar calculates the organic matter content in a sample .

2.2 Remote sensing data and data preprocessing

Landsat 8 is the latest model Landsat Series Earth Observation Remote sensing satellite star , by United States Geological Survey 2013 year 2 Month launch . The satellite carries a 2 sensor : 0 LI and Thermal infrared sensor (tirs), where OLI include 1 Sub resolution to m the panchromatic band of , resolution is m the visible and near of ir Band and 1 shortwave IR Cirrus Band , and tirs set 2 Thermal IR band 9-10 . This research select 2015 year 4 month [Day Landsat 8 Remote sensing image 1 King ,, track number is118 -029, Cloud coverage is 0.4%, and image preprocessing , Mainly includes image radiometric calibration , atmospheric correction , Geometric essence correction and image cropping . convert grayscale values of images to spokes in ENVI software brightness value , complete radiometric calibration ; uses the Flaash Atmospheric Correction ,corrected The main parameter settings : Atmospheric model set to Sub - Arctic Summer•, gas Sol model set to Urban, Aerosol inversion model is 2 - Band (K - T), visibility set to default (40) , entering correct image capture time , Research area average elevation etc ; on erdas software for geometric correction of images , School Positive error control in 1 a like ; on erdas Create interest in software area , and crop the image , obtain remote sensing image covering the research area .

2.3 inversion modeling and model validation

A large number of studies indicate that , to make the appropriate number of object reflectivity in remote sensing images Learning transformations can weaken the effect of noise in an image on the target Spectrum , enhanced reflectivity and its transformation form to soil composition , to Increase soil composition inversion precision [11-12] . In this study, the reflectance of atmospheric corrected remote sensing images Countdown (1 / opens) , logarithm LNL - Order Differential (T), countdown logarithm ln(1/Magic Math Transform , Building Spectrum index .

to randomly divide the collected soil samples into 2 Section : Modeling Sample , Ten Quarantine Samples . Take advantage of SPSS statistical analysis software , using Mathematical Statistics method for randomly selected model samples soil organic matter content and reflectance and its change Change form for statistical analysis , Get the dependencies for both , and multiple regression Analysis Method , to establish an inversion model of soil organic matter content .

The validation of the inversion model includes the 2 Aspects : to reverse the precision of the model , Stable and model predictive capabilities , with decision Factor R2 and total root variance (RMSE) for validation . Model decision factor r2 between 0 (model Precision worst , most unstable set) and 1 (model precision highest , most stablebetween, decision factor r2 The greater the model more stable , Precision Higher ; The predictive capability of the model takes a test sample total root Variance (RMSE) to verify ,ftmse smaller , The greater the predictive power of the model , Fine degrees are higher . Statistically speaking , one A good predictive model ,r2 should do the Large ,and RMSE should be as small as possible .

2.4 Research Area soil decision tree Classification

Decision Tree (decision tree) also known as decision Trees is A common method of the Current Remote sensing image qualitative classification. Each of the internal nodes in represents a property's 1 Secondary Test , each side represents 1 test Results , The leaf node represents a class or the distribution of classes . This study uses decision tree sorting method , introduce normalized Differential vegetation index (NDV /) , normalized town index (NDB /) , normalized difference Water index (mndw /) , and so on, see (1), (2), (3)] multiple points class indicator , Combining Research Area main feature in Landsat 8 Light in remote sensing images Spectrum features , Qualitative classification of cultivated land and bare soil areas in the study area , to Reverse soil

3. Results and Analysis

3.1 Correlation Analysis and regression modeling of reflectance and soil organic matter content Correlation analysis reveals variable statistics in numerical or graphic terms

The strength of the relationship , to obtain a significant correlation between soil organic matter content and reflectivity band , to Improve the accuracy of soil organic matter inversion . This study will soil sample Organic matter assay data and spectral reflection of corresponding sampling points in the image rate correlation analysis .

diagram 2 Displays , organic matter content in soil and Landsat 8 images 7 Bands The reflectivity of the, is negatively correlated . where , Soil organic matter content with page 6 band phase off best , correlation r = -0. 853, decision Factor R 2 =0. 728, P value = 0.000, Has reached a significant level . next to page 7 band , correlation r = -0.837,decision Factor R 2 =0.701, P value =0.000, Has reached a significant level . second to page 5 band , coefficient r= -0.821, decision factor r2 = 0.675, P value =0 . . organic matter content with the first 1 band correlation worst , correlation Factor r= -0.216,P value =0.441, does not reach a significant level .

uses the Landsat 8 remotely sensed image 2~ 7 band reflectivity , take step regression method , Establishment of inversion model of soil organic matter content :SOMcontent = 9.215 XM4 -A. 059 xM6 +4. 116, The decision factor for the model r2 = 0.824,P value = 0.000, reached a significant state , Total root Fangcha said = 0.247.

An inversion model of organic matter content is established using reflectivity , by test sample on Landsat 8 corresponding reflection in remote sensing image , get 10 test Samples Prediction of soil organic matter content , To set up a scatter chart with the measured value . Chart 3 show , The predicted value of the test sample is distributed evenly with the measured values 1 : 1 line sides , decision factor R2 =0.941,P value =0. , Has reached a significant state , Total root variance only MSE = 0 . 166.

3.2 correlation Analysis of the form of reflectance transformation and soil organic matter content and back model to Countdown the reflectivity , logarithm , First-order differential , The logarithm of the countdown , of the logarithm First order differential mathematical transformations, study their correlation with soil organic matter content , soil reflectance and the corresponding characteristic bands of each transformation form and each analysis index with a "" the correlation coefficient of the machine mass content is as table 1 shows , Results Display , to enter the reflection image into line Countdown , log , after the logarithm change of the countdown , A phase of the soil organic matter content The off has varying degrees of improvement . where , countdown to minus , The logarithm of the countdown transformation is positively correlated with soil organic matter content , and the logarithmic transformation of the reflectivity with the soil Soil organic matter content negative correlation , correlation coefficient up to -0.941. Image Reflection rate after first differential , the correlation between and soil organic matter content Although also up to to significant level , but less relevant to organic matter content than before transformation , and the correlation of the first order differential of the reflectivity logarithm with the organic matter content is compared to the prior transformation no significant improvement .

returns the reflectance and its transformation form to the content of soil organic matter . parsing , setting up inversion model of soil organic matter content : SOMContent = -16. 187 XM6 +0.139 /M7 -0. The x (lnm2) ' + 6 . 467, Model decision Factor r2 = 0. 925, P value = 0. , up to a Significant status , always root Variance RMSE = 0.171.

an inversion model of organic matter content based on reflectance and its transformation , Based on The reflection of the location of the test sample , calculates the sample organic matter content Predictive value , Set scatter chart with measured values , As shown in figure 4 shows , to verify the forecast value of the sample is evenly distributed with the measured values 1:1 line sides , decision

factor r2 = 0.965, P value =0. , Has reached a significant state , Total root Variance RMSE = 0. 119, DescriptionThis inversion model can well reverse the soil organic matter content in the study area .

Review 3. 1 and 3. 2 section inversion model Precision , To Select A Landsat 8 inversion model of soil organic matter content based on image spectral index , inversion Research Area soil organic matter Content , and charting , get Changchun North China Spatial distribution and pattern of soil organic matter content . diagram 5 show ,Research Area soil Soil organic matter Content distribution , space difference , Eastern Region soil organic matter content significantly higher than western Region , East , The soil organic matter content in the southern region is general above 3%, and West , The soil organic matter content in the northwestern region is generally lower than the 2 % , especially northwest of the research area (Nongan County Northwest and Songyuan border region), Soil Soil organic matter content at low level , even less than 1%. based on soil field investigate the, Research area The eastern region is in the edge of our black soil region , low ground ping , soil surface is soft dark humus layer , soil fertile , is our important food production base , Therefore, the inversion value of soil organic matter content is higher ; Research area West Department , north to Chernozem area ,and close to China's largest soda-saline soil region , side surface soil organic content is lower (less 2 %), The higher on the other hand salt obscures spectral characteristics of organic matter in soil , make Nongan County West , North - The inversion value of soil organic matter content in the area is lower .

methods to study the spatial distribution of organic matter content in topsoil by remote sensing method has characteristics such as time-saving and high reliability , for soil environment monitoring and can the continued use of has opened up a good avenue . Research at home and abroad generally recognized to , The spectral characteristics of organic matter in soil are mainly manifested in the absorption of organic matter to incident light , The soil reflectivity decreases with the increase of organic matter content. , but The reflectance bands and estimating models selected during the estimation of organic matter content Aspect , Differences between scholars ' findings ,But the overall trend is the same . Ben - Dor through the study that , Soil organic matter content to the entire visible light , near infrared , reflectivity in shortwave infrared bands will have an effect [a] ; Karnieili Research findings , soil organic matter absorption characteristics are mainly reflected in near-infrared band , and and on 1.720, 2. 180, 2.309 pm Peak absorption at [i ; Li Runlin in using TM Remote Sensing Image study on spatial distribution of soil organic matter in Shulan , soil organic matter content andTM Remote Sensing image page 4 (Wavelength is 0. A ~ 0.90 pm),,, 5 (wavelength to 1.55 ~ 1.75 pm,-)first 7 band (Wavelength is 2.08~2.35 pm) reflectivity correlation significant []] ; Zeng Yuawen use ETM + Remote Sensing image inversion of soil organic matter content in Xuzhou mining area , Soil Organic mass content with ETM / +image page 7 Band (wavelength 2. ~ 2.35 pm),, 5 band (The wavelength is 1.55 ~1.75 pm) reflectivity dependency good [[] ; Liu Jiao people with ASD Portable high-level spectrometer for determination of upstream area of Heihe watershed soil spectral reflectance , Results of correlation analysis with soil organic matter content show , organic matter content with visible light (Wavelength Range 0.630 ~0.690 pm), close to Infrared (Wavelength Range 1.550 ~1.750 pm) spectral range reflectance has a more thanstrong Correlation [to]; Zhangfaha The use of remote sensing technology to estimate soil organic matter content To indicate that , to log reflectivity to the , , and so on, can be significantly improved with the The correlation coefficient of the machine mass content [3 - 418]. and this study shows , organic matter in soil content differences inLandsat 8 visible light and near-infrared bands all have a strong expression , Research Area soil organic matter content with Landsat 8 page 6 band (wavelength is 1. 560 ~1.660 pm) correlation factor up to maximum , Second 7 band (Wavelength 2. ~2 pm) and 5 band (The wavelength is 0.845 ~0.885 pm); to Countdown the reflectivity ,logarithm , A mathematical transformation of the logarithm of the countdown

after , to display Increase correlation to organic matter content , Conclusions similar to those of previous studies or similar , But there are differences in the inverse model that is established , may be the reason for the remote sensing number to different , The selection of the model and the difference of soil in the study area are related to .

This study uses multivariate stepwise regression analysis to establish soil organic in the research area mass content regression model , Retrieving soil organic matter in the North-central area of Changchun City with amount , Achieve good forecast , The is used to examine the predicted and measured values of the sample also has better dependencies , main reason : (1) for analysis remote sensing image obtained take time to 4 month , the arable land in the study area for the fallow period , bare surfaceDew without freezing and snow , So the remote sensing image shows a bare soil . The spectral information , No vegetation , Effects of permafrost and other factors ;(2) Soil sampling point evenly distributed in study area , can represent the contents of the soil organic matter in the study area distribution , facilitates the establishment of the inversion model .

however , test Sample organic matter prediction value and real obtained by regression model There is a Certain error in the measured value , reason for : (1) uses the Flaash Atmospheric correction mode For Atmospheric correction of remote sensing images , by atmospheric model and aerosol mode type selection , Input error of parameters such as average elevation and atmospheric visibility in the study area affect , can cause errors in the atmospheric correction process ; (2) because failed to getsame Remote sensing image as sample time , to make soil organic content in the study area Retrieved remote sensing image (imaging time 2015 year 4 Month Day) and soil sampling (2015 year 5 month 22- Day) has a certain time difference , Study later The procedure should choose the same synchronized remote sensing data as the sampling time to increase the anti Perform the precision .

This study takes the Landsat 8 Remote sensing image to data source , The reflectance of soil in remote sensing map image and its various transformation forms for spectral analysis index , United Wilderness Organic matter assay data for soil sampling , with page 2 band reflectivity logarithm First Order differential , 6 band reflectivity , 7band reflectivity countdown to self variable , using multivariate stepwise regression analysis to establish soil organic content in the study area reverse model , back to the north of Changchun City Nong ' an County , Dehui Soil organic matter with quantity . results show , side of stepwise regression analysis using multiple spectral spectrum indices The organic matter inversion model established by the method has higher precision and stability . inverse results show , The content of soil organic matter in the study area is the trend of East High west and low. , the content of organic matter in southeastern region is generally higher than 3%, and Northwest region organic matterContent is generally lower than 2%. use Landsat 8 multispectral Remote sensing data inversion surface layer Soil organic matter content can make good predictions , to get soil parameters provides a quick and efficient way .

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