A SIMPLE METHOD FOR INFORMATION EXTRACTION OF FARM FIELD IN TARIM RIVER BASIN USING MODIS DATA

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ABSTRACT:

High spatial resolution remote sensing data are expensive and hard to cover the whole basin at the same time in Tarim river basin, while, the low spatial resolution data, such as MODIS, which spatial resolution of first (red) and second (infrared) band are 250 m, may cover the whole basin in same day. In this paper, based on previous models and methods, we compared the remote sensing Vegetation index, NDVI, RVI and MSAVI (250m), which are thought most efficiently parameters and have been used widespread in arid and semiarid area. Analyzing changing rule of soil, sparse natural and farm field of underlying surface, we put forward a new method: calculating stand deviation using time series MODIS RVI data from April to October. Compared with extracting farm information method of previous classification method and principle component analysis method using time series MODIS data, the method is more efficient than others, and the accuracy exceed 80%, which verified by Landsat TM data and actual measurement by GPS.

1. INTRODUCTION

Water is the foundation of the composition, development, and stability of oasis ecosystems in arid areas [1]. It determines the evolution of the ecological environment, including the two contrary processes of oasis formation and development and of desertification, and it is the key ecological factor in arid areas [2]. It is widely recognized that human activities will affect water resources and hydrological processes. Located in the arid area of north-western China, Tarim River, about 1321 km long, is the longest continental river in the world. It is mainly fed by glacial/snow melt water, which accounts for 48.2% of the total water volume in the basin [1]. The ecological environment in the Tarim River Basin is extremely vulnerable. The contradiction between ecological protection and economic development is increasingly extrusive in the exploitation and utilization of water resources, and the sustainable development of the regional society and economy is seriously restricted [3-5]. Significant improvements have been made in regulating the main stream of the Tarim River for flood control and water supply mainly for agricultural purposes during the past several decades. These improvements have made a great contribution to the development of the economy in Tarim River Basin [2]. However, its negative influences such as deforestation, desertification, and increased soil salinity have also been considerable. Some eco-environmental problems including the serious degeneration of the natural vegetation that relies on groundwater for existence, the death of the herbs dominated by *Phragmites* the degeneration of *Tamarix chinensis* shrubbery and the *Populus diversifolia* forests in large areas, serious wind erosion and land desertification, as well as the seriously damaged ecosystems [6]. Both local and central governments have paid significant attention to the altered hydrological regime of Tarim River ecology. In an attempt to restore the ecological system, ecological water releases from Boston Lake through Daxihaizi Reservoir were carried out several times [7]. It was realized that these water releases were beneficial to the potential restoration of the ecosystem.

But farm field water consumption is much larger than natural vegetation in same area, so flood control and water supply mainly for agricultural purposes during the past several decades, the ecosystem still is facing deterioration [2，7]. When water supply for field isn’t enough, some field farm would be abandoned, new ecological problems appear again [5], So information extraction of farm field in Tarim River Basin is important to decision making of both local and central governments.

Compared with methods of other investigation, application of remote sensing data is more efficient and timesaving. High spatial resolution remote sensing data, such as Landsat TM, are hard to cover the whole basin at the same time, and the low spatial resolution data, such as MODIS, which spatial resolution of first and second band are 250 m, may cover the whole basin everyday. In this paper, based on previous models and methods, we compared the remote sensing Vegetation index, NDVI, RVI and MSAVI (250m), which are most efficient parameters and are used widespread in arid and semiarid area, and selected NDVI and RVI as basic data of information extraction.

2. SELECTION OF REMOTE SENSING VEGETATION INDEX

Currently, the remote sensing Vegetation index, NDVI, RVI and MSAVI (250m), are most efficient parameters and are widespread used in arid and semiarid area.

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$$NDVI=(NIR-RED)/(NIR+RED) \quad (1)$$

$$RVI=NIR/RED \quad (2)$$

$$MSAVI=((2NIR+1)-((2NIR+1)^2-8(NIR-RED))^{1/2})/2 \quad (3)$$

So we compared the three kinds of vegetation index. The analysis is as following:

Ground object / index	Soil 1	Soil 2	Incrusted soil 1	Incrusted soil 2	Vegetation in water 1	Vegetation in water 2
RED band	0.26	0.25	0.381	0.399	0.047	0.058
NIR band	0.287	0.283	0.406	0.422	0.087	0.091
NDVI	0.04936	0.061914	0.031766	0.028015	0.0298507	0.221477
RVI	1.103846	1.132	0.065617	1.057644	1.851064	1.568966
MSAVI	0.03509	0.043345	0.028027	0.028293	0.072637	0.058759

Table 1. the comparison and analysis among various representative vegetation index

Ground object / index	Vegetation in water 3	Vegetation in water 4	Vegetation in water 5	Vegetation in water 6	Natural vegetation 1	Natural vegetation 2
RED	0.058	0.066	0.074	0.077	0.14	0.114
NIR	0.177	0.075	0.107	0.154	0.349	0.329
NDVI	0.506383	0.06383	0.18232	0.333333	0.427403	0.485327
RVI	3.051724	1.136364	1.445946	2	2.492857	2.885965
MSAVI	0.207608	0.015871	0.057046	0.130821	0.298726	0.321811

Table 2. the comparison and analysis among various representative vegetation index（renew 1）

Ground object / index	Natural vegetation 3	Natural vegetation 4	Natural vegetation 5	Natural vegetation 6	Natural vegetation 7	Natural vegetation 8
RED band	0.203	0.195	0.229	0.143	0.092	0.174
NIR band	0.263	0.287	0.314	0.298	0.29	0.364
NDVI	0.128755	0.190871	0.156538	0.351474	0.518325	0.35316
RVI	1.295567	1.471795	1.371179	2.083916	3.152174	2.091954
MSAVI	0.08317	0.127175	0.112148	0.226332	0.312402	0.258611

Table 3. the comparison and analysis among various representative vegetation index（renew 2）

Ground object / index	Natural vegetation 9	Natural vegetation 10	Natural vegetation 11	Natural vegetation12	Field farm1	Field farm 2
RED band	0.208	0.302	0.177	0.245	0.061	0.085
NIR band	0.341	0.376	0.306	0.352	0.441	0.376
NDVI	0.242259	0.109145	0.267081	0.179229	0.756972	0.631236
RVI	1.639423	1.245033	1.728814	1.436735	7.229508	4.423529
MSAVI	0.17671	0.088996	0.180192	0.136735	0.58767	0.445447

Table4. the comparison and analysis among various representative vegetation index（renew 3）

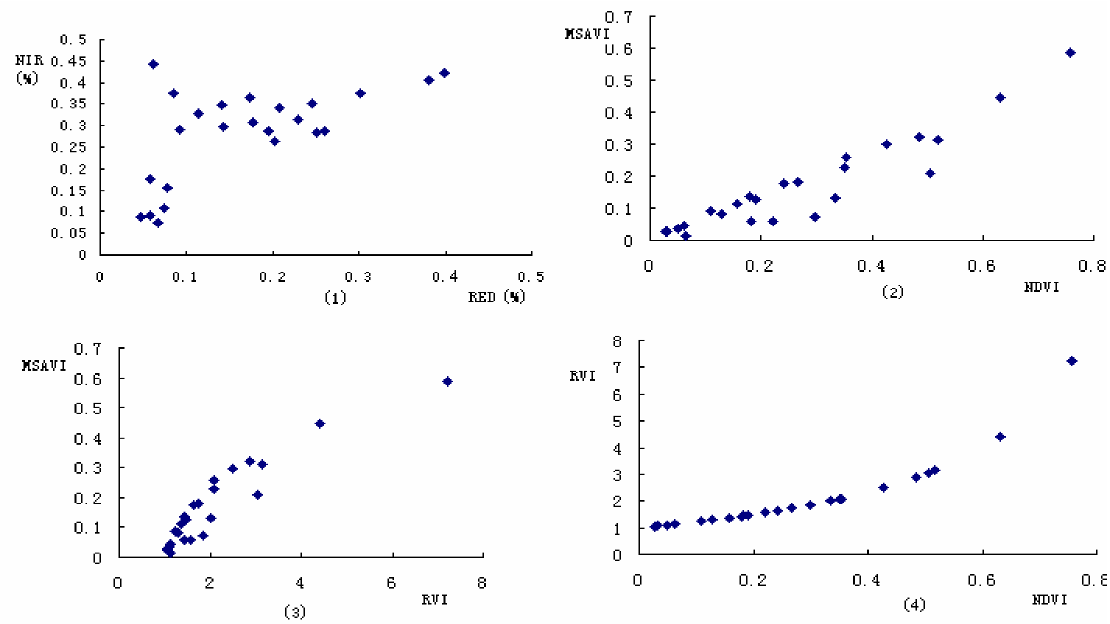

Figure 1. comparison among feature spaces from various vegetation indexes above mentioned

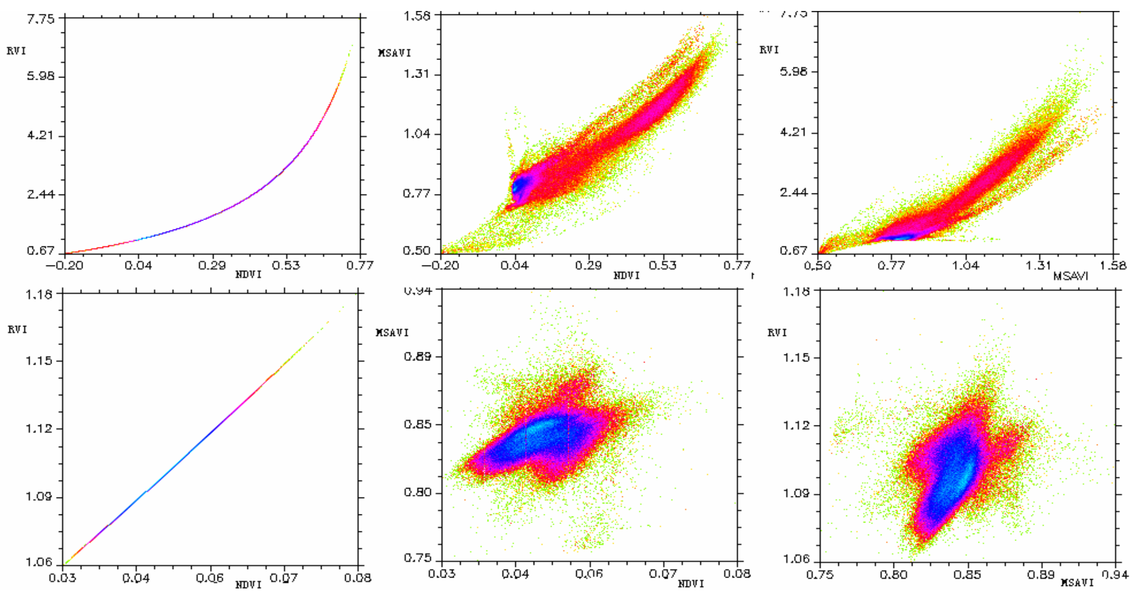

Figure 2. comparison among feature spaces from various vegetation indexes above mentioned

According to the figure 1 and 2, the vegetation NDVI may exaggerate the information of low coverage vegetation and inhibite that of high coverage vegetation such as field farm, but the vegetation index RVI is inverse to that of NDVI. As to MSAVI, it is between NDVI and RVI. So the vegetation index NDVI is effective to research the total areas of vegetation in Tarim river basin.

3. MODEL, VERIFICATION AND RESULT ANALYSIS

The remote sensing vegetation index always changes with life process and growth periodic time of vegetation from bud bursting, growth to wilting. So we thought that remote sensing vegetation index of life process or growth of green vegetation would change, but the soil and litter would not cause spectral changes. In this paper, based on previous models and methods, we compared the remote sensing Vegetation index, NDVI, RVI and MSAVI (250m), which are most efficient parameters and are used widespread in arid and semiarid area, and selected RVI as basic data of information extraction through their comparison. According to above analysis, we presented standard deviation model using time serious MODIS vegetation index RVI. The time series MODIS RVI products (every 16 day) was selected from April to October. The methods were as following:

standard deviation model：

$$\sigma = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} p_i^{2} - \frac{\left(\sum_{i=1}^{n} p_i\right)^{2}}{n}\right]}$$

In the formula, p_i refers to RVI value of the pixel, n is the number of time serious.

Histogram threshing method was used to threshold value set of standard deviation model according to historgram of stand deviation of time serious MODIS RVI data. First, analyzed shape of histogram, then determined possible cut-off point of farm field and non-farm field through special peaks of variance and mean value, finally, selection of cut-off point of farm field and non-farm field was determined by actual measurement by GPS and classification data by Landsat TM.

The farm field information is extracted using above model and method, the result is as following (Figure 3(1) RVI-VAR). Compared with stand deviation of time serious MODIS NDVI data (Figure 3(2) NDVI-VAR), time serious first PCA (Princle Component Analysis) MODIS NDVI (Figure 3(2) RVI-VAR) and RVI (Figure 3(2) NDVI-VAR) data.

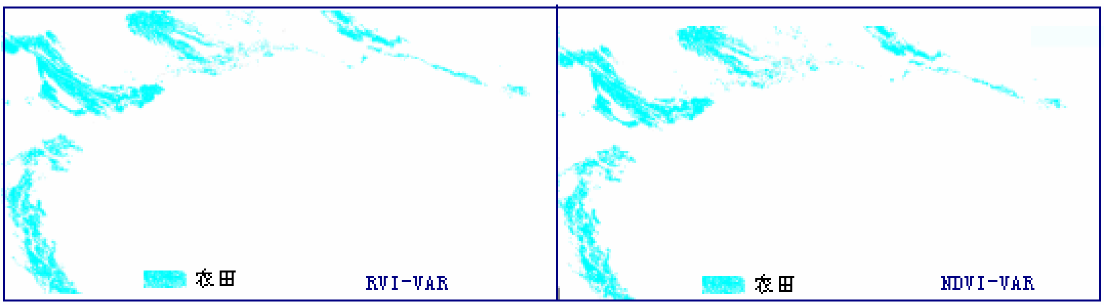

Figure 3（1）extraction of the farm field information through standard deviation model of time serious RVI and NDVI

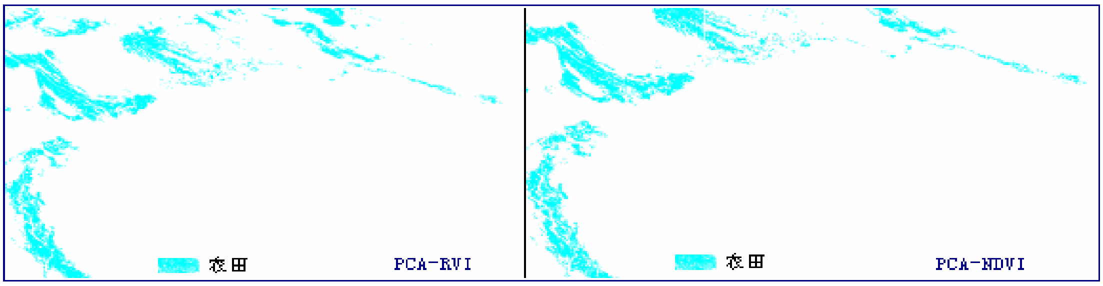

Figure 3（2）extraction of the farm field information through time serious first PCA of RVI and NDVI

Figure 3 various method for extraction of farm information

Compared with extracting farm field information method of previous classification method and principle component analysis method using using time series MODIS data, the variance method is more efficient than others, and the accuracy exceed 80%, which verified by Landsat TM data.

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