Spatial Heterogeneity of Soil Moisture and Vegetation Cover in Shiyang River Basin, Northwest China

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Abstract. Landsat TM remote sensing images were used to calculate and analysis distribution characteristics of soil moisture and vegetation cover in Shiyang River Basin in 2010. According to the images and reference to the general method, the vegetation index of Shiyang River Basin was divided into bare land, sparse vegetation, moderate vegetation and lush vegetation. Besides, the direct effects of different soil moisture on vegetation cover were also analyzed according to the spatial distribution characteristics of soil water. The results showed that the ecological environment in Shiyang River Basin was further deteriorating in the past, the production capacity of land was decline in the research period.

1. Introduction
The vegetation coverage refers to the percentage of the vertical projection area of the vegetation in the unit area [1]. It is not only an important indicator to measure the status of ecological environment, but also an important parameter in many soil erosion models [2]. Obtaining the information of surface vegetation cover and its change is of great significance for estimating soil erosion and evaluating the regional ecological environment. Soil moisture is not only vegetation and crops directly the water resources, land productivity, and in mutual role of the interface between the surface and the atmosphere, control and regulate the interactions between the atmosphere and the ground, on vegetation distribution plays a decisive role in [3]. According to the distribution of soil water content, the coverage of vegetation can be reversed.

In the northwest arid inland river basin, the ecological environment problems caused by the exploitation and utilization of water resources have been a long time, which is almost always accompanied by the development of human society. In recent years, ecological environment of the arid inland river basin is getting worse, with the rapid development of natural oasis in the lower reaches of the basin of atrophy or disappear, terminal lakes have dried up, land desertification. Moreover, the economic development and social stability of arid region were restricted by poor ecological environment for a long time. The change of vegetation coverage in arid and semi-arid area can cause a series of changes in the near surface layer [4]. Shiyang River Basin in the natural ecological environment sensitive area of climate and fragile, in recent decades, with the increasing human activities and climate change, excessive harvesting of groundwater resources excessive exploitation, the forest resources and land resources over exploitation, within the region's natural ecological environment is getting worse, especially in recent ten years, the natural ecological environment

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deterioration has exacerbated the trend. The vegetation is a sign of degradation of Minqin oasis water ecology and integrated ecosystem characteristics [5]. Reveal the Shiyang River in the past ten years vegetation changes in the number and spatial change characteristics, clear changes its direction, the correct evaluation of the Shiyang River basin development process and status, oasis soil and water resources management and sustainable utilization of decision-making and protection of the ecological environment have scientific significance.

2. Study area
The Shiyang river basin (101°22´-104°16´E and 36°29´-39°27´N) is one of the three inland river basins in the Hexi corridor, lying in the east of the corridor, Gansu Province, north of the Qilian mountains and between the Badanjilin desert and the southern part of the Tenggeli desert. The basin occupies an area of 4.16 ×104 km2 and includes seven counties. The basin is located in continental temperate zone with arid climate and variable topography. The annual precipitation is 100–600mm, whereas the annual pan evaporation is 700–2600 mm. The Shiyang River originates from the Qilian Mountains with eight tributaries, which are mainly fed by rainfall; snowmelt and glacier melt in the Qilian Mountains. Influenced by the climate, eco-hydrology, landscape and other natural conditions, the soil and vegetation types of the basin form an obvious vertical spectrum of soil-vegetation.

3. Data material and processing
TM 2010 remote sensing image was used to study the change of vegetation cover and the distribution of soil moisture content. Vegetation indicates were extracted from the multispectral remote sensing data of the earth surface vegetation cover quantitative numerical, the normalized difference vegetation index (NDVI) for monitoring vegetation changes as the index. The formula is:

\[
\text{NDVI} = \frac{(\text{CH}_2 - \text{CH}_1)}{(\text{CH}_2 + \text{CH}_1)}
\]  

(1)

In the formula, NDVI is the normalized difference vegetation index; CH2 and CH1 are the visible light and near infrared reflect values respectively.

Based on image and comprehensive method, the vegetation index of Shiyang River Basin is divided into bare land, sparse vegetation, moderate vegetation, and lush vegetation. For criteria for the classification of the TM remote sensing images of vegetation index, land (NDVI is less than or equal to 0), sparse vegetation (0<NDVI less than or equal to 0.2), moderate vegetation (0.2<NDVI is less than or equal to 0.7), dense vegetation (NDVI> 0. 7), the standard for NOAA data of vegetation index for: bare land (NDVI is less than or equal to 0), sparse vegetation (0 <NDVI is less than or equal to 0.1), moderate vegetation (0.1<NDVI is less than or equal to 0.4), lush vegetation NDVI>0.4. Then using ERDAS software for calculation, were extracted from the four levels of distribution. The remote sensing inversion of soil moisture using Ts/NDVI method for slope of Shiyang River Basin Analysis of soil moisture. The TS / NDVI slope method, Moran found scattered point diagram is a trapezoid, under the same atmospheric and surface moisture conditions, different surface types with different TS / NDVI slope and intercept [6], according to the value of each pixel to the edge of the dry and wet edge distance and dry wet soil moisture, equations can be obtained[7] :

\[
\text{RSM} = \frac{\text{RSM}_w - \text{RSM}_D}{\text{T}_D - \text{T}_w} \text{T}_D - \text{T}_w
\]  

(2)

\[
\text{RSM} = \frac{\text{RSM}_w - \text{RSM}_D}{\text{T}_D - \text{T}_w} (\text{RSM}_w - \text{RSM}_D)
\]  

(3)

In RSM said a pixel relative soil water content, RSMW is maximum soil relative water content (RSMW=100%) and rsmd is minimum relative soil water content; t is the surface temperature of a pixel estimation value, TW is on behalf of the minimum surface temperature, TD is the highest surface temperature.
4. Results and Discussion
Combination of different vegetation index using satellite images, the band calculation can be used to monitor the status of plant growth index [8-9]. In recent years the rapid development of remote sensing technology produced many new vegetation index, the normalized difference vegetation index NDVI (normalized difference vegetation index) was still with its unique advantages in vegetation remote sensing in the most widely used [10-11]. The vegetation map of Shiyang River Basin was shown in figure 1.

![Figure 1. The vegetation cover distribution in Shiyang River Basin](image)

The Shiyang River watershed vegetation cover distribution diagram of extraction of Shiyang River Basin, vegetation index data and draw out the Shiyang River Basin, vegetation types change trend chart. As shown in figure 2, from the figure available in Shiyang River Basin bare land area accounts for the total drainage area of 45.85%, sparse vegetation area accounts for 29.59% of the total area, moderate vegetation area occupies a total area of 21.64%, dense vegetation area accounted for a total area of 2.92%. Thus the bare land accounted for the largest area of Shiyang River Basin.

![Figure 2. Different vegetation coverage area distribution](image)

According to the index of the vegetation in Shiyang River Basin distribution of inversion in Shiyang River basin soil moisture map (figure3), the inversion results show that soil water in Shiyang River Basin water in the dense forest area of soil water content was higher, in sparse vegetation area soil moisture content is low, and in bare land in the area of soil moisture content was the lowest. In the calculation formula, the minimum soil water content is RSMD=4%, the maximum soil moisture content is RSMW=100%.
Figure 3. Map of soil water distribution in Shiyang River Basin

Through the analysis of the annual precipitation and the rivers are the direct factors of soil moisture, but also from the figure that the change of moisture content of the vegetation coverage plays a decisive role. Through the research, it was found that distribution of vegetation status of Shiyang River basin not only in the area of various types of vegetation changes, but also in the Shiyang River Basin is not only a large area of bare land as the main body and vegetation distribution uneven trend, and there is a phenomenon of a vegetation type is completely disappeared in the Shiyang River basin not only vegetation types in that. And the uneven distribution of vegetation has seriously affected the soil water content, the annual precipitation showed a downward trend. This shows that the ecological environment in Shiyang River Basin further deterioration, decline in land production capacity. We should “implement the scientific concept of development, plans the human and the natural harmonious development”, to take scientific attitude and positive measures to treat our home, take the road of sustainable development, ecological environment will get better protection and improvement.

5. Conclusions
In this study, using Landsat 5 TM data products, the vegetation index as the discriminant threshold, select the NDVI and Ts/NDVI slope method, this two kind of methods to build the inversion model. The results show that the combination of the two can make up for their own shortcomings, and effectively realize the complementary advantages, and improve the accuracy of the inversion of soil moisture content.

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