LAKE SHRINKAGE ANALYSIS USING SPECTRAL-SPATIAL COUPLED REMOTE SENSING ON TIBETAN PLATEAU

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1. INTRODUCTION

Tibetan Plateau is a typical study area of global environment change, and lake is an important ecological factor to reveal eco-environment evolution. Thus, monitoring the succession law of lakes on Tibetan Plateau is of great significance to global environment change research. Because of the harsh environment and low accessibility of the plateau, remote sensing becomes a convenient and effective way to monitor lake status.

Different from conventional methods which mainly consider the spectral information of remotely sensed image, this paper presents a combined method which contains both the high-precise extraction of modern lake and paleo shoreline based on spectral-spatial coupled remote sensing information. First, using spectral feature fitting method to get a water fit index to discriminate water and land more easily; then, using multi-level spatial scale transformation mechanism of "whole-local" in spatial domain to achieve gradually approach of modern lakes' optimal edges by setting up an iterative algorithm based on the index; last, detects and recovers paleo shorelines by judging the elevation difference using fusion data of LANDSAT ETM+ image and SRTM. By comparing the extent of modern lake and paleo shoreline, result of lake shrinkage can be discovered clearly and in time.

2. METHODOLOGY

2.1 Work flow

In order to analyze lakes' shrinkage, we need the data of both modern and paleo lakes. The former of which can be extract directly, and the later be recovered using existing paleo shorelines. Thus, there are three main processes in this work: modern lake extraction, paleo shoreline detection and recovery, and then lake shrinkage analysis. Based on this, the whole work flow is given as Figure 1.

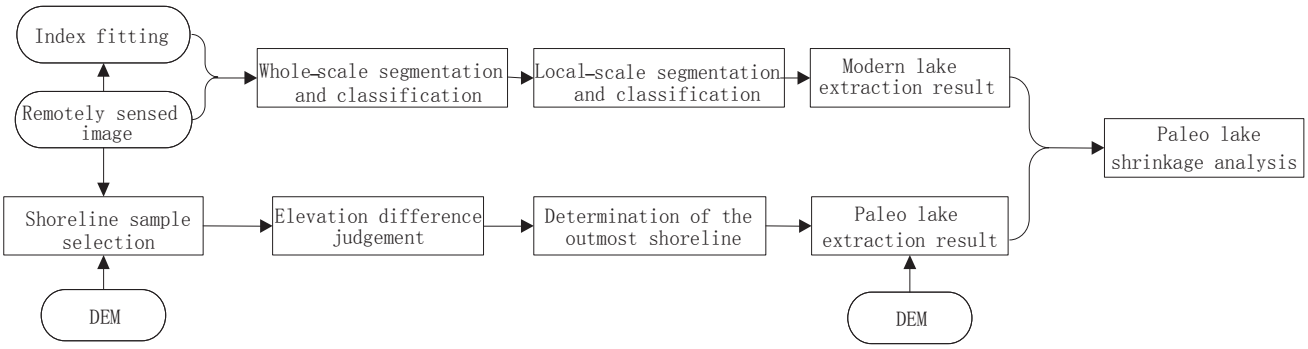


Fig.1 Flow chart of lake shrinkage analysis

2.2 Modern lake extraction

We can extract the existing modern lakes directly on remotely sensed images, using not only the spectral information but also the spatial distribution and variation pattern, which is realized through whole-scale segmentation and classification and the following local-scale segmentation and classification based on the water fit index through spectral feature fitting method.

2.3 Paleo shoreline detection and recovery

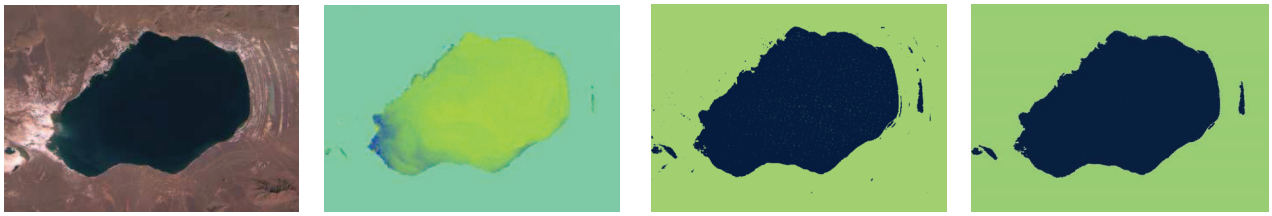
Paleo shorelines demonstrate the existing of huge paleo lakes in ancient times, which can also be recovered by the former. The outmost paleo shoreline is determined to be the shoreline of Great Lake Period, which is the target of paleo shoreline extraction. Because they are discontinuous, only using the spectral information could not extract them; and then, by selecting shoreline samples from the fusion data of LANDSAT ETM+ image and SRTM semi-automatically, we can get the elevation data of each shoreline, then determine the outmost shoreline through elevation difference judgment, and finally trace it on DEM to recover the paleo lake.

2.3 Paleo lake shrinkage analysis

As we have already obtained the both extent of modern and paleo lakes, using simple overlay analysis and map algebra operation can get the shrinkage result of lakes across the Tibetan Plateau.

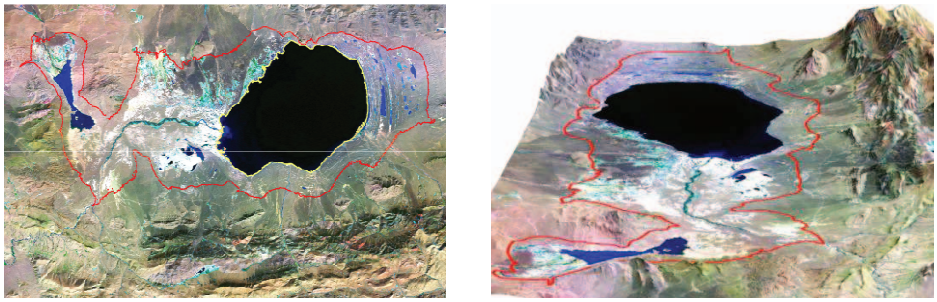
3. EXPERIMENTS

Here we select a LANDSAT ETM+ image of Dagze Co. on Tibetan Plateau as the experiment image (Figure 2(a)), and implement the method according to that showed in Figure 1. The results of modern lake and paleo shoreline extraction are listed as Figure 2 and Figure 3 respectively. Besides, the three dimensional stereogram is also given here (Figure 3(b)).



a. ETM+ image b. Water fit index c. Whole-scale processing d. Local-scale processing

Fig.2 Result of modern lake extraction



a. plane graph b. three dimensional stereogram

Fig.3 Reconstruction of paleo Dagze Co.

According to Figure 2, modern lake can be basically extracted from background information through the procedure of spectral feature fitting, whole-scale segmentation and classification. The following process of local-scale segmentation and classification can remove small areas and noise and obtain the lake's optimal margin finally. After determining the outmost shoreline, paleo shoreline can be easily traced on DEM according to Figure 3.Thus, a nearly 570km^2 area shrinkage and a nearly 60m elevation decrease of Dagze Co. can be easily got.

4. CONCLUSIONS

This paper uses spectral-spatial coupled information of remotely sensed image, which provides a more comprehensive and reasonable way for accurate analysis of lake shrinkage across the Tibetan Plateau through the combined method of modern lakes extraction and paleo shorelines recovery. Both of the two processes are high-precise and practical, so that the result of lake shrinkage analysis could be more reliable. This method can also be used on other lakes on the plateau, and then can gain a full view of lakes on Tibetan Plateau in the future, which could provide fundamental information support to study on global paleo-climatology and paleo-hydrology change since the Quaternary period, and is also of great help to the related research on Tibetan Plateau.

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