Spatial and temporal distribution variation and meteorological factors analyzing of algal blooms based on HJ-1 satellites in Lake Dianchi, China, 2009

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1. Introduction

Since the 1990s, Lake Dianchi，called as “pearl of the plateau” and “the mother lake” of Kunming city in Yunnan Province, has become more and more entropic. Excessive additions of phosphorus and nitrogen caused the rapid excessive growth of algae blooms, which appeared in a large area lasting for a long time resulting in the death and reduction of fish and shrimp populations in the lake. Nowadays, the water quality of Lake Dianchi is lower than the V level of the water quality (GB2828-88 in China) and the harmful algal blooms (HABs) pose a serious threat to humans, animals and lake ecosystems. When the water temperature, sunlight and other conditions are suitable for algae breeding, the microcystis aeruginosa, which are dominant algae in Lake Dianchi, can format algal blooms quickly. On the other hand, the algal blooms also disappear quickly because the microcystis aeruginosa, with airbags, can move vertically underwater. For monitoring “elusive” algal bloom in Lake Dianchi, remote sensing technology can play an important role because of its advantages, such as large-scale, rapid, low cost and dynamic monitoring. HJ-1 satellites were successfully launched on September 6, 2008, which serve for environmental protection and disaster prevention and mitigation. There are multi-spectral CCD cameras on both of HJ-1 A and B satellites. Compared with MODIS data, the CCD camera with the spatial resolution of 30 m, is more suitable for monitoring algal blooms of Lake Dianchi. And the CCD camera has four bands whose wavelength ranges and spatial resolution are all similar to the first four bands of Thematic Mapper (TM), while its image coverage is 14 times that of TM image and its revisit frequency is 8 times that of TM image. So CCD cameras in HJ-1 satellites are more suitable for dynamic monitoring algal blooms.

2. Data sources

From January to December in 2009, there are 66 effective HJ-1 CCD images which exclude cloud day and can be used to monitor algal blooms of Lake Dianchi. These images include: 2 images in January, 10 images in February, 7 images in March,7 images in April, 5 images in May, 3 image June, 2 images in July, 1 image in August, 4 images in September, 7 images in October, 7 images in November and 11 images in December.

3. Methods

Based on the analysis of the measured spectra of field experiment data in Lake Dianchi in October 2009, the reflectance spectral of algal blooms is similar to that of vegetation. The threshold of NDVI values from HJ-1 CCD data after calibration and atmospheric correction can be used to identify the algal blooms from water. But the multi-spectral remote sensing data could not be used to identify accurately the algal blooms and water grass. The distribution of water grass is stable and could be identified by the Hyperspectral Remote sensing data. So we can exclude the water grass region at first, then the distribution of algal blooms can be distinguished from water.

4. Data Processing and Results

1) Preprocessing

Firstly, radiometric calibration was carried out to obtain TOA radiance and reflectance from DN values of CCD images. Secondly, an orthographic projection HJ-1 CCD image was chosen as the reference image to complete the geometric correction and re-projection based on ERDAS software. Lastly, cloud recognition was completed depending on the difference of TOA radiance of land, water and cloud.

2) Extraction of algal blooms distribution

Firstly, water body and land area were identified using the water boundary vector with the same projection as preprocessed CCD image. Then, the water grass region was excluded using the priori knowledge and the distribution of algal blooms was obtained using the different NDVI values of water and algal blooms area. Lastly, the algal bloom distribution thematic map in Lake Dianchi was completed using the background image with channel 3(R), 4(G) and 2(B) and the names notes of Dianchi River.

3) Acquisition and analysis of algal blooms frequency

In order to analyze the risk of algal blooms, we defined an index called as the algal blooms frequency, defined as dividing the number of days with algal blooms by the number of days throughout the year. Firstly, the multi-temporal distribution images of 2009 were overlaid in raster format and the algal bloom frequency was calculated according to the definition. Then the algal bloom frequency thematic map in Lake Dianchi was completed in sub-five colors in accordance with the five categories of frequency ranges (<5%, 5-10%, 10-15%, 15-20%, and >20%).

4) Analysis of meteorological factors affecting the distribution of algal blooms

Lastly, the algae bloom's relevance with wind speed, temperature and sunlight hours, was analyzed based on the meteorological data of Kunming station in 2009. The result showed there are no obvious relations between the algae bloom distribution area and wind speed, temperature and sunlight hours. And the data of more years should be analyzed to obtain the relations between algae bloom and meteorological factors in the future.

5. References

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