

Comparison of the ecological environment of the downstream of Heihe before and after water division based on the remote sense monitoring

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Abstract: The NDVI of the downstream of Heihe was calculated based on the data derived from Landsat TM/ETM+ images in 1996, 2000, 2002 and 2006. The four images all are same season's data, the span of time fall short of fifteen days, so we can ignore error due to seasonal aspect. After the NDVI was calculated, the land cover was divided into five types based on the light of NDVI's value: the water area, the bare land, the sparse vegetation area, the lower vegetation area and the dense vegetation area. Counting the areas of each grade vegetation zone, and meanwhile combining the information of hydrological observation with through the comparison of the different grade vegetation area and lake area change before and after water division, the restoring effect of the vegetation in the downstream of Heihe can be found out, and this can supply the scientific foundation for the Heihe water-division plan of the next step. The monitoring results show that lake area shrink rapidly and the ecological environment of the downstream of Heihe kept deteriorating before 2002, but after seven year water division from upper and middle reaches of Heihe river, lake area extension compare quickly, the increment of the sluice is also very obvious, the environment deteriorating was alleviated and vegetation was restoring stage by stage.

Keywords: Ecological environment; the downstream of Heihe; water division; remote sense monitoring

1. Introduction

The Heihe downstream area is beset with lower mountains in its south, west and north side. Its east side is well-known the Badain Jaran desert. Its height above sea level is 820-1127m, and its bottom are west and east Juyan Lakes, its apogee is the Langxin Mountain. ^[1] This region located at hinterland of the Asian continent, its climate belongs to continental climate ^[4]. According to *compilation of Inner Mongolia Municipality climate data from 1971 to 2000*, mean annual precipitation of this area is 35.2mm, and average annual evaporation is 3136.6mm. So water quantity of the Heihe downstream fewer

influenced by precipitation. The water quantity mostly determined by precipitation of the Heihe upstream and midstream, and water consumption of midstream.

Due to discharge water quantity of midstream comparatively many formerly, so the water table has been higher. So in the Ejin oasis, there used to grow many kind of vegetation, such as *Populus euphratica*, *Elaeagnus angustifolia*, *Tamarix chinensis*, *Haloxylon ammodendron*, *Achnotherum sp.*, *Phragmites communis*, *Sophora alopecuroides*, *Lycium ruthenicum*, *Glycurrhiza uralensis*. In recent years, the midstream area developed industrial and production bases of commodity grain rapidly. So water consumption rose sharply, to cause water quantity of discharge is shrinking substantially. This lead up to largely *Populus euphratica* death and largely grassland desertification ^[1].

For increase water quantity of downstream, and then relieve ecological environment degradation of downstream area, the State Planning Commission approved *the water division plan about the Heihe main stream* in 1992. the Departments of the State Council and academician inspection tours both conducted scientific survey in the Heihe downstream in 1995 ; State Department approved *the water division plan about the Heihe main stream*, and established the Heihe Valley Administration in 1997^[2].

Remote sensing monitor have many advantages. Such as fast, macroscopic, accuracy, dynamic, etc. These characterize proved effectively ensure for a wide range of ecological environment monitor. For know how does the Heihe main stream influence downstream, this paper make use of high special resolution Landsat satellite data study change of the Heihe downstream vegetation and the East Juyan surface area. Through this study result, we can know how water division influence downstream, and then prove science foundation for make a next plan.

2. Material and methods

We difficult to obtain good image during wet

season, so in this paper, we selected four remote sensing images that orbit is 134/31 in September. They are Landsat5-TM in September 15th, 1996; Landsat5-TM in September 10th, 2000; Landsat7-ETM+ in September 24th, 2002; Landsat5-TM in September 11th, 2006, etc. Because of, growing season already passed, and that span of time of four remote sensing images less than 15 days, we may ignore error due to season different.

Through system rectification and atmospheric rectification can eliminate image spectra brightness distortion. Because this region's relief is inconspicuous, so we were excused from orthorectification, we just need to do geometric accuracy rectification. There are some the rule of select GCP point. For example, first, must have enough points. Second, these points must distribute well on uncorrected image. Third, selected point must be adequate.

The Ejina oasis vegetation condition may use NDVI reflect. Normalized Difference Vegetation Index (NDVI) calculation is based on the principles of green leaves' spectral character, which is relatively strongly absorbed in the red spectrum of visible light, while is highly reflected in the near-infrared spectrum. The calculation formula is as (1):

$$NDVI = (\rho_4 - \rho_3) / (\rho_4 + \rho_3) \quad (1)$$

Where, ρ_3 is the reflectance of red band which is corresponding to the third band of TM data. ρ_4 is the reflectance of near-infrared band corresponding to the fourth band of TM data.

3. Results

3.1 change of lake surface area

With the reduction in runoff, water area of East Juyan Lake is seriously shrunk and turned into an intermittent lake. It can be known that by means of the visual interpretation of LANDSAT materials. (See figure 1). Water area of East Juyan Lake is reduced to 27.16km², and fully dried up during the year 2000 and 2001. Distctive changes could be seen through the reduction in time of the water accumulation and the reduction in the amount of water accumulation. After the implementation of Heihe water supplying project in 2000, dramatic change has happened to the water area of the East Juyan Lake. It varies from 0 km² in 2000 to 7.73 km² in September, 2002. And it has extended into 37.41 km² in September, 2006.

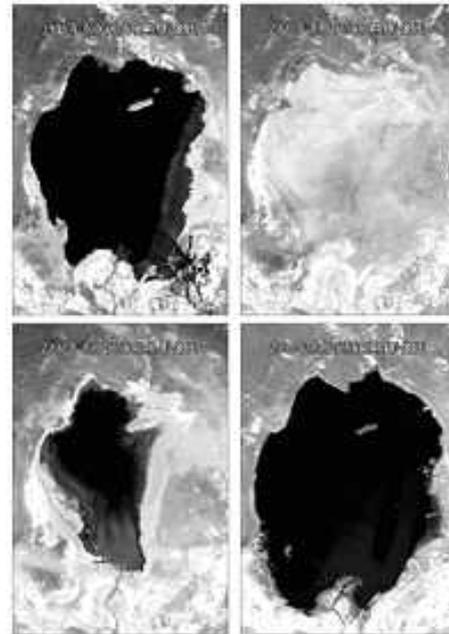


Fig . 1 The change of lake area in the East Juyan from 1996 to 2006

3.2 change of the Ejina oasis

In order to facilitate comparative analysis on the differences between different years, The result of calculation of vegetation index is divided into four grades, The definition of $NDVI < 0.05$ for the bare land, $0.05 \leq NDVI < 0.3$ for sparse vegetation area, $0.3 \leq NDVI < 0.6$ vegetation zones for the middle, $NDVI \geq 0.6$ for dense vegetation zone. Monitoring results indicate that (see figure2), area of the bare land of Ejina Oasis is 774.98Km² in September 1996, area of sparse vegetation zone is 241.46Km², area of vegetation zones for the middle is 25.82Km², area of dense vegetation zone is 0.005Km². It is clear that ecological environmental degradation of Ejina oasis has become a very serious situation. Although the Heihe water division begin from 2000. However, due to the extreme drought of the runway and low level of underground water, Ejina Oasis has vanished in the riverbed before the supply reached there. Under such circumstance, the image in September 2000 still indicates an on-going deterioration. Bare land and sparse vegetation area have still been 810.65 km² and 226.14 km². Meanwhile, moderate vegetation area and thick vegetation area have been 13.84 km² and 0 km². After the second implementation of the water supplying project from Heihe in July, 2002, had the water reached the East Juyan Lake and the result is not significant till September the same year. Being in bad condition, the bare land area has expanded into 960.88 km², sparse vegetation area, together with moderate

vegetation area and dense vegetation area have been 87.71 km², 0.52 km² and 0 km². Vegetation area is no more than 1/10 of bare land. We could see very little help of the Project to the deterioration.

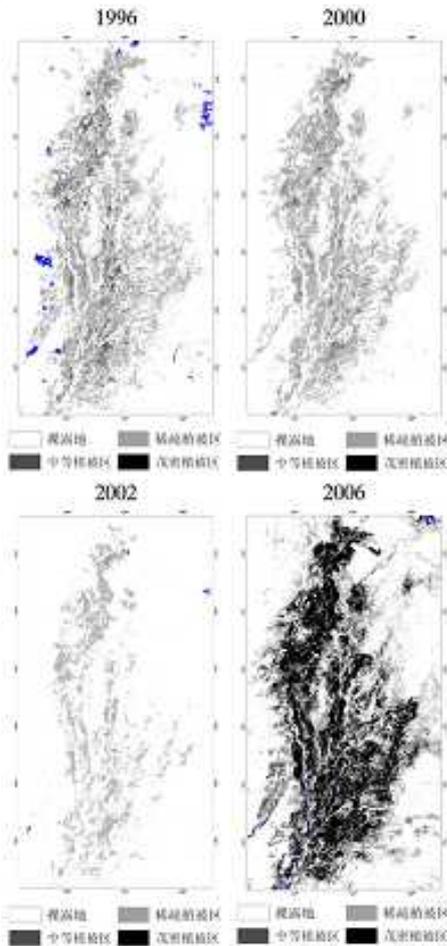


Fig . 2 The changes of vegetation of the Ejina oasis from 1996 to 2006

Seven years' water supply by Heihe River welcomes a turning point in the vegetation coverage of Ejina Oasis. Deterioration of the ecological environment was slowed down and the condition in this area has been improved. Some facts are shown through analysis and research. First of all, the area of the bare ground had been reduced by 31.1%, from 774.98 km² in 1996 to 533.14 km² in 2006, and sparse vegetation area is 214.96 km² which equals the same amount in 2000. Secondly, moderate vegetation area and dense vegetation area have seen a growth, which is from 25.82 km² and 0.005 km² in 1996 to 106.77 km² and 193.5 km² in 2006. During these 10 years, dense vegetation area has raised by 99.9% and moderate vegetation area by 66.2%. (See figure 3)

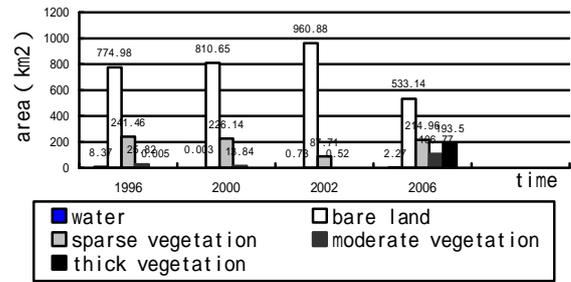


Fig . 3 different brackets grade vegetation the area variety

3.3 change of river bank vegetation

In September 1996, the river bank area has 3573.42 km² bare land, 180.58 km² sparse vegetation area, 6.84 km² moderate vegetation area and 0.02 km² thick vegetation areas. This trend was not changed in September 2000, bare land being 3600.36 km², sparse vegetation area being 154.41 km², moderate vegetation area being 5.88 km² and thick vegetation area being 0.01 km². Until September 2002, the situation has been still worse. The Bare land area has expanded into 3712.401 km², sparse vegetation area, together with moderate vegetation area and dense vegetation area have been 47.80 km², 0.44 km² and 0 km². Seven years' water supply by Heihe River welcomes a turning point in the vegetation coverage of Ejina Oasis. Deterioration of the ecological environment was slowed down and the condition in this area has been improved. Some facts are shown through analysis and research. Till September 2006, bare land area has been reduced to 3226.40 km², sparse land had expanded to 335.92 km², moderate and thick vegetation area had been 101.26 km² and 97.08 km² which show an obvious improvement.

4. Discussions

The existence of the Ejina Oasis is playing a very important role in terms of industrial and agricultural development as well as ecological environment. Its ecology is mainly dependent on the water supply of the downstream of Heihe River. Before the water of Heihe River reach East Juyan Lake, Ejina Oasis had been reduced greatly in area and quality as well as de-functioning. Seven years' water supply by Heihe River welcomes a turning point in the vegetation coverage of Ejina Oasis. Deterioration of the ecological environment was slowed down and the condition in this area has been improved.

The downstream drainage of Heihe is dry desert area. Its eco-system is so fragile that once it is broken, it would be hard to recover. For this

reason, we should have an overall planning on water resource of middle and downstream of Heihe River to achieve a harmonious development in industrial and agricultural field as well as ecology.

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