Primary Ecological Effect Analysis of Emergent Water Transportation in the Lower Reaches of Tarim River Based on RS Technology

Mei Xu, ShiFeng Huang
Remote Sensing Application Center, Ministry of Water Resources China
20 West Chegongzhuang Road, Beijing 100044,CHINA
xumei1013@sina.com

Yu He
Tarim Basin Management Bureau, Yellow River Conservancy Commission
Kuerle 841000, Sinkiang, CHINA
heyucc@sina.com

Abstract: Tarim River is the biggest inland river in China, its problem of eco-environment is worsening in the lower reach. For keeping this trend within limits, the measure of emergent water transportation to the lower reach was taken. In this paper, the remote sensing technology will be applied to the analysis of eco-environment effect after water transportation. The result is: the vegetation index and cover ratio increased but not markedly, the eco-environment situation can't been improved obviously up to now. It is some effective but temporary. The continuity, quality and quality of water source for the Tarim River must been ensured.
Keywords: Tarim River, RS, vegetation Index

1. Introduction

The length of Tarim River is 2,400 km, it is the biggest inland river in China. The climate character is drought, low rainfall and high evaporation, so the water resource is lacking, and eco-environment is weak. In these years, the water resource that can reach to the lower reach of Tarim River almost is zero. The problem of worsening eco-environment especially in the lower reaches has come to high attention of the government and the public. For keeping this trend within limits and resuming ago Green Corridor, from the 2000 year, the measure of emergent water transportation from Bosteng Lake to the lower reach of Tarim River was taken.

2. Ecological Effect

The eco-environment situation of the lower reach has been little improved after water transportation. The remote sensing technology will be used to the analysis of eco-environment effect after water transportation. Several main aspects of eco-environment change are discussed and analyzed such as vegetation index and land cover from remote sensing image of three times. The change of groundwater level through detection also be discussed because reasonable groundwater table not only be propitious to the growth of vegetation also to the saving of water resource through lessen of void water evaporation.

1) Emergent Water Transportation of Tarim River

From the year 2000 to 2003, water transportation to the lower reach has been run for five times. The water resource amount to $14.29\times10^8 m^3$ in all. The majority of water resource is from Bosteng Lake and a part from the upper reach of Tarim River itself. In the last three times, the waterhead extended to the Taitoma Lake that once was the tail reach of Tarim River and had dried up for more than 30 years because of cut-off of the flow stream.

2) Water Surface Area

In the first and second water transportation, the waterhead didn't reach to the end of Tarim River. One of the main reasons is that large amount of water soaked into the ground. The soil is too lack of water. In the last several times of water transportation, more and more water reached to the tail reach and formed water surface. After each time, the water surface area was monitored by MODIS remote sensing image. The water surface area enlarged with more times of water transportation. It amounted to $10km^2$ in the third time and 28.74 km^2 in the fourth time. But the water transportation is discontinuous, the water surface area wound minish after the end of water transportation and wound dried up again after a period of time.

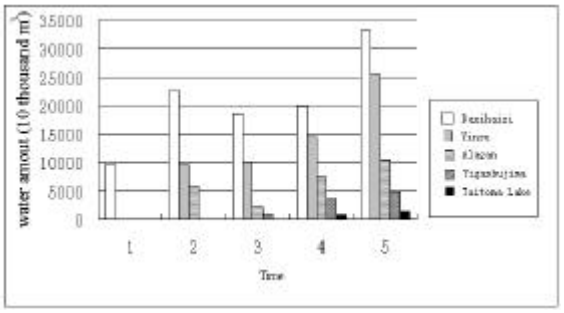

Fig. 1. Water Amount During Water Transportation

3) Surface Water Runoff

In the above figure, x represent order of water transportation, y represent water amount of hydrographic station, and each type of column represent different station. This figure display the change of surface water runoff, it also shows that with more times of water transportation, the distance, area and water amount get more increase.

4) Groundwater Level

Reasonable groundwater level: if the groundwater level is too deep then the vegetation will not grow and finally lead to desert because the soil is lack of water, if the groundwater level is too shallow, then the valuable water resource will be vaporized in vain and form salina. So the reasonable groundwater level is favorable and very important to eco-environment especially in dry area such as Tarim River. Most research result shows that in Tarim River, 2-4.5 meter is relational groundwater level.

Groundwater level before water transportation: according to the observation data of groundwater in 1997, the groundwater level upwards Yinsu is deep to cautionary level about 4-6 meter, vegetation such as Populus euphratica and Tamarix spp can grow but not well. The groundwater level downards Yinsu is deep to below 9-12 meter, in this condition, almost all kinds of vegetation can't grow, strongly decline and lead desert.

Groundwater level after water transportation:

Table 1. Groundwater level after water transportation

Profile	Distance	2nd	3rd	4th
Yinsu	150	5.7	4.7	3.7
	500	7.9	6.0	5.8
Alagan	150	11.3	9.7	9.5
	500	12.4	11.2	10.7
Yiganbujima	150		10.0	9.2
	500	5.7	4.7	3.7

In above table, distance means from river center. It shows that groundwater level raise at large along river in 1000 meters width range, and raise extent is get strong with near to river center. From Daxihaizi to Yiganbujima, in 50 meters width range, the raise extent is about 5.95 meters in average, in 250 meters range, it is about 3.67 meters in average, in 700 meters range, it is about 1.22 meters in average, and in 1000 meters range, it is about 0.31 meters in average. Contrast with reasonable level, the situation is still not too optimistic especially in lower area. But after a period of time, the groundwater level would descend again until to next time of water transportation.

5) Natural Vegetation

Vegetation growth status can express whole eco-environment quality of a region. Vegetation index and cover ration are important indication of eco-environment. In this application field, remote sensing (RS) technology has particular advantage. It can supply wide range, dynamic and real-time image data. Many kinds of vegetation index and cover ration can be got from the image.

In this program, the RS technology is applied to research of eco-environment effect of water transportation in the lower reaches of Tarim River. The selected image data is ETM of the year 2000 and 2001. The first image is before water transportation and the second is after the third water transportation.

1. Image pre-processing:

The first step is image georefrencing to match geographically with the other vector map layer. And then registration each other between images of two dates must be processed accurately. Image enhancement is also necessary.

2. Image normalization

Image normalization is very important to eliminate or lessen the change that aroused by different radiation condition.

3. Area of Natural vegetation enlarged a little

Change of vegetation can clearly display the effect of water transportation. The change of vegetation can be discussed from three aspects such as vegetation area, vegetation cover ration and vegetation index. Vegetation includes manual vegetation and natural vegetation. Change on natural vegetation may be aroused by other important factors besides water transportation. Change on natural vegetation mainly was aroused by water transportation because raise of groundwater level is direct and principle factor for growth of natural vegetation. In the Tarim River, rainfall is so small that it can been ignored, the water transportation is the only reason for change of groundwater level. So, in this program, only the change of natural vegetation is considered. Water transported to lower river is discharged from Daxihaizi Reservoir, cut-off of stream flow is from Yinsu begin, downwards Daxihaizi Reservoir. The main research range in the direction along river is from Daxihaizi Reservoir to Taitoma Lake and in the direction vertically to the river is about 3 kilometers each side of riverway because out of this range almost no vegetation being or vegetation that with no relation to water transportation to the Tarim river.

In the whole range of research, distribution of natural vegetation had not changed too much, only some change in several local places. By means of supervised classification and manual interpret and comparing between two times of image, the area of vegetation obviously enlarged or increased was about 11 square kilometers.

4. Vegetation Index

The above result shows that the enlarged area is very little with compared to the whole range. In fact, the change happened on the natural vegetation mainly consists in the situation of growing. Then the vegetation index can best displayed. NDVI is one of the important vegetation index that is most widely used in research of vegetation by remote sensing. Its value is

sensitive to the change of vegetation. Spectral normalization between images of different times is very important. After this step, calculate NDVI of each peace of image. Then compare the NDVI image of two times. The result shows that NDVI of 2001 largened widely than NDVI of 2000. See the figure.2, it displayed the change of NDVI.

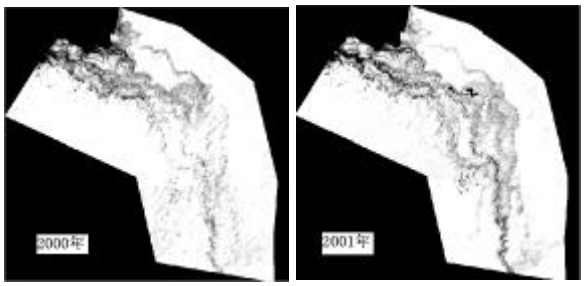

Fig. 2. NDVI Image of 2000 & 2001

The above NDVI image is calculated from ETM. NDVI is integrated reflection of vegetation type, vegetation cover configuration and growing situation in one unit of image pixel. Its value lies on the several factors such as vegetation cover ratio, LAI and so on. Many research results indicate that vegetation cover ratio is nearly related to vegetation index NDVI. So the extent and distribution of vegetation change on NDVI is nearly in accordance with vegetation index. The whole vegetation cover ration increased but not too much.

Besides NDVI, there are other vegetation index such as LCI, RVI, DVI, Ts-VI, PRI and so on can illustrate the change of vegetation, but the NDVI is the one most widely used and researched and easily get from many kinds of remote sensing image.

The change information from these two times remote sensing image is not completely displayed the true effect of water transportation. One of reason is that the time of image is not proper. The third time of water transportation is just finished in June 2001, the effect on vegetation will displayed after about two months, so image of June is too earlier, if the image of August or September can be get, then the change information may be rather correct. Another reason is that in fact the change itself is not obviously. The growing of natural vegetation here mainly or uniquely depends on the depth of groundwater level. After the third time of transportation, the groundwater level raised a little than before but yet not adapt to the growth of vegetation. After the more times of water transportation, the change must be get strong.

6) Water quality

According to the data about water quality monitored, it shows that water quality improved after water transportation. The main indicator mineralization extent reduced obviously.

7) Results

By reconnaissance on the spot, the way crop of growing becamed well than before. Such as some kind of arbors that already dead relive again, shrub grow along the riverway. And some kind of birds that disappeared several years ago fly back after water transportation because the environment they depend get well.

With more times of water transportation, the range of response became wide. Much more types of vegetation benefits from water transportation. Because different type of vegetation have different ability of enduring drought, in other words, the water quantity they required are variant, the effects to water transportation is different. Herbage plant such as bulrush is sensitively. Arbor plant such as Populus euphratica is sensitively.

3. Conclusions

In this program, remote sensing technology is applied to the research of ecological effect. By this means, the change happened on the whole range could be found timely. And in another aspect, if the change extent is not too much that it can't be find through general means, the remote sensing technology shows off its advantage. If the monitored data on the spot can be supplied at the same time, then the research result may be more correct. The vegetation index such as NDVI from remote sensing image can well display the change information of vegetation.

According to the research result, it shows that water transportation to the lower reaches of the Tarim River is effective and pivotal to lighten the ecological pressure. But at present, the water quantity is not enough to satisfy the need to raise the groundwater to a proper level that suit to the growth of vegetation. And the water transportation is not continuous, the water source is not ensured. All these factors influence the effects of water transportation. So if the environment situation of the Tarim River especially the lower reaches want to be improved to a certain extent, only the emergent water transportation is not enough.

References

[1] Li Xin, Zhou H F. Sustainable utilization of water resources of Tarim River under the influence of human activities. *Geographical Research*, 1998, 17(2): 171-177.

[2] Chen Y N, Cui W C, Li W H et al. Utilization of water resources and ecological protection in the Tarim River. *Acta Geographica Sinica*, 2003, 58(2): 215-222.

[3] Chen Y N, Li W H et al. The Influence of Groundwater on Vegetation in the Lower Reaches of Tarim River, China. *Acta Geographica Sinica*, 2003, 58(4)