RESEARCH ON THE REASONS FOR ANGULI LAKE′S SHRINKAGE AND DRYING UP USING SATELLITE REMOTE SENSING

Qiao Yanxiao*, Hao Yuesheng, Lv Fengjun

Remote Sensing Centre of Hebei Province, Shijiazhuang, Hebei，China

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ABSTRACT:

There are a group of arc lines in the remote sensing image beside Anguli lake. Through interpretation image carefully, we find which are not only parallel to each other, but also to the lake east shore. We consider that the area surrounded by the outmost arc line is exactly the lake water area in history. These arc lines that are parallel to the current lake shore are precisely the vestiges of Anguli Lake's shrinkage, which are some troughs made by water waves lapping against the lake band in the stages of the lake water stability. Satellite remote sensing study shows that Anguli Lake experienced a long-term course from the initial shrinkage to the final drying up in the past. A careful study shows that the global climate change is the main cause .Nowadays, the global temperature keeping on rise is a established fact during nearly one hundred years. .In Hebei Province, China,the temperature has risen 1.0-2.1℃ since 1950's. Especially, the temperature of Anguli Lake region even rose 2.1℃. Meanwhile, the annual average precipitation dropped by 62.1mm in the period of 50 years. So, we consider that the shrinkage and drying up of Anguli Lake experienced a long-term course from initial shrinkage to final drying up in the past, and the main reason for Angulu Lake's shrinkage and drying up is the global temperature keeping on rise.

1. INTRODUCTION

Anguli Lake that enjoys the biggest inland lake in north China,located in the northwest of Hebei province, belonging to a part of the Inner Mongolia Plateau, had dried up since the autumn of 2004[1]. The area of Anguli Lake is located in the temperate zoon and enjoys continental monsoon climate. The annual average precipitation is 300-350mm. The character of climate is drought, very windy and sandy. After the lake dried up, it is compared to the second Lop Nur Lake by experts. They said that this is a warning that the Mother Nature gave to man. In China, lakes′ drying up is no news to the public. People have no interest in such thing. However, why did Anguli Lake′s drying up arouse the interest of the public? I think the main reason is its special geographical position. The Bashang area is the nearest source of sandy and dusty to Beijing. Desertification land expansion is a serious problem in the area. As Anguli Lake′s drying up utterly, the larger uncovered lake floor will make the geological environment getting worse. Then the worse geological environment here will certainly threaten the environmental quality of Beijing area. After a burst of surprise, many reasons for Anguli Lake′s drying up have been put forward. But there is a common point for these reasons. People think that Anguli Lake′s drying up only has happened

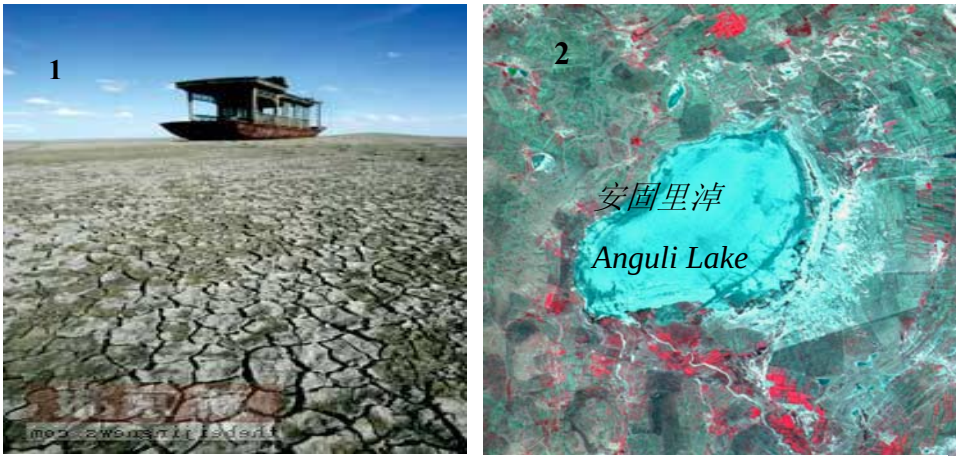

Fig.1 The Dried-up Anguli Lake(1 on-the –Spot Picture Took in Set, 2004
2 Satellite Remote Sensing Image Acquired on Aug. 31, 2006)

* Corresponding author: Qiao Yanxiao (1954-),male, Now he is a professional senior engineer of Remote Sensing Centre of Hebei Province and has been engaged in remote sensing of environment for many years.E-mail:qiaoyanxiao@yahoo.com.cn.

in a few past years[2]. Is it true? Because it is concerned in the study of the real reasons for Anguli Lake′s drying up, restore and control, as well as the policy decision of some vital problems, it is necessary to make a careful analysis using a satellite remote sensing image.

2. PREVAILING REASONS FOR ANGULI LAKE′S DRYING

To sum up, there are only following three reasons for Anguli Lake′s shrinkage and drying up. One is the successive years of drought and rainless. The water of the lake was vaporized. Second is the exploitation of large quantity of groundwater in order to irrigate crop，vegetables and trees. The level of groundwater has dropped by over 10 meter during ten years. Third lies in a hybrid cause that consists of drought, rainless and the exploitation of a large quantity of groundwater[2].

It is ease to find that these reasons above mentioned is established on a basic common point that Anguli Lake′s drying up only took place in the last few years and to try to answer a common hypothetical proposition —why Anguli Lake dried up in the past few years. Is this true?

3. REMOTE SENSING IMAGE PROCESSING

Landsat7-ETM+ image data acquired in 1999 was used as a main remote sensing data in the project. Image processing methods include fusion, false composition and supervised classification. The aim of image fusion is to enhance the spatial resolution of multi-spectral image. False composition could improve the effect of image visual interpretation. Through supervised classification the features of interesting objects can be extracted.

4. INTERPRET THE REASONS FOR ANGULI LAKE′S DRYING UP FROM A SATELLITE REMOTE SENSING IMAGE

4.1 What does Anguli Lake look like on a satellite remote sensing image?

In a satellite remote sensing image processed by computer image enhancement in 1999, Anguli Lake is a ellipsoid in shape before drying up. Its major axle stretches about 10 Km in the direction of northeast and southwest, and the minor axle about 6 Km in the direction of northwest and southeast. The lake water covers about 50 km² and looks clean. There are two rivers flowing into the lake from east and south respectively. The depth of the lake water gradually increases form east to west. The lake faces a wide open gentle lowland in terrain on the east. On the west, there is a undulating hilly land. On the satellite remote sensing image, a phenomenon being worth attention is there is a group of arc lines images that are not only parallel to each other, but also to the lake east shore. The plane shape of these arc lines images looks like an ear of man. Anguli Lake lies in it. Both these arc lines images and Anguli Lake jointly compose of a larger ellipse. The major axle of the larger ellipse is about 17.2 Km, and the minor axle about 13 Km. Accordingly, the largest acreage of Anguli Lake had ever been about 187 km². It is as about 3.6 times as the present lake area.

4.2 Satellite remote sensing image features analysis

What do the satellite remote sensing image features express? In fact, it shows to us how it was and what changes took place in history. The largest area of the lake water in history was exactly the area surrounded by the outmost arc line. Those arc lines that are parallel to the current lake shore was precisely the vestiges of Anguli Lake′s shrinkages, which were some troughs made by waves lapping against the lake band in the stages of the lake water stability. As for the cause of these troughs, I think, one is the erosion against the lake band by water waves, the other is dams made by turbulent waves. Owing to accumulated water in these troughs , some dark tone arc lines show in the satellite remote sensing image. Morevoer, the satellite remote sensing image shows there is an arc accumulated water trough outside the current lake water.

Following above analysis, we can reach a conclusion that all the troughs—wave-cut pits and wave-built dams formed by waves lashing the lake shore in the stage of the lake water relative stability, not in the stage of the lake water shrinkage. The fact that we don't find any arc lines in the satellite remote

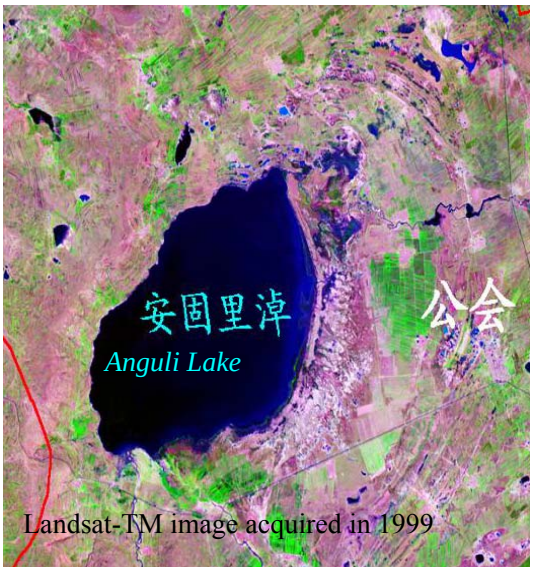

Fig.2 Landsat-TM Image Acquired in 1999

sensing image of Anguli Lake area after the lake drying up proves right this point. The reason is that the rate of the lake water shrinkage is too quick to form a trough for lack of enough time. In this way both a stability stage and a shrinkage stage of Anguli Lake took place in alternately in history, which formed a group of arc accumulated water troughs outside the lake water. Through further study of the satellite remote sensing image, we can still find some other vestiges of Anguli Lake′s shrinkage, such as lack of residential area, low and gentle of the terrain, interesting village's name (for instance, a village name house for reclamation). Applying a basic research method for geology study—demonstrate the past by the present, it is without a doubt that the group of arc lines in satellite remote sensing image is exactly the vestiges of Anguli Lake′s shrinkage in history.

According to the above analysis of the satellite remote sensing image, we can safely draw following conclusions. The present Anguli Lake form is very different from its in history in area. In history, the largest acreage of Anguli Lake had ever about 187km². It is as about 3.6 times as the present lake area. From

the original shrinking to the final drying up, the lake went through 8 cycles from one shrinkage to one steady state at least. The northeast is a favorable direction for the lake shrinkage; the second east and southeast, and the minor west and northwest. Anguli Lake experienced a long-term course from the initial shrinking to the final drying up in the past. So, all the reasons above mentioned for Anguli Lake′s drying up are not correct. Besides, we can generally know the relative rate of Anguli Lake shrinkage from the satellite remote sensing image according to the density of the arc lines. Larger density area indicates that the rate is slower and lower density area means the rate is faster.

4.3 The cause analysis of the arc accumulated water troughs

4.3.1 Wave –cut notch

Generally, formed a wave-cut notch around a water body

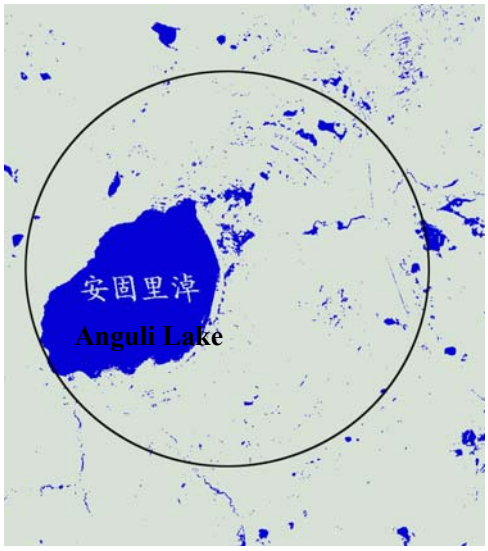

Fig.3 Water Information Extraction Around Anguli Lake

simultaneously needs four conditions. One is a motive force. The force comes from large waves. Second is the motive force has sustainability. Third is a suitable lithology character. Fourth is a long term steady area of water. Anguli Lake area completely satisfies all the conditions listed above. Moreover, frequent wind and steady wind direction provide a force to form large waves. The lake shore clay with a certain cohesion is a plastic carrier keeping the shape of a wave-cut notch. Under the circumstances, these wave-cut notches — arc accumulated water troughs have been formed.

4.3.2 Wave-built dam

When a strong wind sweeps over the surface of the lake water, the sediment in the lake bed, such as mud, sand, are carried by huge waves to surge over the lake shore. While waves draw back, mud and sand can't be carried back together, because of the wave energy releasing. In this way, they are stayed on the lake shore to form a so-called wave-built dam. Such a dam, like a reservoir dam, intercepted the rainfall form outside the dam, and formed a arc accumulated water zone.

No matter what the cause of those arc accumulated water troughs is, the conclusions from the analysis of Anguli Lake′s shrinkage and drying up can't be affected completely.

5. THE REASONS FOR ANGULI LAKE′S SHRINKAGE AND DRYING UP ON THE BASIS OF THE SATELLITE REMOTE SENSING IMAGE

Through the analysis of the satellite remote sensing image of Anguli Lake area, we are sure that Anguli Lake′s shrinkage and drying up didn′t take place in recent years. So, the above mentioned reasons are not correct, at least not main reason. However, what on earth is the main cause for Anguli Lake′s shrinkage and drying up? A careful study shows that the global climate change is the main cause. Nowadays, the global temperature keeping on rise has become an established fact during nearly one hundred years. In China, the earth′s surface temperature has risen 0.5-0.8℃ since 1950's. The increasing temperature rate is 0.1-0.2℃ every ten years[3]. In Hebei

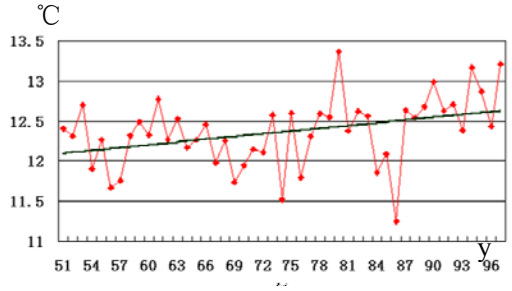

Fig.4 TheTemperature Changes in Recent 50 Years in China

Province, the annual average temperature has risen 1.0-2.1℃ in last 50 years. The rate of temperature rise is 0.2-0.4℃ each year. Especially, the annual average temperature of Anguli Lake region even has risen 2.1℃ during over 50 years. Meanwhile, the annual average precipitation has dropped by 62.1mm in the period of 50 years[4].

So, it was the global temperature keeping on rise over a long period of time that resulted in Anguli Lake′s shrinkage from the initial 187 km² to final drying up. As for other reasons, they are only minor effect at most. Only by using the global warming, can we correctly interpret the arc lines remote sensing image around Anguli Lake, and can we correctly interpret the fact that the annual average 20 lakes were disappeared all over the country in last 50years[5], and can we correctly interpret the fact that the number of lakes is decreasing on a global scale year after year.

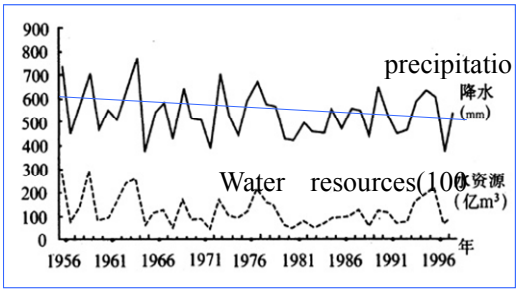

Fig.5 The Precipitation Changes in Hebei Province

6. CONCLUSIONS

(1)According to the analysis of the characteristics of the satellite remote sensing image of Anguli Lake area, we suggest

that the shrinkage and drying up of Anguli Lake experienced a long-term course from the initial shrinkage to the final drying up in the past. It is only one stage of the long-term shrinkage course, a accelerate stage at most. The largest acreage of Anguli Lake had ever been 187 km². It is as about 3.6 times as the current lake area.

⑵The main reason for Angulu Lake′s shrinkage and drying up is the global temperature keeping on rise. As for other reasons, they are only minor effect at most.

⑶ The study of the cause of Anguli Lake′s shrinkage shouldn′t only be limited in a few years before the lake drying up, while should trace back to many years ago.

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