# APPLICATION OF SPACE REMOTE SENSING IMAGES FOR THE STUDY OF THE VICISSITUDES OF THE DISASTER ENVIRONMENT ON THE SILK ROAD

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**ABSTRACT**

The application of space remote sensing images for studying the changes of the disaster environment on the west part of Silk Road in China is described in the paper. The change process of lakes and water bodies and the Lop–Nur lake water in dynamic state and modern environmental factors were analyzed. The tectonic and environmental conditions for forming and expanding further of the deserts and desertification and the neotectonic movement and earthquake activity characteristic on the Silk Road were discussed. By using the space remote sensing images and its interpreted result in conbination with material from the practical investigation, the disaster environment can be outlined in the region.

KEY WORDS: Remote Sensing, Disaster Environment

## INTRODUCTION

The silk trade across the Asia began to become a regular practice as for back as 106 B.C.. The Silk Road was an important commercial way on which the chinese silk was transmitted from ancient China to the west contries. The starting point of the ancient Silk Road was the city Chang–An, the capital of the chinese west Han dynasty. The road passed through cities Dun–huang, Yumen–Guan, Lop–Nur region and the southern road was converged to the northern one at the city Kashi. The road reached the final destination – the east seashore of the Mediterranean Sea. The Silk Road crossed over the complicated tectonic unit and different geographic – geomorphologic landscape. Since the Quaternary period, various natural disaster occurred frequently, the ecology and calamity environment has undergone long time changing. The main problems are under discussion as follows: opening of the road, its changes and the evolution in space–times, paleogeographic – geomorphologic and paleogeology – tectonic decisive factors and the vicissitudes characteristic of the regional ecologic environment etc.. The Lop–Nur region was an important place on the ancient Silk Road. The evolution complication of ecologic and disaster environment in the area is typical. The discussion is about the disaster environment changes in the Lop–Nur region by using space remotely sensed images in combination with material from the practical investigation and other geological geographic and disaster data has an important significance for a deep understanding and studying the change reguration of the disaster and ecologic environment in the west part of the Silk Road.

## THE SHRINK AND VANISHING OF LAKES AND WATER BODIES

### 1. The space image characteristic of the Lop–Nur lake

The Lop–Nur is a well–known lake in the arid region of China, it was a place of the communications hub on the Silk Road. This region became into a wilderness as a result of the natural condition and social – economic changes. The space remotely sensed image provides a scientific basis for observation and studying changes of the lakes and water bodies in dynamic state.

According to the space remotely sensed images obtained with American satellite "Earth Resource Technology Satellite" (ERTS) launched in 1972, it was first discovered that the Lop–Nur lake was dry. On the remotely sensed image a few different grey sections in helix form are clearly interpreted and their distribution is presented in the form of concentric circles. The form and range changes of the Lop–Nur lake are also shown on the image and different lines of the lake bank can be interpreted (Fig.). Their formal and material component and grey difference are formed due to arid times and intensity of accumulated salt process of the lake water in the different historic period of the Lop–Nur. The light tone images in helix form shows a thick salt crust in tortoiseshell moire form and the dark tone image shows a thin sheet of the salt crust. The surface of the thick salt crust is solid and smooth, according to spectrum characteristic analysis, the

spectrum reflectivity will be intensive, therefore the light tone was shown on the image. The surface of the thin sheet salt crust is soft and rough, it has strong absorption of the spectrum, so that dark tone was shown on the space image.

2. The dry changes of the Lop–Nur lake

Since the Middle Holocene epoch, the natural environment change took place and human activities were intentified, the lake gradually retreats in the southwestern direction due to the reduced discharge from the river Tarim into the Lop–Nur lake. A few concentric circle imagery with narrow range appeared on the space images (Fig.). It records tracks of the lake left over during its historic evolution process.

Since the Tertiary period the Lop–Nur lowland was occupied by vast lakes. There is a large number of sediment materials. The Lop–Nur lake all long was a shallow water after its formed time, it is proved by the rich content of the gypsum stratum in the low part of the geological section. The shallow water is evaporated in the dry climate condition, after the evaporation the salt was accumulated here. There is not the gypsum stratum in the high part of the geological section, it is proved that lake water of the Lop–Nur was relatively rich from the end of the Pliocene epoch to the early of the Quaternary period.

3. The lake water dry was caused by modern environmental factors

From the analysis of the historical materials, the dry of the Lop–Nur lake water was caused by modern environmental factors. According to the historical records,

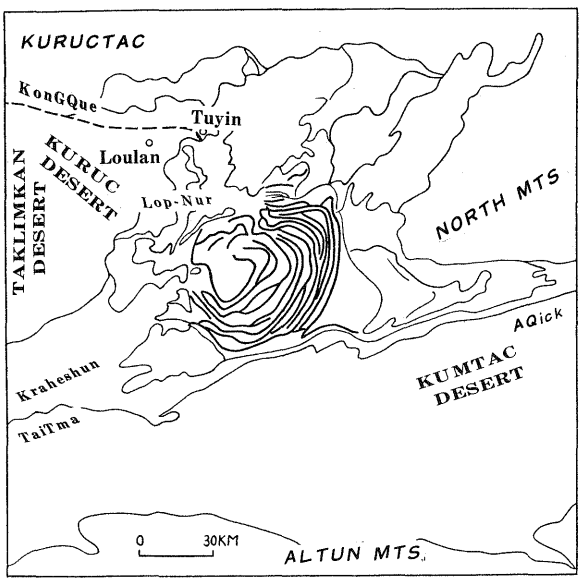


Fig. Interpreted map of the Landsat image (MSS) of the Lop–Nur region

the area of the Lop–Nur lake water was reached 150 sq km at the 6th century A.D. The Lop–Nur lake reached to the west part of the Aqick valley at the 476 B.C.. According to the records in 1782, the Lop–Nur lake water occupied 100 km from east to west, over 50 km from north to south. At the end of the Qing dynasty (1616 – 1911 A.D.), the area of the Lop–Nur lake was in 40–45 km in length and the narrowing area was still more than that at the early of the Qing dynasty. The field surveying area of the lake reached 1900 sq km in 1931, the area reached 3006 sq km in 1942, enlarge the area in 60% than in 1931. According to the topographic map in scale 1:200000 which was surveyed in 1962, the area of the lake reached 660 sq km. According to the investigation at the area there was water in the Lop–Nur lake in the 50's. The lake's coordinate is 40 ° – 41 ° north latitude and 90 ° 10′ – 90 ° 30′ east longitude. Until the end of the 19th century the Lop–Nur lake wasn't dry, the water supply from the Kraheshun lake was admited, after the streaming water from the Tarim river into the Kraheshun lake, the river water was getting into the Lop–Nur lake through the river course of length 400 km. In the 70's, there have been developing of agriculture and pasturage in the middle–upper reaches of the Tarim and Kong–que rivers. The all runoff of rivers was blocken, the Lop–Nur lake has became dry. The discovering of the Lop–Nur lake's dry is due to satellite images which first to people demonstrates the fact that the Lop–Nur lake is dry.

4. Comparison of lake changes

Several lakes in the area have been gone through the dry changes. According to the investigation result in 1959, the Taitma lake was situated in the range with coordination 39 ° 26′ north latitude and 88 ° 30′ east longitude. The area of the lake water have been reached 88 sq km. The average depth of the lake was 30 – 40 cm, it was became dry in 1981.

The Kraheshun lake is situated 39 ° 35′ north latitude and 89 ° 15′ – 90 ° 00′ east longitude, the area was about 1100 sq km. It was a freshwater lake when someone had a investigation in 1876 and 1897. This lake was became dry can was interpreted in air remotely sensed images, according to the record in the historical documents the lake became dry in 1931.

From the interpreted satellite images we can see that several deltas are generated at the entrance to te Lop–Nur lake (Fig.) and these deltas are in correspondence with a few different grey section images in helix form. The rela-

tion between the generation time of the delta with the stop time of the lake water was known. The lake group generated in the lower reaches of the Tarim river and lakes in bend of tributary of the Kong–que river have shown on the topographic map which was surveyed and mapped in 1942, but these lakes became dry. The result of the remote sensing interpretation shows that there are already semi fixed dune and shifting cresent dune.

## GENERATION OF DESERT AND DESERTIFICATION

From satellite images we can see that large area of the oases on the Silk Road is occupied by vast deserts. In about 206 B.C., the desert on the Silk Road was distributed only in the east of the Lop–Nur, namely desert Kumtac. It had formed after the middle Pleistocene epoch and expanded further after the late period of the Pleistocene epoch. In the west of the Lop–Nur was the oasis too before the 4th century B.C.. There was crops planted there during the living period of the ancient town Lou–Lan. It became into the desert named the Kuluc. The large desert is observed from the satellite images. The natural environment and geology in the area provided conditions for the formation of the desert. The lowest area in the Tarim basin is the converged center for a lot of rivers originating in the Tian–Shan, Kun–Lun and Altun mountain chain where the large delta and alluvial and lacustrine plains were formed. According to the drilling data in this area the Quaternary period stratum with thickness of 500m has been confirmed.

At the end of the Tertiary period and the beginning of the Quaternary period there was the uplift of the Tian–Shan and Kun–Lun mountains and the Qinghai –Tibet plateau was going up by a big margin which formed "the highest roof of the world". The conditions of the atmospheric circulation and water–temperature balance in the Northern Hemisphere is destroyed seriously. Since the Quaternary period there has been the arid climate in Central Asia. The Qinghai–Tibet plateau became a natural barrier for humid airflow from the Pacific Ocean to Tarim basin, therefore the flow of wind from the southwest to the north is obstructed. As a result the exceeding arid continental climate is formed and has offered climatic conditions for formation and expansion of the desert.

## THE NEOTECTONIC MOVEMENT AND EARTHQUAKE ACTIVITY

There are active neotectonic movements in this area. After the Neocene period, the Tarim block underwent the positive uplifted movement. Since the Quaternary period the block rose to a height of 600 – 1000m. The Lop–Nur lowland is characteristic of the activated platform which was influenced by the neotectonic activity in the marginal area. It is expressed by the accompany of the elevation and some fracture movement. A fracture with south –north direction is interpreted on the space images and the earthquake occured as well in the lake basin. It shows that the Lop–Nur lowland is an activated platform area. The mountain front deep fracture as well old fracture revived and since the Neocene epoch have been in the active state, and the Quaternary period stratum has been cut by the Quaternary fault. This fault outcroped on the earth's surface, therefore it is shown on the space images. The earthquake is frenquent. The violent earthquake with the magnitude 5.0, 5.25 and 6.5 (on the Richter scale) occurred there.

## CONCLUSIONS

As stated above, the space remote sensing images can outline the disaster environment in the region which can be concluded by the analysis of the images and other material data. The research results of west China on the Silk Road have shown that the changes of the natural circumstances and climate in the Central Asia and Tarim basin are decisive factors in influencing the natural landscape in this region. At the beginning of the Quaternary period the Qinghai–Tibet plateau had been uplifted, the rising movement led to creating the exceeding arid climate in the Tarim basin and even in the Central Asia. As a result of the lakes and rivers reducing and drying the geomorp hologic landscape was destroyed, the Yardan relief was formed and the desert was expanded. The revival of old fracture and occurrence of the Quaternary fault caused by the intense neotectonic movement are characteristic of the typical activated platform. The frenquent earthquakes have proved the current activities of the earth's crust.

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