Journal of Environmental Sciences Vol. 11, No. 2, pp. 211—215, 1999 ISSN 1001—0742

Landscape ecology of the region around Qinghai Lake, Qinghai Province of China based on romote sensing*

Ni Shao-xiang, Jiang Jian-jun, Wang Jie-cheng

College of Geographic Science, Nanjing Normal University, Nanjing 210097, China

Gong Ai-qi, Wang Wei-jun

General Grassland Station of Qinghai Province, Xining 810001, China

F. Voss

Institute of Geography, Technical University of Berlin, 10623 Berlin, Germany

Abstract—A region surrounding Qinghai Lake was chosen as the study area and nine ecological landscape types that were recognized based on Landsat TM image classification of land cover/use types along with the ancillary data, and their ecological features and the measures dealing with the eco-environmental problems are presented in this paper. The study has shown that using this approach the ecological landscape types in a region like the study area can be readily recognized and their ecological features can be rather accurately derived. Moreover, the deterioration in near all landscape ecological types in the area is quite serious. Therefore, effective and proper measures have to be taken in order to realize a sustainable development of the region.
Keywords: landscape ecology, remote sensing, Qinghai Lake.

1 Introduction

As a very high and cold region, the Qingzang Plateau (Tibet-Qinghai Plateau) is very peculiar in ecological landscape feature. Although many studies were conducted on the geology, geomorphology, soil, vegetation and land use of the region, little works have been done so far on the ecological landscape features in particular at a medium or large scale and based on remote sensing. This kind of study will not only provide basic data on ecological landscape features of the plateau which are essential to rational use of natural resources and improving of the ecological environment of the region, but also will add knowledge to the research on regional landscape ecology of China.

2 Study area

A region surrounding Qinghai Lake, with 36°20′—37°26′ N and 99°26′—101°13′ E, was selected as the study area, which is located on the northeastern Qingzang Plateau and in the eastern Qinghai Province. It is surrounded by Datong Mountain, Riyue Mountain, Qinghainanshan Mountain and the alluvial plain of Buha River in the north, east, south and west respectively, and Qinghai Lake with 4304.5 km^2 in area is located in its center. The elevation of the study area ranges from 3200m to 3500m above sea level except for the high mountains with 3500—4000m or more above sea level. The landform include the terraces formed by Qinghai Lake and the terraces along the rivers draining into the lake, as well as tectonic platforms, hills, and low, medium and high mountains.

The study area is dominated by continental climate with some distinct features such as high drought, low temperature and strong wind. In the region, winter is long and frigid, summer is short and mild, spring is dry and wind. The annual average of temperature ranges from −0.7℃ at Gangcha and Tiebojia to 0.5℃ at Jiangxigou. The annual average of precipitation is from 343.8 mm at Tiebojia to 381.1 mm at Jiangxigou. The annual average of evaporative capacity is from 1378.7 mm at Jiangxigou to 1502.0 mm at Gangcha. During recent 100 years, a tendency toward

* Supported by the National Natural Science Foundation of China (No. 49671056)

drier and warmer in climate was discovered (Zhou, 1992a). Combined with human activities it has caused dropping of water level of Qinghai Lake for 3.35m during recent 30 years (Zhou, 1992b).

It is the most important grazing area in Qinghai Province and one of the key grazing regions in China. Therefore, it is obvious that protection and improvement of its eco-environment is extremely important.

3 Methodology

Two scenes of Landsat TM image (133/34 and 133/35) acquired by Beijing Satellite Receiving Station on 23 June 1997 were used in this study and the following digital processes were carried out using ERMAPPER software.

3.1 Geometric correction

The projection of the TM images were transferred into the universal transverse mercatou (UTM) with the aid of the geographical coordinates of 16 recognizable ground points which were obtained by a global positioning system (GPS).

3.2 Image combination

Each geometrically corrected TM image was cut into two half scenes. The upper half scene of the image at 133/35 was digitally combined with the lower half scene of the image at 133/34, resulted in a new TM image with 5449×7212 pixels which covers the whole study area.

3.3 False color composition

The images of Landsat TM 4, 3 and 2 were registered with red, green and blue colors respectively and composited on computer. As a result, a false-color composite of images was created, which shows clearly a variation of ground features in color and indicates the different ecological landscape types of the study area and therefore, provided a base for the digital image classification of land cover/use types of the region.

3.4 Image classification of land cover/use types

In order to make a classification of the land cover/use types of the study area a supervised image classification using maximum likelihood function was conducted based on the training data acquired in field survey and with the aid of GPS data. Through an interactive operation on computer, the map showing land cover/use types of the study area was obtained.

3.5 Delineation of landscape ecological types

Based on the map of land cover/use types and the data of landform, soil etc., the map of landscape ecological types of the study area was generated (Fig.1).

4 Analysis of the ecological landscape types

Landscape ecology is such a discipline that deals with pattern, characteristics of eco-systems in a given geographical region and over a time period, rules controlling the exchange between material and energy flows, succession and development tendencies of the eco-systems under human interference, and their current and potential impacts on human society. Its main purpose is to provide a scientific base for ecological landscape management and design. Based on the theory of ecology and for the above purpose, the ecological features of the ecological landscape types of the study area were briefly summarized as follows.

4.1 Farmland

It includes two sub-types, namely, cultivated farmland and abandoned farmland.

4.1.1 Cultivated farmland

It is located mainly on the deltas of the big rivers draining into Qinghai Lake, and on gentle slopes of the hills or low mountains, with an elevation ranging from 3200m to 3400m, above sea level. The dominant crops are highland barley, oat, wheat, bean and rape seeds.

The farmland is a typical artificial agro-ecosystem in the area. The major problems of this eco-system at present include insufficient input and low biomass productivity, which has aggravated its fragility and greatly reduced its tolerance to the external interference coming from wind erosion and desertification. Therefore, it is necessary to take some measures, such as making crop fields more level, carrying out intensive and meticulous cultivation, using more organic and phosphoric

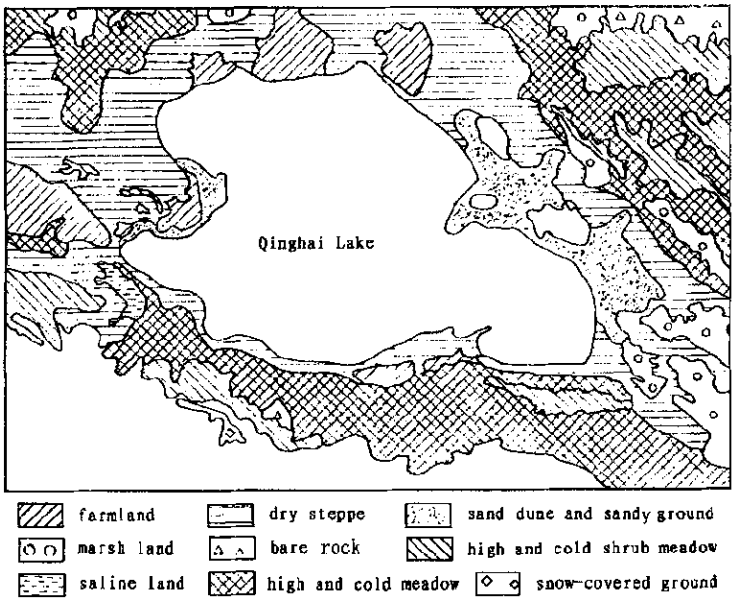

Fig. 1 Map of landscape ecological types of the study area

fertilizers as well as rebuilding or improving existing water conservancy projects. In addition, ecological screens to protect the farmlands from wind erosion and desertification have to be constructed.

4.1.2 Abandoned farmland

It was formed by a large-scale reclamation on the former natural grasslands during 1950s and, in fact, is a transitional one between agro-ecosystem and natural grassland eco-system. The common plant species are *stipa* sp., *Leymus dasystachys*, *Orinus kokonorica* and so on. The total vegetation coverage is very low and bare sandy ground has appeared in many places due to wind erosion.

In order to make the eco-system move towards a positive direction, a majority of the abandoned farmland in the study area should be returned to grassland through sowing of perennial grass species, except for a limited number of areas under a relatively good condition may be reclaimed into farmland. Besides, on those abandoned farmlands located on slopes of hill or low mountain fuel wood can be developed according to local growing condition, which will be beneficial not only to alleviation of fuel shortage, but also to protection of the farmlands from wind erosion.

4.2 Dry steppe

It is located mainly in areas with an elevation of 3200—3350m above sea level, such as those on the lake-formed terraces of Qinghai Lake and terraces of the rivers draining into the lake, as well as on the tectonic platforms and sunny slopes of hills and low mountains. This drought and freezing-resistant dry steppe eco-system has 50%—60% in total vegetation coverage and is dominated by those species such as *stipa* sp., *Agropyron cristatum*, *Achnatherum splendens* and *Orimus kokonorica*. The light chestnut or chestnut soil has 50—60 cm at depth and 1.5%—4.5% at organic matter.

Although dry steppe is the most important grazing land in the study area, particularly in winter and spring seasons a severe degradation has been found in the eco-system, which was caused mainly by long-term overgrazing on the grasslands and the damage to the steppe from mice and grasshoppers. As a result, the ecological function of the eco-system with high fragility is being become more and more dropping. The most noticeable is that the biomass productivity is getting lower and lower and the number of some grass species with high yield and good quality are

declining. On the contrary, some poisonous weeds such as *Stellera chamaejasme* and those non-edible weeds such as *Thermopsis lanceolata* are ever increasing. In other words, the changes of the eco-system toward a negative direction are being augmented and its grazing value is dropping. In addition, the serious wind erosion in the eco-system should not be any neglected.

In order to prevent the eco-system from deterioration and to recover its original ecological function, it has to be considered, firstly, to set a limit for livestock number coordinated with grass yield. Moreover, a rotation grazing system should be adopted and no grazing is allowed on the most seriously degraded grasslands. Secondly, any grassland closed by a fence should be separated into a number of small plots and, then, a rotation grazing system can be adopted in order to enhance the utilization rate of the grassland within the fence. Thirdly, the comprehensive prevention and control measures dealing with the damage to grassland by mice and grasshoppers have to be executed. Fourthly, more attention should be paid to reconstruction and improving of stock barn, grassland fence and water irrigation system. Finally, in order to eliminate those speckles of sandy grasslands grass screens against moving sands have to be set up.

4.3 High and cold meadow

It is located on slope of sub-alpine or alpine mountains, with an elevation over 3400m above sea level. The soil is sub-alpine or alpine meadow soils with 8%—15% of organic matter in surface layer. The dominant vegetation species are *Kobresia pygmaea*, *K. humillis*, *Stipa* sp., *Potentilla* sp. and so on. The total vegetation coverage is over 75%. The relatively superior condition such as high soil moisture capacity, big soil depth, high content of organic matter have made the eco-system the most important grazing land in summer and early autumn seasons.

Although the vegetation community and ecological function of the sub-alpine or alpine meadow are rather stable, some problems still exist and of which the most serious is the damage by mice. According to field survey (Wan, 1990), there are 75—165 mice and more than 4500 holes made by mice per hectare on the meadow. Therefore, it is extremely urgent to take effective measures to prevent and control the damage together with stopping overgrazing.

4.4 High and cold shrub meadow

It is located normally on shadow slope of sub-alpine mountains, with an elevation of 3350—3800m above sea level. The vegetation community with 90%—95% of total coverage are consisted of two layers, i. e. shrubs dominated by those species such as *Salix cupularis*, *Potentilla fruticosa* or *Caraganan jubata*, and grasses such as *Kobresia capillifolla*, *K. humillis* and *Polygonum viviparum*. The soil is sub-alpine shrub meadow soil.

Originally, it was a eco-system with rather stable ecological function, good vegetation community structure and high biomass productivity. Nevertheless, severe degradation of the eco-system has been revealed in many places, such as dropping of biomass productivity and declining of ecological adaptation. The major factors causing the degradation are overgrazing and, in particular, cutting shrubs for fuel collection. Two measures should be taken. The first is to stop any shrub cutting of shrubs and keep the eco-system in natural way. The second is to give up any overgrazing and, if necessary, carry out grazing coincided with livestock carrying capacity.

4.5 Marsh land

It distributes in somewhat waterlogged areas along Qinghai Lake and the rivers draining into the lake. The dominant vegetation species are *Blysmus sinocompressus*, *Pottentilla anserina*, *Carex scabrirostris*, *Triglochin maritimum* and so on. The total vegetation coverage is 90%—95%. The boggy soil or meadow-boggy soil has about 1m at depth and more than 16% of row organic matter. Although the eco-system has rather high biomass productivity the livestock carrying capacity is quite low. This kind of grazing land is only suitable for grazing of big animal like horse because of high ground water level and wet environment along with parasites and pathogens in some ponds with stagnant water.

The major measures to improve the eco-system include dredging waterways and excavating drainage ditches in order to drop ground water level and make it gradually leave away from the wet environment.

4.6 Sand dune and sandy ground

Shifting sand dunes with the materials from the deposits of Qinghai Lake are located mainly in east of Qinghai Lake, with an elevation of 3200—3350m above sea level. The next is on the delta of Buha River in west of Qinghai Lake, where the sediments carried by Buha River have made the Birds Island in Qinghai Lake connect with the land and, therefore, the island has become a peninsula since 1978 (Chen, 1995). The aeolian soil has its depth at 10—20 cm and organic matter less than 1.0%. The vegetation cover is very low and dominated by those species such as *Artemisia desertorum*, *Orinus kokonorica*, and *Triglochin maritimum*. Due to cutting of shrubs such as *Salix cheilophila*, and *Sabina vulgaris* for house construction and cooking as well as digging of shrubs for making traditional Chinese medicine the original shrubs have nearly disappeared, resulting in an aggravation of wind erosion and land desertification. The original fixed or semi-fixed sand dunes have become shifting with a velocity of 5m per year and many negative influences to neighboring grazing land or farmland have appeared. The most urgent measure to protect this fragile eco-system is to stop immediately any grazing and shrub cutting or digging. In addition, setting up wind breaks against wind erosion and making shifting sand dunes fixation should be executed.

4.7 Saline land

It also distributes mostly on deltas of the rivers draining into Qinghai Lake such as Busha River and in some places along the rivers and their tributaries with shallow ground water level. The soil is meadow solonchak with 0.8%—1.1% of salt content and 1.1% of organic matter in its surface layer. The dominated species are *Puccinellia distans* and *Salsola collina* accompanied by those species such as *Elymus nutans*, *Blysmus sinocompressus* and *Iris ensata*. The total vegetation coverage is only 20%—30% except for the sites where only *Iris ensata* is growing. Although the eco-system is suffering from high salt content in soil some salt-resistant and early-matured superior grass species can be planted in the places with a relatively favorable condition. In addition, overgrazing must be totally avoided in the eco-system.

4.8 Bare rock

It is located mostly in the watershed area of Qinghainanshan Mountain. Although there is no human interference, the bare rock areas are in a crucial condition due to high frigidity and exposition.

4.9 Snow-covered ground

It is also located on the ridge of Qinghainanshan Mountain. No human activities exist on this kind of ground.

5 Conclusions

Based on a Landsat TM image classification of land cover/use types along with the data of landform, soil and so on, ecological landscape types in such a region like the study area with a large area, complex landform and inconvenient transportation can be readily recognized and their ecological features can be rather accurately derived.

Although the population density in the study area is very low the eco-environment deterioration, especially grassland degradation and land desertification still are very serious. Therefore, more attention has to be paid to these problems and some effective measures have to be adopted in order to realize a sustainable development of the region.

References

Chen C C, Pen M, Zhou L H, Ma S Z, Wang Y X, 1995. Arid Land Geography, 18(3):57—62
Wan Y B, Wang L M, 1990. Grassland in China, 58—60
Zhou L S, Yang W D, 1992a. Journal of Lake Sciences, 4(3):25—31
Zhou L H, Chen G C, Peng M, 1992b. Journal of Lake Sciences, 4(3):32—37