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DIGITAL EXTRACTION AND CHANGE ANALYSIS OF ALTITUDINAL NATURAL ZONES IN TIANSHAN TOMUR NATURAL HERITAGE SITE

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ABSTRACT:

The Tomur Natural Heritage Site possesses the most typical altitudinal natural zones on the south slope of the Tianshan Mountains. Five altitudinal zones have developed on the south faced slope, including: warm temperate desert zone, mountain steppe zone, alpine meadow zone, alpine cushion vegetation zone and ice-snow zone. The demarcation elevation of the altitudinal natural zones on the south slope was extracted based on surface classification data, DEM and NDVI of the 1992 and 2016 Landsat TM/OLI data. The results showed that the demarcation elevation between the warm temperate desert zone and the mountain steppe zone rose by 6 m, the mountain steppe zone and the alpine meadow zone fell by 25 m, the alpine meadow zone and the alpine cushion vegetation zone moves up by 26 m, and the lower limit of the ice-snow zone rose by 11 m.

1. INTRODUCTION

Domestic and foreign scholars have carried out a lot of research on altitudinal natural zones. Stanyukovich systematically and comprehensively divided the structure of the altitudinal natural band spectrum by collecting and sorting out the vegetation distribution data of the various mountainous areas in the Soviet Union[1]. Based on the Global Alpine Environment Observation and Research Program, Erschbamer B. et al. studied the elevation gradients of biodiversity and species distribution in the middle of the Alps and the central part of the Greater Caucasus, and completed the comparison of analysis in the large-scale inland line and the glacial area[2]. Some scholars quantitatively analyzed the variation of plant species diversity with elevation gradient and the altitudinal distribution of different diversity structure components through field investigation of altitudinal natural zones, and explained its cause from the perspective of environmental factors[3, 4]. Because remote sensing technology can greatly reduce the workload and difficulty in the field, it is more convenient to obtain large-scale, long-term surface coverage data and environmental factor data. Therefore, it has gradually become an important tools and technology for the study of altitudinal natural zones. The Tomur Natural Heritage Site is where the main peaks of the Tianshan Mountains and the largest center of glaciation [5]. It has a typical altitudinal natural zone on the southern slope of the Tianshan Mountains. Therefore, the changing characteristics of the altitudinal natural zones of the Tomur Natural Heritage Site are of great significance for its protection and sustainable development.

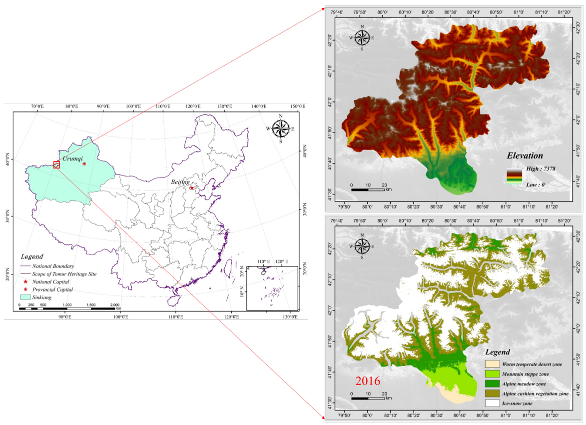

Figure 1. Location and scope of the study area.

2. DATA AND METHODOLOGY

In this study, the data mainly included Landsat TM / OLI satellite remote sensing images and DEM data from the United States Geological Survey (USGS). In order to control the accuracy of the snow-line elevation and obtain better vegetation coverage, the summer image landsat5-TM data for August 1992 and the landsat8-OLI data for June 2016 were selected. The meteorological data came from the ground observation station data of the Aksu site of the China Meteorological Administration Meteorological Data Center. The data included annual average temperature data and annual precipitation data from 1985 to 2016.

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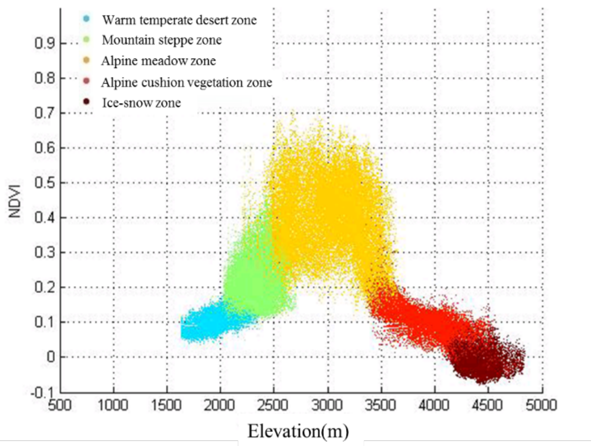
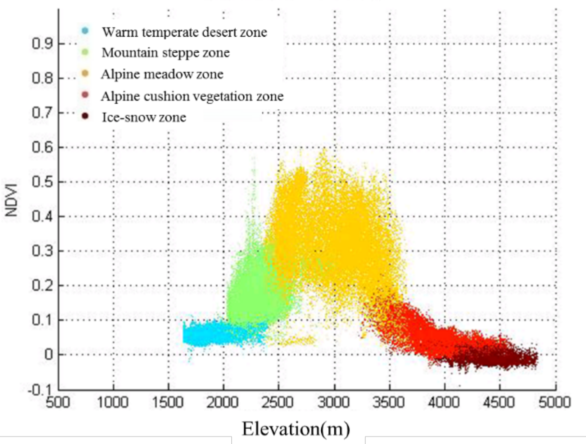
3. RESULTS AND DISCUSSION

The Tomur heritage site is significantly affected by the topography. The climatic elements like temperature and precipitation change with the elevation, and the heat and humidity are different on the north and south slopes. The precipitation is concentrated in summer and autumn with more rainfall on the north slope than the south slope. The front mountain on the south slope is greatly affected by the desert climate of Tarim, and the precipitation is less than 100mm [6]. With elevation rise, the effect of the desert climate gradually decreases, and two precipitation zones were formed. The vegetation types also showed regular changes, forming five altitudinal zones. Due to the large extent of the Tormur heritage site, the vertical natural zone of the south slope is relatively complete. Therefore, we selected the strip of the southern slope to obtain the distribution of vertical natural zones. The scatterplots of DEM, NDVI, and classification result for 1992 and 2016 were established (Figure 2a-b), in which the abscissa represented elevation, the ordinate represented NDVI, and the color represented land classification information. At the same time, there were obvious demarcations between the scatter plots of different altitudinal natural zones. From the distribution of scatter points, the two-year tendency showed the inverted "V" shape of uniform rise-uniform decline.



(a)1992



(b)2016

Figure 2. Scatter plots of Tomur Site in 1992(a) and 2016(b)

Based on statistical theory and threshold sliding window, the demarcation elevation of the altitudinal natural zones of the Tomur Natural Heritage Site in 1992 and 2016 is identified. The results are summarized in Table 1. It can be seen from the table 1 that the demarcation elevation between the warm temperate desert zone and the mountain steppe zone rose by 6 m, the demarcation elevation between the mountain steppe zone and the alpine meadow zone fell by 25 m, the demarcation elevation between the alpine meadow zone and the alpine cushion vegetation zone moves up by 26 m, and the lower limit of the ice-snow zone rose by 11 M.

Based on the temperature data (Figure 3) and precipitation data (Figure 4) of Aksu Station, the variation of the altitudinal natural zone in Tomur from 1992 to 2016 was analyzed in combination with topographic and geomorphological factors

The climate of Tarim desert had a great influence on the front mountain area of the south slope of Tomur. From 1985 to 2016, the temperature showed an upward trend and the precipitation showed a fluctuating increase trend. Under this climate change, the change of altitudinal natural zone is analyzed. The demarcation elevation between warm temperate desert zone and mountain steppe zone increased by 6m, and the change was not obvious. In the past four years since 2014, the precipitation has gradually decreased, and the temperature has decreased or stabilized, which is not conducive to the growth of steppe at low elevation, resulting in steppe degradation, leading to an increase in the upper limit of the warm temperate desert zone and an increase in the desert range.

The upper limit of the mountain steppe zone is reduced by 22m, the range of the mountain steppe zone is narrowed and the vegetation coverage is reduced. Since 2013, the temperature has decreased first and then increased, and the precipitation has continued to decrease, which made the habitat suitability of mountain steppe decline and steppe degradation occurred. On the other hand, the mainstream view is that overgrazing is the main cause of steppe degradation in protected area[7, 8].

The lower limit of the alpine meadow zone is reduced by 25m, the upper limit is increased by 26m, the bandwidth is changed from 1004m to 1055m, and the strip is widened as a whole. With the increase of elevation, although the temperature is reduced, it is moist, which provides favorable conditions for the growth and development of steppe vegetation, and the vegetation coverage is high. The temperature increased, and the precipitation showed a fluctuating increase trend. That provided a suitable growth environment for the vegetation of wormwood and spruce, which made the alpine meadow zone expand 51m.

Table 1. Results of demarcation elevation in 1992 and 2016 (m)

	Warm temperate desert zone - Mountain steppe zone	Mountai n steppe zone - Alpine meadow zone	Alpine meadow zone- Alpine cushion vegetation zone	Alpine cushion vegetatio n zone - Ice-snow zone
1992	2067m	2502m	3506m	4165m
2016	2073m	2477m	3532m	4176m
Difference	+6m	-25m	+26m	+11m

Note： The difference is positive for the rise of the demarcation elevation and negative for the decline of the demarcation elevation.

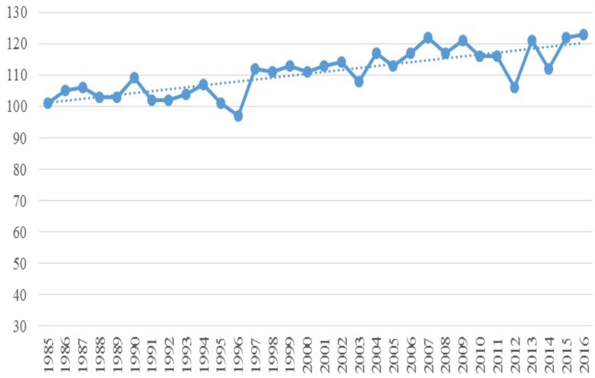


Figure 3. Average annual temperature of Tomur from 1985 to 2016 (0.1℃)

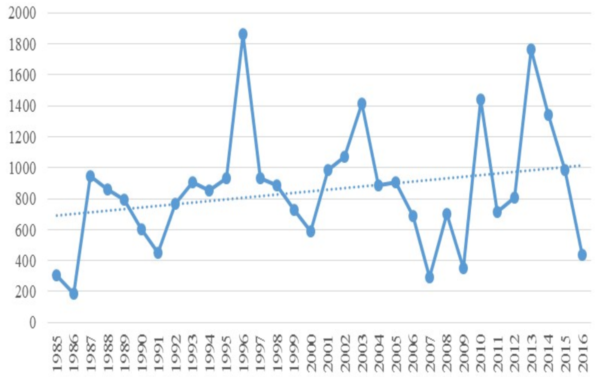


Figure 4. Average annual precipitation of Tomur from 1985 to 2016 (mm)

The lower limit of ice-snow zone rose by 11m, and the demarcation elevation of ice-snow zone rose to a high elevation. Since 1985, the temperature has increased in the past 30 years. Although the precipitation has increased fluctuated, the increase of precipitation cannot compensate for the loss of glacier caused by the increase of temperature. Therefore, the lower limit of the ice-snow zone is regressed.

4. CONCLUSION

The Landsat images of 1992 and 2016 were classified using a hierarchical classification of comprehensive visual interpretation, supervised classification and decision tree classification. A scatterplot was constructed based on the classification data of land cover, digital elevation model (DEM) and normalized vegetation index (NDVI). And the demarcation elevation of altitudinal natural zones was identified by combining statistical theory and threshold sliding window. Attribution analysis of altitudinal natural zone changes was made using temperature and precipitation data for nearly 30 years.

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