Remotely sensed dataset of grassland degradation on the Qinghai-Tibet Plateau

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Abstract: Remotely sensed dataset of grassland degradation in the Qinghai- Tibet Plateau (GLD_Tibet) is a production based on a related research about spatiotemporal changes of grassland degradation on the Qinghai- Tibet Plateau (QTP) over the periods of 1991- 2000 and 2001- 2012 using Sense's slope and Mann- Kendall trend test. During the 1990s, more than half (53.41%) of the grassland on the QTP was in some degree of degradation, but after 2000, more than three-fourths (78.62%) of the grassland had improved. The dataset provide scientific evidence for monitoring, assessment, and restoration management of alpine grasslands on the QTP, as well as the sustainable development and management of other grassland ecosystems.

Keywords: Qinghai-Tibet Plateau; grassland degradation; remote sensing; spatial data
DOI: 10.11821/dlxb2014S011
Citation: WANG Liang, XU Xinliang, LIU Luo. Remotely sensed dataset of grassland degradation on the Qinghai- Tibet Plateau. Global Change Research Data Publishing and Repository, 2014. DOI:10.3974/geodb.2014.01.11.v1, http://www.geodoi.ac.cn/WebEn/doi.aspx?doi=10.3974/geodb.2014.01.11.v1

1 Introduction

The Qinghai-Tibetan Plateau, called "the roof of the world," is a giant landform unit at the highest altitude in the world. The plateau is rich in grassland resources with alpine meadow, alpine grassland, alpine semi-desert and alpine desert successively distributed from southeast to northwest, which accounts for one third of the total grassland area in China. Grassland on the plateau plays a very important role in livestock production, water conservation and global climate change. However, about one third of the grasslands have degraded due to human factors such as seasonal overgrazing and mining, and adverse natural factors such as warming and drying trend of climate change and damage by rodents. Remotely sensed dataset of grassland degradation on the Qinghai- Tibetan Plateau (GLD_Tibet) is an important achievement of scientific researches in grassland degradation on the Qinghai- Tibetan Plateau, as well as important digital resources for monitoring and

Received: 2014-03-20; **Accepted:** 2014-07-20
Foundation: National Key Project of Scientific and Technical Supporting Programs, No. 2013BAC03B01; Chinese Academy of Sciences Action-plan for West Development Project, No. KZCX2-XB3-08-01
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Table 1 Summary of the GLD_Tibet metadata

Full name of dataset	Remotely sensed dataset of grassland degradation on the Qinghai-Tibetan Plateau		
Short name of dataset	GLD_Tibet		
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Geographical region	The region extends from 26°50' to 39°59' N and 74°27' to 104°58' E involving Qinghai, Xinjiang, Tibet, Gansu, Sichuan, and Yunnan, six provinces in China. Besides, grassland and unused land were extracted based on the land use data at a spatial resolution of 100 m in 2010.		
Year of the dataset	1991-2000; 2001-2012		
Spatial resolution	8 km (1991-2000)	1 km (2001-2012)	
Data format	ARCGIS GRID	Dataset size	37.4 KB, 918 KB
Data publisher	Global Change Research Data Publishing and Repository, DOI:10.3974/		
Data access and services platform	Global Change Research Data Publishing and Repository, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, http://www.geodoi.ac.cn National Data Sharing Infrastructure of Earth System Sciences of China, http://www.geodata.cn		
Academic editors	LIU Chuang, SHI Ruixiang, WANG Zhenxing, HE Shujin		
Data sharing policy	The authors of the dataset agree to publish the data here according to the Article I of Data Sharing Policy of the Global Change Data Publishing and Repository, which states that the dataset can be used freely for research, education, and decision making; any users for commercial uses should get formal permission from IGSNRR/CAS.		

assessment of ecological environment changes, management for grassland animal husbandry and sustainable development of social economy on the Qinghai-Tibetan Plateau. The authors published this dataset along with the publication of a research paper [1] about the grassland degradation on the Qinghai-Tibetan Plateau.

2 Metadata of the GLD_Tibet

The descriptions of the remotely sensed dataset of grassland degradation on the Qinghai-Tibetan Plateau (GLD_Tibet for short) dataset are recorded. These information include the dataset full name, dataset short name, corresponding author, authors, geographical region of the dataset content, year of the dataset, number of the dataset tiles, dataset spatial and temporal resolution, dataset format and size, data publisher, data sharing platform and contact information, technical editors, foundation and the data sharing policy. Table 1 below summarizes the main metadata elements of the GLD_Tibet dataset.

3 Methods

The annual NDVI datasets were obtained through Maximum Value Composite (MVC) based on 8-km AVHRR-NDVI data during 1991-2000, and 1-km SPOT-NDVI data during 2001-2012. Secondly, remotely sensed dataset of grassland degradation on the Qinghai-Tibetan Plateau was obtained using Sense's slope and Mann-Kendall trend test. Detailed information is as follows.

3.1 Sense's slope

Using long time-series NDVI data, $X_t = (x_1, x_2, \ldots, x_n)$, the Sense slope, β, is calculated as in Eq. (1):

$$\beta = Median\left(\frac{x_j - x_i}{j - i}\right), \forall j > i \qquad (1)$$

β is calculated based on the median of the NDVI time-series data, which could reduce abnormal data effects to some extent. A positive β value indicates an upward trend, whereas a negative one indicates a downward trend. The significance of a detected trend must be determined by the Mann-Kendall trend test because β is not a normalized parameter.

3.2 Mann-Kendall trend test

The Mann-Kendall trend test is based on the correlation between the ranks of a time series and their time order, which is quantified using the test statistic S, which is defined as in Eq. (2):

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \mathrm{sgn}\left(x_j - x_i\right) \qquad (2)$$

Where

$$\mathrm{sgn}\left(x_j - x_i\right) = \begin{cases} +1, x_j - x_i > 0 \\ 0, x_j - x_i = 0 \\ -1, x_j - x_i < 0 \end{cases} \qquad (3)$$

Under the null hypothesis, x_i and x_j are independent and randomly ordered; the test statistic S is approximately normally distributed when n ⩾ 8 and the variance var(S) is calculated by:

$$\mathrm{var}(S) = \frac{n(n-1)(2n+5)}{18} \qquad (4)$$

Finally, the standardized statistic Z is used to test the change trend, where Z is computed by:

$$Z = \begin{cases} \dfrac{S-1}{\sqrt{\mathrm{var}(S)}}, & S > 0 \\ 0, & S = 0 \\ \dfrac{S+1}{\sqrt{\mathrm{var}(S)}}, & S < 0 \end{cases} \qquad (5)$$

The standardized Mann-Kendall statistic Z follows the standard normal distribution with a mean of 0 and variance of 1 under the null hypothesis of no trend. In this study, the significance of a trend was tested by comparing |Z| with the standard normal vitiate $Z_{1-\frac{\alpha}{2}}$, which equaled 1.96, at the significance level α = 0.05 $\alpha = 0.05$.

When β > 0 and |Z| > 1.96, the status of a grassland was obviously better. Conversely, the status of a grassland showed a serious degradation trend when β < 0 and |Z| > 1.96. Therefore, the degree of grassland degradation could be classified into five groups (i.e., serious degradation, slight degradation, no change, slightly

Table 2 Grassland degradation degree and precision assessment[1]

Change trend of NDVI	Degradation Degree	Sample sites	Precision
β < 0, |Z| > 1.96	Serious degradation	162	89.4
β < 0, |Z| ⩽ 1.96	Slight degradation	179	90.3
β = 0	No change	187	92.6
β > 0, |Z| ⩽ 1.96	Slightly better	208	91.6
β > 0, |Z| > 1.96	Obviously better	321	92.4

better, and obviously better (Table 2)). This approach proved to have excellent performance with data without a specific distribution, as well as in error resistance. It has been broadly applied in fields such as hydrology and meteorology, and has great potential for application in vegetation change studies.

4 Dataset description

4.1 Remotely sensed data of grassland degradation on the Qinghai-Tibet Plateau (GLD_Tibet1) during 1991-2000

GLD_Tibet1 (Figure 1) is the remotely sensed data of grassland degradation on the Qinghai- Tibetan Plateau during 1991-2000 as the format of ARCGIS GRID at a spatial resolution of 8 km. The data need to be uncompressed before applied in ARCGIS. The data size is 38 KB.

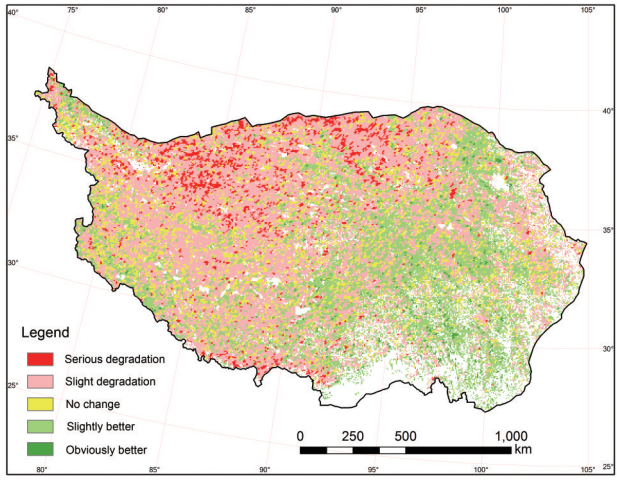

Figure 1 Distribution of grassland degradation on the Qinghai-Tibet Plateau during 1991-2000[1] (Visualization map of the dataset GLD_Tibet1)

4.2 Remotely sensed data of grassland degradation on the Qinghai- Tibet Plateau (GLD_Tibet2) during 2001-2012

GLD_Tibet2 (Figure 2) is the remotely sensed data of grassland degradation on the Qinghai- Tibet Plateau during 2001-2012 as the format of ARCGIS GRID at a spatial resolution of 1 km. The data need to be uncompressed before applied in ARCGIS. The data size is 919 KB.

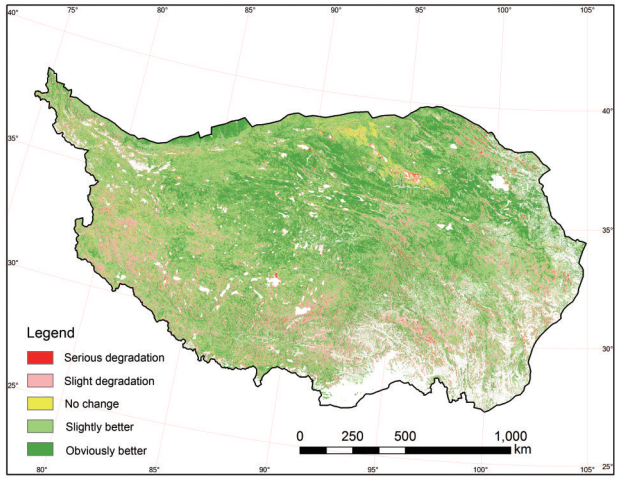

Figure 2 Distribution of grassland degradation on the Qinghai-Tibet Plateau during 2000-2012[1] (Visualization map of the dataset GLD_Tibet2)

5 Dataset quality control and validation

To validate the precision of remote sensing monitoring of grassland degradation, we conducted a field investigation on the Qinghai- Tibet Plateau in the summers of 2012 and 2013, including an accumulated survey length of 89,271 km across the QTP, a total of 1057 survey points, and 2343 photos that were located with GPS facilities. After comparison and validation between ground observations and remote sensing monitoring results, we determined the precision of the different grassland degradation degree categories (Table 2). The conclusion can be drawn that monitoring results for grassland degradation based on the

method of combining Sen's slope and Mann-Kendall trend tests not only had a relatively high accuracy, but could also reflect grassland change processes on the QTP from a macroscopic perspective.

6 Conclusion

This dataset is remotely sensed dataset of grassland degradation on the Qinghai-Tibet Plateau at the spatial resolution of 8 km (1991-2000) and 1 km (2001-2012). It can provide basic information for researches on spatiotemporal change patterns of grassland ecosystem on the Qinghai-Tibetan Plateau.

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