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The Area Dynamics of Taro Co Lake in Tibet: A Time Series Dataset (1975–2020)

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Abstract: The magnitude and intensity of climate change on the Tibetan plateau are higher than that of the global average. Lakes are important sources of surface water and they are relatively sensitive to climate fluctuations. Taro Co is situated at the northern foot of the Kailas Range in the Tibetan Plateau hinterland, with a geographic position between 31°03′N–31°13′N and 83°55′E–84°20′E, Taro Co is located at an altitude of about 4,566 m and has an area of about 486 km^2. The authors developed a dataset concerning the area dynamics of Taro Co spanning 26 years from 1975 to 2020. The dataset is based on a series of reference maps and Landsat images, as well asGF series satellite images from 1976 to 2020. The boundary data and areas of the lake in each year were developed according to people-machine interactive interpretations. The spatial resolution of the data is 30 m, the dataset format is .shp, and the data size is 768 KB (compressed to 531 KB in one file). The water area of Taro Co over time is shown to first decrease and then increase, with water expansion mainly distributed in the eastern and southwestern regions.

Keywords: Tibetan Plateau; Taro Co; Area dynamics; Long time series; Climate change

Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2021.01.09.V1.

1 Introduction

The magnitude and intensity of climate change on the Tibetan Plateau are higher than the global average[1], with a mean temperature increase of 0.3–0.4 °C per decade[2]. Indeed, this area is known as a "driver" and "amplifier" of global climate change[3]. As an important source of surface water, lakes are more obviously affected by climate change and more sensitive to climate change fluctuations[4], which is important for revealing global changes and regional response characteristics[5,6]. As one of the most lacustrine areas in China, the Tibetan Plateau has more than 1,000 salt and freshwater lakes with an area of more than 1.0 km^2[7]. Some data show that seven of the world's warmest years were recorded in the last

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[2] Zeng, L., Niu, X. J., Li, L. Taro Co changes dataset (1975–2020) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2021. https://doi.org/10.3974/geodb. 2021.01.09.V1.

decade[8], with warming triggering accelerated glacier melting, permafrost melting, and other water resource changes, sparking widespread concern about lakes on the Tibetan Plateau[9]. Most of the lakes are far away from the disturbing influence of human activities like agriculture and industry, and thus the changes in their area and water volume are mainly in response to changes in natural environmental factors and anthropogenic climate change[10]. In view of this, the establishment of a long time series lacustrine dataset is important for research into global and regional climate change, including mitigation and adaptation strategies.

The Taro Co is located in the southwest of the Tibetan Plateau, on the northern slope of the Kailas Range with a geographical location between 31°03′N–31°13′N and 83°55′E–84°20′E. The elevation of the lake water level is about 4,566 m and the maximum water depth is about 132 m[11]. The basin area of Taro Co is 487.6 km^2, and the catchment area is 6,929.4 km^2[12]. The main recharge source is Budo River, which originates from the glacial meltwater of the Kailas Range[13]. The basin is located in an alpine semi-arid region, with an average annual precipitation of about 200 mm and an average annual temperature of 0–2 ºC[12]. The vegetation types are mainly alpine grasslands and alpine meadows[14].

2 Metadata of the Dataset

The metadata of the Taro Co changes dataset (1975–2020)[15] are summarized in Table 1. They include the full dataset name, short name, authors, data year, temporal resolution, spatial resolution, data format, data size, data files, data publisher, and data sharing policy, etc.

Table 1 Metadata summary of the Taro Co changes dataset (1975–2020)

Items	Description
Dataset full name	Taro Co changes dataset (1975–2020)
Dataset short name	TaroCo_1975-2020
Authors	Zeng, L., Climate Centre of Tibet Autonomous region, 979952727@qq.com Niu, X. J., Climate Centre of Tibet Autonomous region, niuxj2014@126.com Li, L., Climate Centre of Tibet Autonomous region, 493710564@qq.com
Year	1975–2020
Time resolution	Every 6 years on average before 2000 and annually after 2000
Spatial resolution	30 m Data format .shp
Data size	768 KB (531 KB after compression)
Composition of dataset	Vector boundary and area data of Taro Co for a total of 26 years: 1975, 1977, 1988, 1990, 1996, 2000–2020
Foundations	Ministry of Science and Technology of P. R. China (2019QZKK0105- 06); National Natural Science Foundation of China (41165002); Tibet Autonomous Region (XZ202001ZY0023N)
Data computing environment	PIE Basic 6.0 Trial Version, ArcGIS 10.4 Trial Version
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[16]
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS, Crossref

3 Methods

3.1 Data Sources

The lakes on the Tibetan plateau show obvious fluctuations due to intra-annual variations of precipitation, glacial meltwater, and evaporation. The image data selected in the construction of the dataset mainly focus on October and November of each year when the lake area is relatively stable. The selected remote sensing images are of good quality with cloud coverage never exceeding 5%. The data sources include a 1:100,000 topographic map data in 1975, 30 m DEM, Landsat MSS data, Landsat TM data, Landsat ETM data obtained from Geospatial Data Cloud[1], and GF1-WFV data acquired by the China Resources Satellite Application Center[2] (Table 2).

Table 2 List of the data sources

Data Type	Description
DEM	ASTER GDEM data were jointly developed by METI (Japan) and NASA (USA), and are generated based on "Advanced Spaceborne Thermal Emission and Anti-Radiometer (ASTER)" data computation. They are obtained from the Geospatial Data Cloud with a resolution of 30 m
Topographic map	1975 topographic map data with a resolution of 1:100,000
Landsat MSS	Includes data for May 15, 1977 (strip: 153, row: 38), acquired from the Geospatial Data Cloud with a resolution of 60 m
Landsat TM	Includes data for December 6, 1988, June 3, 1990, October 9, 1996, November 11, 2008, October 13, 2009, October 16, 2010, and November 4, 2011 (strip: 142, row: 38), acquired from the Geospatial Data Cloud with a resolution of 30 m
Landsat ETM	Includes data for October 28, 2000, October 30, 2001, December 5, 2002, October 21, 2003, November 24, 2004, November 11, 2005, October 13, 2006, November 17, 2007, and November 14, 2012 (strip number: 142, line number: 38), acquired from the Geospatial Data Cloud with a resolution of 30 m
GF1-WFV	Includes data for November 12, 2013 (WFV3), November 15, 2014 (WFV3), November 2, 2015 (WFV1), November 5, 2016 (WFV2), September 13, 2017 (WFV3), November 22, 2018 (WFV4), November 13, 2019 (WFV2), and November 12, 2020 (WFV2), acquired from China Center for Resources Satellite Data and Application with a resolution of 16 m

3.2 Dataset Development Process

The Landsat data are from the Geospatial Data Cloud were geometrically corrected and geographically aligned. The PIE remote sensing processing software developed by Aerospace Corp. was used to synthesize the Landsat data into true color images by band, and then orthorectify the GF1-WFV satellite data by combining with DEM. WFV data with Landsat data served as the reference image for geometric correction, geographic alignment, and other pre-processing. All remote sensing images are projected and converted to a CGCS2000 coordinate system in ArcGIS software, and then the remote sensing interpretation and extraction of the lake boundaries, vector editing, area calculation and mapping are carried out. The extraction of the lake boundary is undertaken by visual interpretation by professional technicians in ArcGIS software, and the results are cross-checked and corrected to render the

[1] http://www.gscloud.cn.
[2] http://www.cresda.com.

lake boundary results as accurate as possible, calculate the lake water area in different years, and establish the lake water spatial database.

4 Data Results

4.1 Dataset Composition

The time series dataset (1975–2020) of the lake area of Taro Co in Tibet includes vector data (.shp) during theof 26 years: 1975, 1977, 1988, 1990, 1996 and each year between2000-2020. The data consist of a surface element and contain the lake water field (area in km^2) in addition to the necessary fields (Table 3).

Table 3 Area dynamics of Taro Co Lake (1975–2020)

Year	Area (km^2)	Year	Area (km^2)
1975	482.37	2008	487.91
1977	482.38	2009	486.86
1988	482.00	2010	483.09
1990	480.93	2011	485.07
1996	470.11	2012	483.72
2000	477.90	2013	485.28
2001	480.72	2014	484.66
2002	479.68	2015	482.21
2003	479.45	2016	482.67
2004	479.99	2017	485.22
2005	480.18	2018	489.86
2006	482.15	2019	492.41
2007	483.22	2020	493.51

4.2 Data Results

The water area of Taro Co from 1975–2020 experienced a process of first decreasing and then increasing (Figure 1) i.e., between 1975–1996 the water area decreased from 482.37 km^2 to 470.11 km^2 and then began to gradually increase, reaching 493.51 km^2 in 2020. Fitting an ordinary least squares (OLS) trend line to these data shows an average annual increase of 0.54 km^2 (P < 0.005). significance test (= 3.135).

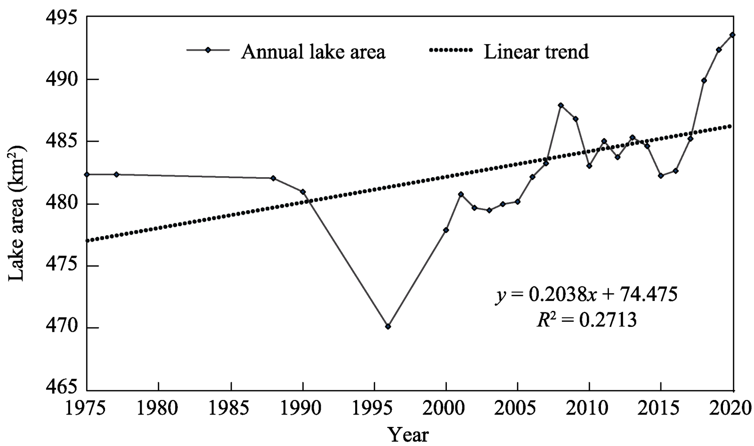

Figure 1 Area dynamics of Taro Co Lake (1975–2020)

Spatial changes in the water boundary of Taro Co Lake are shown in Figure 2. It can be discerned that, before 2010, boundary expansion mainly occurs in the eastern region of the lake; after 2010, boundary expansion mainly occurs in the southwestern region of the lake.

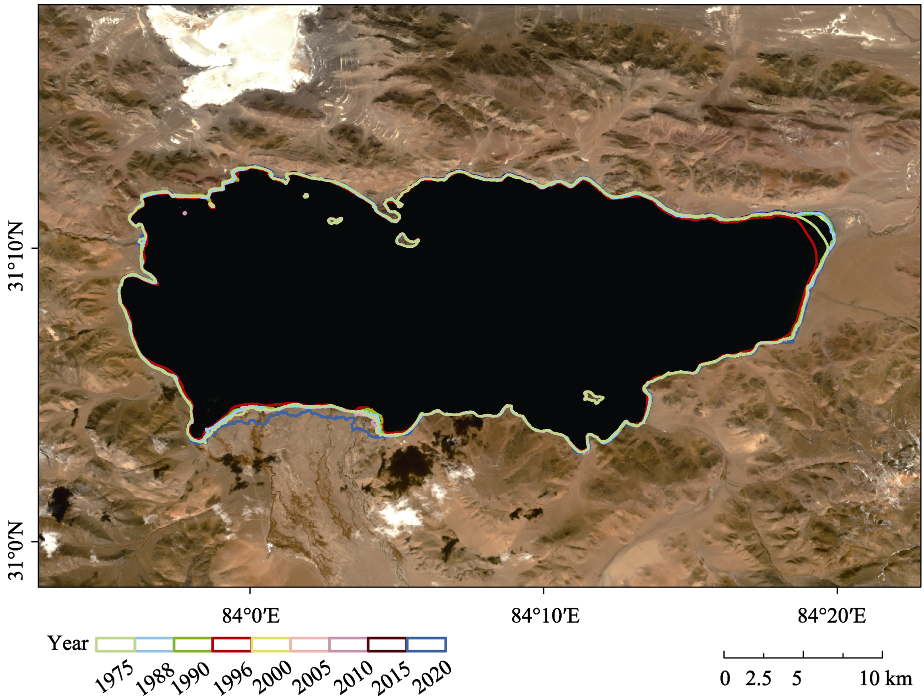

Figure 2 Map of spatial variation of the watershed boundary of Taro Co Lake (1975–2020)

5 Discussion and Conclusion

As an important source of surface water, lakes are significantly affected by climate change and are sensitive to climate fluctuations, which is of great scientific significance in the context of revealing the response mechanisms of land surface water cycles to climate change. From the data results, the watershed area of Taro Co Lake experienced a process of first decreasing and then increasing during the period from 1975 to 2020; watershed expansion is mainly distributed in the eastern and southwestern regions of the lake. This dataset constructs a longer time series vector dataset of the area and spatial changes of Taro Co Lake compared to what was previously available. As such, the data can be leveraged in future research concerning the biophysical, ecological, and environmental responses of Taro Co Lake to climate change.

Author Contributions

Niu, X. J. designed the study; Li, L. collected the Landsat (MSS, TM, ETM) and GF1 (WFV) data; Niu, X. J. and Zeng, L. processed, interpreted and analyzed the data; Zeng, L. wrote the manuscript. All authors reviewed and approved the final submission.

Conflicts of Interest

The authors declare no conflicts of interest.

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