Journal of Global Change Data & Discovery. 2023, 7(4): 369-374
www.geodoi.ac.cn

Construction of Half-century Dataset of Lake Area Changes in Mapam Yumco and La'ang Co (1972–2023)

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Abstract: This paper developed the vector boundary data of Mapam Yumco and La'ang Co through manual visual interpretation from 1972–2023 using the Landsat series and GF1 remote sensing images as data sources. The corresponding lake area was calculated to obtain the Mapam Yumco and La'ang Co change datasets (1972–2023). The two datasets include the vector boundary and area of Mapam Yumco and La'ang Co in 27 periods of 1972, 1977, 1994, and 2000–2023. The spatial resolution of the data is 30 m. The datasets are archived in the.shp data format, and both Mapam Yumco and La'ang Co are composed of 189 data files. From 1972–2023, the area of Mapam Yumco showed a slightly decreasing trend, with an area of about 412 km^2. The area of La'ang Co showed a significant decreasing trend, with an average rate of –4.238 km^2/10a. The spatial change of the Mapam Yumco Lake surface was not obvious, while the shoreline of the northeast and south of the lake changed slightly. The large changes in La'ang Co were concentrated primarily in the north and southwest.

Keywords: Mapam Yumco; La'ang Co; lake area; remote sensing

DOI: https://doi.org/10.3974/geodp.2023.04.04

CSTR: https://cstr.escience.org.cn/CSTR:20146.14.2023.04.04

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.2024.02.01.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2024.02.01.V1.

https://doi.org/10.3974/geodb.2024.02.02.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2024.02.02.V1.

Received: 20-10-2023; **Accepted:** 18-12-2023; **Published:** 24-12-2023

Foundations: Ministry of Science and Technology of P. R. China (2019QZKK020809, 2019QZKK0105-06) and Science and Technology Department of Tibet (XZ202102YD0012C)

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Data Citation: [1] Zeng, L., LA, Z., Deji, Y. Z., *et al*. Construction of half-century dataset of lake area changes in Mapam Yumco and La'ang Co (1972–2023) [J]. *Journal of Global Change Data & Discovery*, 2023, 7(4): 369–374. https://doi.org/10.3974/geodp.2023.04.04. https://cstr.escience.org.cn/CSTR:20146.14.2023.04.04.

[2] Zeng, L., La, Z., Deji, Y. Z., *et al*. Mapam Yumco changes dataset (1972–2023) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2024. https://doi.org/10.3974/geodb.2024.02.01.V1. https://cstr.escience.org.cn/CSTR:20146.11.2024.02.01.V1.

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1 Introduction

The Tibetan Plateau is known as the "Water Tower of Asia" due to its largest area, highest altitude, and greatest number of plateau lakes in the world[1,2]. Lakes participate in the natural water cycle process through the convergence and evaporation of surface water, which links the atmosphere, cryosphere, and hydrosphere and reflects the response characteristics to the climate and environment[3]. As a sensitive area, the Tibetan Plateau has a greater amplitude and intensity of climate change than the global average[4]. Under the influence of global climate change, lake areas[5,6], water volumes[7,8], and water levels[9,10] are changing to varying degrees. Therefore, establishing a long time series of lacustrine datasets from Mapam Yumco and La'ang Co is vital to studying regional ecosystem changes and response characteristics to climate change within the Tibetan Plateau.

The Mapam Yumco and La'ang Co are located in Purang county, Ngari prefecture, Tibet autonomous region. These lakes are adjacent with a river connecting them. The main peak of the Kailas Range, Kailash, stands in the north of the Mapam Yumco basin with the Himalaya Mountains in the south. Therein, Mount Naimona'nyi is in the south of the basin[11,12]. Mapam Yumco is an inland freshwater lake, with an altitude of about 4,500 m. The lake basin is wide in the north and narrow in the south with an approximately elliptical shape. La'ang Co is a saltwater lake with an altitude of about 4,570 m and is roughly spoon-shaped. The annual average temperature of the lake area is about 2 °C[13].

2 Metadata of the Dataset

The metadata of the Mapam Yumco[14] and La'ang Co change dataset (1972–2023)[15] are summarized in Table 1. The dataset full name, short name, authors, year of the dataset, temporal resolution, spatial resolution, data format, data size, data files, data publisher, data sharing policy, and others are all given.

Table 1 Metadata summary of the Mapam Yumco and La'ang Co changes dataset (1972–2023)

Item	Description
Dataset full name	Mapam Yumco changes dataset (1972–2023)
Dataset short name	MapamYumco_1972–2023
Authors	Zeng, L., Climate Centre of Tibet Autonomous region, 979952727@qq.com La, Z., Climate Centre of Tibet Autonomous region, 821360896@qq.com Deji, Y. Z., Climate Centre of Tibet Autonomous region, 1308709602@qq.com Niu, X. J., Climate Centre of Tibet Autonomous region, niuxj2014@126.com
Geographical region	Purang County, Ngari Prefecture, Tibet Autonomous Region
Year	1972–2023
Temporal resolution	1972, 1977, 1994, and annually after 2000
Spatial resolution	30 m
Data format	.shp
Data size	276 KB (198 KB after compression)
Data files	Vector boundary and area data of Mapam Yumco for a total of 27 years: 1972, 1977, 1994, and 2000–2023
Dataset full name	La'ang Co changes dataset (1972–2023)
Dataset short name	La'angco_1972–2023
Authors	Zeng, L., Climate Centre of Tibet Autonomous region, 979952727@qq.com La, Z., Climate Centre of Tibet Autonomous region, 821360896@qq.com Deji, Y. Z., Climate Centre of Tibet Autonomous region, 1308709602@qq.com Niu, X. J., Climate Centre of Tibet Autonomous region, niuxj2014@126.com
Geographical region	Purang County, Ngari Prefecture, Tibet Autonomous Region
Year	1972–2023

(*To be continued on the next page*)

(*Continued*)

Item	Description
Temporal resolution	1972, 1977, 1994, and annually after 2000
Spatial resolution	30 m
Data format	.shp
Data size	729 KB (498 KB after compression)
Data files	Vector boundary and area data of La'ang Co for a total of 27 years: 1972, 1977, 1994, and 2000–2023
Foundations	Ministry of Science and Technology of P. R. China (2019QZKK020809, 2019QZKK0105-06); Science and Technology Department of Tibet (XZ202102YD0012C)
Data computing environment	ENVI Trial Version, ArcGIS 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	(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 by definition are also value-added service providers, and are welcome to redistribute ***Data*** subjects 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 percent 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, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

Table 2 Areal dynamics of Mapam Yumco and La'ang Co

Mapam Yumco				La'ang Co			
Year	Area (km^2)	Year	Area (km^2)	Year	Area (km^2)	Year	Area (km^2)
1972	414.15	2011	410.70	1972	268.48	2011	255.23
1977	414.17	2012	411.12	1977	269.95	2012	254.91
1994	409.19	2013	413.82	1994	267.01	2013	254.48
2000	415.78	2014	412.20	2000	267.11	2014	254.49
2001	412.47	2015	411.33	2001	262.65	2015	253.87
2002	413.80	2016	412.13	2002	262.30	2016	254.24
2003	412.43	2017	412.73	2003	261.28	2017	255.32
2004	410.36	2018	414.23	2004	258.08	2018	254.28
2005	410.83	2019	414.62	2005	260.84	2019	253.72
2006	410.59	2020	414.97	2006	257.49	2020	253.44
2007	411.30	2021	413.26	2007	257.41	2021	251.87
2008	412.18	2022	412.51	2008	257.11	2022	249.87
2009	410.30	2023	412.21	2009	257.46	2023	248.32
2010	412.32			2010	256.64		

3 Methods

3.1 Data Sources

The lakes on the Tibetan Plateau fluctuate under the influence of temperature, precipitation, evaporation, and glacial meltwater. Thus, the lake areas vary significantly over a year. Therefore, the selected remote sensing image data are concentrated primarily from September to November, when the lake area is relatively stable. The selected images are of good quality, with clear sky or cloud cover never exceeding 5% over the lake. The data include ASTERGDEM 30 m resolution digital elevation model (DEM) data obtained from

the Geospatial Data Cloud, Landsat MSS data (path: 155, row: 39) in 1972 and 1977, Landsat TM data (path: 144, row: 39) in 1994, Landsat ETM data (path: 144, row: 39) from 2000–2012, and GF1-WFV data from 2013–2023 obtained by the China Resources Satellite Application Center.

3.2 Data Collection or Processing

The Landsat and GF1 remote sensing images were preprocessed using the ENVI software, including geometric correction, image enhancement, and reprojection. The projection adopted the CGCS2000 coordinate system, and the preprocessed Landsat8 image in 2015 was used as the benchmark to register the GF1 remote sensing data. Two technicians extracted the lake area using ArcGIS software via visual interpretation and cross-checked the extraction results. The vector data were added to the lake area field to obtain the lake area of Mapam Yumco and La'ang Co over the different years. Thus, the spatial database of the lake area was established.

4 Data Results and Validation

The Mapam Yumco change dataset (1972–2023) and La'ang Co change dataset (1972–2023) include vector data (.shp) of Mapam Yumco and La'ang Co from 1972, 1977, 1994, 2000–2023, a total of 27 periods. The data consist of a surface element, including the lake area field (in km^2) in addition to the necessary fields.

The overall area of Mapam Yumco showed a slightly decreasing trend from 1972–2023, with an average rate of –0.051 km^2/10a (Table 2, Figure 1). The Mapam Yumco area decreased from 414.15 to 409.19 km^2 from 1972–1994, a decrease rate of 1.20%. Then, the area increased and reached a maximum in 2000 (415.78 km^2). The area showed a significant decreasing trend from 2000–2004, with an average rate of –10.88 km^2/10a, and a fluctuating increasing trend from 2005–2023, with an average rate of 1.63 km^2/10a.

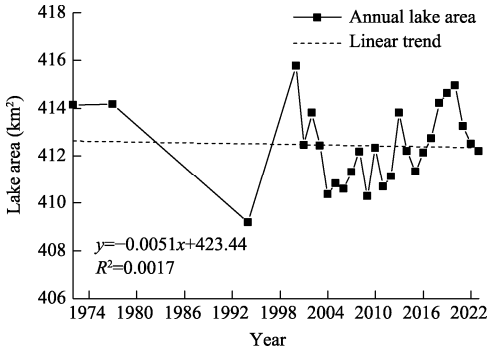

Figure 1 Areal dynamics of Mapam Yumco (1972–2023)

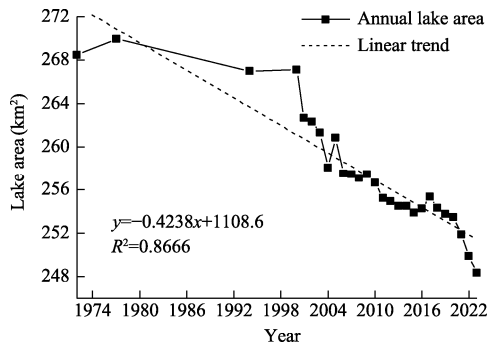

Figure 2 Areal dynamics of La'ang Co (1972–2023)

The area of La'ang Co showed a decreasing trend from 1972–2023, with an average rate of –4.238 km^2/10a (Table 2, Figure 2). The lake area was stable at about 268 km^2 from 1972–2000. After 2000, the lake area fluctuated less, and decreased to a minimum of 248.32 km^2 in 2023, with an average rate of –5.563 km^2/10a. There is no obvious overall change in Mapam Yumco based on the spatial variation of the lakes (1972–2023) (Figure 3), and the water shoreline in the northeast and south changed slightly. The strong changes in La'ang Co were concentrated primarily in the north and southwest, and the northern part of the lake shrank obviously after 2004.

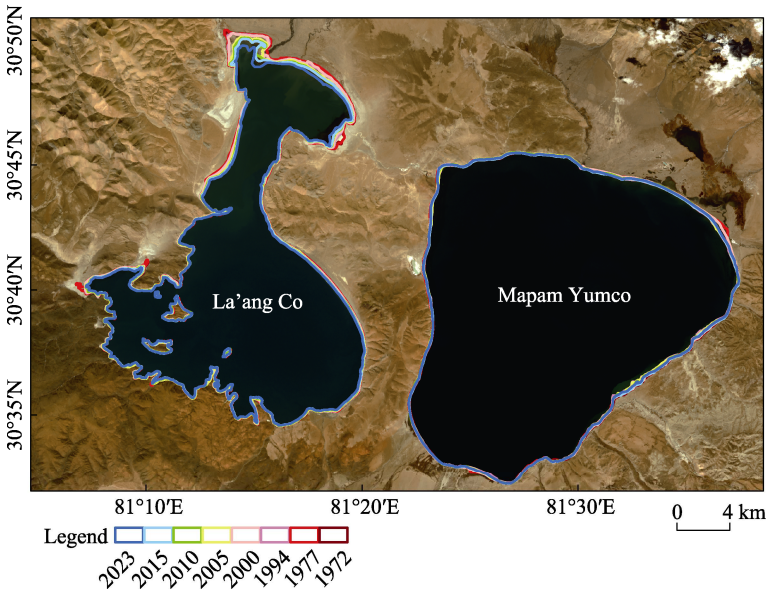

Figure 3 Spatial variations of Mapam Yumco and La'ang Co Lakes (1972–2023)

5 Discussion and Conclusion

Lakes are an important part of the natural water cycle process and the link between the atmosphere, cryosphere, and hydrosphere. Under the influence of climate change, all these aspects change to varying degrees and are significant for studying sensitive responses to climate change. This paper used the Landsat and GF1 remote sensing image data from 1972–2023 as sources and preprocessed the data via geometric correction, image enhancement, image registration, and reprojection. The lake areas over 27 periods were digitized and calculated through manual visual interpretation. The results of the area extraction of Mapam Yumco and La'ang Co from 1972–2023 give a slightly decreasing trend in the area of Mapam Yumco, with an area of about 412 km^2; and a decreasing trend in the area of La'ang Co, with an average rate of –4.238 km^2/10a. After 2000, the La'ang Co area fluctuated less and reduced to a minimum in 2023. There was no strong spatial change in the Mapam Yumco Lake surface, and the shoreline in the northeast and south changed slightly. The obvious changes in La'ang Co were concentrated primarily in the north and southwest. The long-term spatial change vector datasets of Mapam Yumco and La'ang Co reveal the spatial characteristics of the lake area and surface change, which has a certain scientific reference significance for studying the sensitive response characteristics of lakes under the backdrop of climate change.

Author Contributions

Zeng, L. designed the algorithms of the dataset; La, Z. and Niu, X. J. collected and processed remote sensing image data from Landsat (MSS, TM, ETM+) and GF series satellites (GF1-WFV); Deji, Y. Z. designed the model and algorithm; and Zeng, L. wrote the data paper.

Conflicts of Interest

The authors declare no conflicts of interest.

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