

# Dataset Development of Butuo Lake Changes in Xizang Autonomous Region of China (1988–2024)

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**Abstract:** We preprocessed Landsat series and GF1 remote sensing images from 1988 to 2024 through orthorectification and image registration. Using manual visual interpretation, we delineated the vector boundary of Butuo Lake and calculated the corresponding area, thereby constructing a dataset of the lake changes in the Xizang Autonomous Region of China (1988–2024). The dataset includes vector boundary and area data for 33 time periods. The results show that the area of Butuo Lake has exhibited an overall expansion trend, with an average growth rate of 0.20 km<sup>2</sup>/10a. The maximum recorded area occurred in 2019 (16.14 km<sup>2</sup>), while the minimum was observed in 1990 (15.16 km<sup>2</sup>). This dataset provides insights into the temporal and spatial dynamics of Butuo Lake and offers a solid data foundation for further research on climate change, ecological environment, and water resource management in the region. The dataset is archived in .shp format and consists of 231 files with a total size of 377 KB.

**Keywords:** Butuo Lake; area; remote sensing; 1988–2024

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**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.2025.07.03.V1>.

## 1 Introduction

The Qinghai-Xizang Plateau, often referred to as the “Third Pole of the Earth” and the “Water Tower of Asia”<sup>[1]</sup>, is the world’s highest-altitude region with the densest distribution of lakes. Its total lake area accounts for more than 50% of the country’s total lake area, making it one of the key lake regions in China<sup>[2]</sup>. Owing to its remote geographical location and limited human disturbance, the dynamic changes of these lakes serve as highly sensitive indicators of climate change<sup>[3]</sup>. Variations in lake area and water level<sup>[4]</sup> are closely linked to factors such as precipitation, temperature<sup>[5]</sup>, and glacial ablation<sup>[6]</sup>.

In recent years, the lakes on the Qinghai-Xizang Plateau have undergone significant transformations. While most of the lakes are expanding<sup>[7,8]</sup>, some have shown a shrinking

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trend<sup>[9,10]</sup>. To achieve a precise understanding of these dynamics, long-term, continuous, and high-quality lake monitoring data are essential. In this context, the establishment of a dataset on water area changes in Butuo Lake provides a valuable basis for advancing research on climate change, ecological systems, and water resource management in the region.

Butuo Cuoqing and Butuo Cuoqiong, collectively known as Butuo Lake, are located in Dingqing County, Changdu City, within the Xizang Autonomous Region. These alpine lakes lie in the Sequ River Basin, an important tributary of the Lancang River. Among them, Butuo Cuoqing Lake extends in a north-south orientation, while Butuo Cuoqiong is located to the east. Both lakes are primarily fed by nearby glaciers, making them typical representatives of alpine lake systems<sup>[11]</sup>.

## 2 Metadata of the Dataset

The metadata of the Dataset of Butuo Lake changes in Xizang Autonomous Region of China (1988–2024)<sup>[12]</sup> is summarized in Table 1. It includes information such as the full dataset name, short name, authors, year of release, temporal and spatial resolution, data format, data size, data files, publisher, and data sharing policy.

**Table 1** Metadata summary of the Dataset of Butuo Lake changes in Xizang Autonomous Region of China (1988–2024)

Items	Description
Dataset full name	Dataset of Butuo Lake changes in Xizang Autonomous Region of China (1988–2024)
Dataset short name	ButuoLake_1988-2024
Authors	Yang, D., Climate Center of the Xizang Autonomous Region, 1136458728@qq.com Baima, Y. Z., Climate Center of the Xizang Autonomous Region, 724509860@qq.com Zhaxi, Y. Z., Climate Center of the Xizang Autonomous Region, zxyz65@163.com Zhang, W. H., Climate Center of the Xizang Autonomous Region, 839070317@qq.com Yu, X. T., Meteorological Station of the Xizang Autonomous Region, 1035762632@qq.com Cili, Y. Z., Meteorological Station of the Xizang Autonomous Region, 2254803057@qq.com
Geographical region	Dingqing County, Changdu City, Xizang Autonomous Region
Year	1988–2024
Temporal resolution	Year
Spatial resolution	16 m
Data format	.shp
Data size	377 KB
Data files	Vector boundary data and area data of Butuo Lake for 33 periods, 1988–1990, 1992, 1995–2007, 2009–2024
Foundations	Xizang Autonomous Region (XZ202301ZY0054G, XZQH202410LM02Z)
Data computing environment	ENVI, ArcGIS
Data publisher	Global Change Research Data Publishing & Repository, <a href="http://www.geodoi.ac.cn">http://www.geodoi.ac.cn</a>
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	(1) <i>Data</i> are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use <i>Data</i> subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute <i>Data</i> subject to written permission from the GCdataPR Editorial Office and the issuance of a <i>Data</i> redistribution license; and (4) If <i>Data</i> are used to compile new datasets, the “ten percent principal” should be followed such that <i>Data</i> records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset <sup>[13]</sup>
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS, GEOSS, PubScholar, CKRSC

## 3 Methods

For the data sources, Landsat images with a spatial resolution of 30 m were obtained from

the Geospatial Data Cloud<sup>[14]</sup>, while GF1 remote sensing images with a spatial resolution of 16 m were acquired from the China Centre for Resources Satellite Data and Application website<sup>[15]</sup>. To ensure data consistency, images captured during summer and autumn were preferentially selected for the study period (Table 2).

**Table 2** Remote sensing image data sources for the study area

Sensor	Row/column number or latitude/longitude	Images time	Spatial resolution (m)
Landsat5 (TM)	135/38	1988–1990, 1992, 1995–1998, 2000–2002	30
Landsat7 (ETM+)	135/38	1999, 2003–2007, 2009–2012	30
GF1-WFV4	95.1°E/31.9°N	2013-10-13	16
GF1-WFV3	95.1°E/32.3°N	2014-10-03	16
GF1-WFV2	95.0°E/30.9°N	2015-11-25	16
GF1-WFV4	95.9°E/31.9°N	2016-11-12	16
GF1-WFV1	96.3°E/31.3°N	2017-07-15	16
GF1-WFV4	95.2°E/31.8°N	2018-10-31	16
GF1-WFV4	95.2°E/31.9°N	2019-08-26	16
GF1-WFV1	95.8°E/31.3°N	2020-09-01	16
GF1-WFV1	95.7°E/31.3°N	2021-10-16	16
GF1-WFV3	96.6°E/32.3°N	2022-08-16	16
GF1-WFV4	95.4°E/31.9°N	2023-09-14	16
GF1-WFV4	95.8°E/31.8°N	2024-07-01	16

All Landsat series and GF1 remote sensing images from 1988 to 2024 were preprocessed using ENVI software. The preprocessing operations included orthorectification, image registration, and related procedures. To ensure data standardization and interoperability, the coordinate system was uniformly defined as the China National Geodetic Coordinate System (CGCS2000). Subsequently, the area of Butuo Lake was extracted through visual interpretation in ArcGIS, followed by area statistics and data verification<sup>[16]</sup>, leading to the establishment of a spatial database of lake areas.

## 4 Data Results

### 4.1 Dataset Composition

The Dataset of Butuo Lake changes in Xizang Autonomous Region of China (1988–2024) includes a total of 33 time periods of vector boundary data and area data (in .shp format), covering 1988–1990, 1992, 1995–2007, and 2009–2024. The dataset consists of 2 polygon features, with an attribute field representing the lake area (km<sup>2</sup>).

### 4.2 Data Results

The area of Butuo Lake exhibited an overall fluctuating expansion trend ( $R^2 = 0.594$ ), with an average growth rate of 0.20 km<sup>2</sup>/10a. The maximum lake area was recorded in 2019 (16.14 km<sup>2</sup>), while the minimum occurred in 1990 (15.16 km<sup>2</sup>). Over the study period, the water area increased from 15.17 km<sup>2</sup> to 15.99 km<sup>2</sup>, representing a 5.41% growth. Compared with 1988, the area in 2019 increased by 6.39% (Table 3).

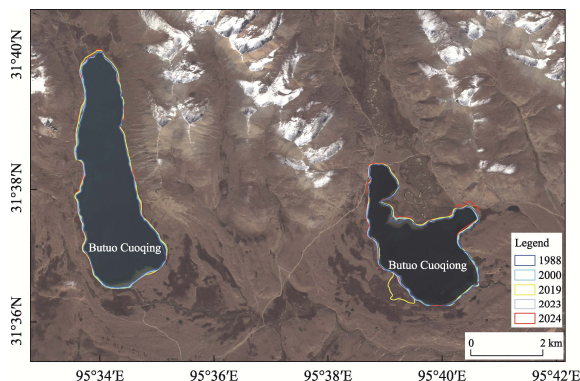
The water areas of Butuo Cuoqing and Butuo Cuoqiong showed an overall expansion trend. For Butuo Cuoqing, the average growth rate was 0.13 km<sup>2</sup>/10a ( $R^2 = 0.618,8$ ), with a maximum area of 9.55 km<sup>2</sup> recorded in 2021. During the study period, its water area increased from 8.81 km<sup>2</sup> to 9.41 km<sup>2</sup>, representing a 6.81% expansion. Compared with 1988, the area in 2021 increased by 8.40%. For Butuo Cuoqiong, the average growth rate was 0.07

$\text{km}^2/10\text{a}$  ( $R^2 = 0.368,3$ ), with a maximum area of  $6.78 \text{ km}^2$  recorded in 2019. Over the study period, its water area expanded from  $6.36 \text{ km}^2$  to  $6.59 \text{ km}^2$ , with an increase of  $3.62\%$ . Compared with 1988, the area in 2019 increased by  $6.60\%$ .

**Table 3** Statistics table of Butuo Lake area (1988–2024)

Year	Area ( $\text{km}^2$ )			Year	Area ( $\text{km}^2$ )		
	Butuo Cuoqing	Butuo Cuoqiong	Sum		Butuo Cuoqing	Butuo Cuoqiong	Sum
1988	8.81	6.36	15.17	2009	9.18	6.47	15.65
1989	8.92	6.32	15.24	2010	9.16	6.45	15.61
1990	8.88	6.27	15.16	2011	9.29	6.56	15.85
1992	9.08	6.34	15.42	2012	9.25	6.49	15.74
1995	9.06	6.34	15.40	2013	9.30	6.53	15.84
1996	9.02	6.25	15.27	2014	9.25	6.49	15.74
1997	9.04	6.40	15.43	2015	9.24	6.37	15.61
1998	9.06	6.28	15.34	2016	8.95	6.35	15.30
1999	9.11	6.41	15.52	2017	9.32	6.55	15.87
2000	9.04	6.35	15.40	2018	9.04	6.29	15.33
2001	9.02	6.39	15.41	2019	9.36	6.78	16.14
2002	9.12	6.43	15.56	2020	9.26	6.45	15.71
2003	9.10	6.39	15.49	2021	9.55	6.39	15.93
2004	9.09	6.39	15.48	2022	9.28	6.51	15.79
2005	9.16	6.44	15.59	2023	9.26	6.49	15.75
2006	9.19	6.45	15.64	2024	9.41	6.59	15.99
2007	9.23	6.52	15.75				

In terms of spatial changes in the water area (Figure 1), the northwestern shoreline of Butuo Cuoqing experienced noticeable expansion. For Butuo Cuoqiong, the most significant changes occurred in the southwestern part, followed by the northern shoreline, which also showed clear alterations. Compared with 1988, the northwestern and southeastern shores of Butuo Cuoqing expanded outward in 2019, and a pronounced expansion was observed in its southwestern part. By 2024, Butuo Cuoqing showed even greater expansion in the northwest and southeast, whereas Butuo Cuoqiong exhibited more evident growth along its northern shoreline.



**Figure 1** Spatial changes of Butuo Lake water area (1988–2024)

## 5 Discussion and Conclusion

In this study, 33 periods of Landsat and GF1 images were preprocessed through orthorectification and image registration, followed by the extraction of Butuo Lake's area. The results indicate that the lake exhibited an overall expansion trend from 1988 to 2024, with an average growth rate of  $0.20 \text{ km}^2/10\text{a}$ , reaching a maximum of  $16.14 \text{ km}^2$  in 2019. Among the 2 sub-lakes, Butuo Cuoqing expanded at an average rate of  $0.13 \text{ km}^2/10\text{a}$ , while Butuo Cuoqiong expanded at  $0.07 \text{ km}^2/10\text{a}$ . Spatially, Butuo Cuoqing showed notable expansion along its northwestern shoreline, whereas Butuo Cuoqiong experienced significant changes

in its southwestern and northern parts. The dataset of Butuo Lake changes in the Xizang Autonomous Region captures both area and spatial dynamics of the lake, providing essential support for research on climate change responses in southeastern Xizang, as well as important data for ecological security and sustainable development in the region.

### **Author Contributions**

Yang, D. designed the algorithms of dataset. Baima, Zhang, W. H. acquired and processed remote sensing image data. Baima, Y. Z. designed the model and algorithm. Yu, X. T. and Cili, Y. Z. did the data validation. Yang, D. wrote the data paper.

### **Conflicts of Interest**

The authors declare no conflicts of interest.

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