Time Series Dataset of Wuhan East Lake Changes (1990–2020)

Liu, X. Q.[1]   Ma, B. W.[2]   Wang, X.[2]   Li, D.[3]   Chen, K. L.[4*]

1. School of Environmental Studies, China University of Geosciences, Wuhan 430074, China;
2. School of Geography and Information Engineering, China University of Geosciences, Wuhan 430074, China;
3. Institute of Geography and Tourism, Guangdong University of Finance & Economics, Guangzhou 510320, China;
4. School of Physical Education, China University of Geosciences, Wuhan 430074, China

Abstract: East Lake of Wuhan exists as a large urban lake in the eastern fringe of Wuhan, a comprehensive mega city. This area had experienced rapid urbanization in recent years, and it is an ideal area to study the changes of urban water body under the progress of rapid urbanization. Based on the Landsat Image (with a spatial resolution of 30 m), the data of the water body for East Lake is extracted based on the Modified Normalized Difference Water Index (MNDWI) and refined by referring to the images on Google Earth. Then the final data for 1990, 1995, 2000, 2005, 2010, 2015 and 2020 are obtained. The statistical results show that the water body of the East Lake had shrunk by 14% (5.10 km^2), and the shoreline length had been reduced by 22% (43.47 km). The dataset is archived in .shp and .kmz formats in seven files with the data size of 1.91 MB.

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.2021.04.06.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2021.04.06.V1.

1 Introduction

As an important part of urban wetland system, urban lake plays an important role in urban development, ecosystem balance and flood control[1–3]. In recent years, with the continuous progress of urbanization, the expansion of urban built-up areas had brought economic prosperity to the urban waterfront. However, there are bad influences such as the aggravation of water pollution, the decline of flood control capacity, the deterioration of ecological security and the reduction of biodiversity[4,5].

Data Citation: [1] Liu, X. Q., Ma, B. W., Wang, X., *et al*. Time series dataset of Wuhan East Lake changes (1990–2020) [J]. *Journal of Global Change Data & Discovery*, 2021, 5(2): 143–147. https://doi.org/10.3974/geodp.2021.02.05. https://cstr.escience.org.cn/CSTR:20146.14.2021.02.05.
[2] Liu, X. Q., Ma, B. W., Wang, X., *et al*. Time series dataset of Wuhan East Lake changes (1990–2020) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2021. https://doi.org/10.3974/geodb.2021.04.06.V1. https://cstr.escience.org.cn/CSTR:20146.11.2021.04.06.V1.

East Lake of Wuhan is located on the South Bank of the Yangtze River Basin, with a water area of about 30 km^2, which is six times larger than the West Lake in Hangzhou. Before 2014, East Lake was the largest urban lake in China[6]. With the rapid development of society and economy, Wuhan had undergone a rapid urbanization process after the reform and opening up. The central city had been expanding continuously, as a result, the water body of East Lake had been occupied and the area is increasingly shrinking. After 2014, East Lake had been ranking as the second largest urban lake in China, after Tangxun Lake also in Uwhan. It is good for the protection of Lake wetland system, the coordination of urban development, environment and urban landscape planning and management to know the water body change process of East Lake for the reason that East Lake is one of the most typical urban lakes in the Yangtze River Basin and even in China.

In this study, seven periods of remote sensing image data of East Lake from 1990 to 2020 were collected. The remote sensing image of water body was extracted and modified by means of ENVI and ArcGIS platform. The 1990–2020 morphological change dataset is achieved by calculating the area and shoreline length.

2 Metadata of the Dataset

The metadata of the Time Series Dataset of Wuhan East Lake Changes (1990–2020)[7] is summarized in Table 1[8].

3 Methods

3.1 Raw Data

The data of this study is obtained from USGS website[1]. The spring and summer in the research area are rainy seasons and rains frequently and heavily. Therefore, the cloud in the remote sensing image is dense and the boundary of the water body is not clear. Therefore, the remote sensing data in the season with little rain in autumn and winter are selected in this study to avoid the above problems.

This study selected seven Landsat remote sensing images, including 1990/09/02, 1995/08/31, 2000/09/13, 2005/09/11, 2010/12/30, 2015/10/12, 2020/08/03 (column number 123/039, with cloud cover below 10%), to extract the water body information of East Lake in Wuhan[10].

3.2 Algorithm Principle

(1) Based on ENVI software, the Modified Normalized Difference Water Index (MNDWI) was used to extract the water body of East Lake[10,11]: ① the remote sensing image is preprocessed by radiometric calibration and atmospheric correction; ② calculate MNDWI index; ③ judge whether there are abnormal values, if there are abnormal values, eliminate the abnormal values; ④ by adjusting the parameters and combining with the existing domestic research, the threshold value is set to 0.2 to separate land from water; ⑤ extracting water body data.

(2) Based on the ArcGIS technology platform and combined with the data correction of Google Earth image in the same period, the smooth tool in ArcGIS software was used to smooth the jagged boundary in the interpretation and make it closer to the actual boundary. After tests, it can be seen that when the smoothing tolerance is 90 m, it is closest to the actual boundary. After finishing the boundary smoothing work, the extracted data were

---

[1] USGS. https://earthexplorer.usgs.gov/.

refined by referring the Google Earth images of the same period.

(3) The area and shoreline length of East Lake in different periods are calculated by using the calculation tools of ArcGIS.

Table 1   Metadata summary of the Time series dataset of Wuhan East Lake Changes (1990–2020)

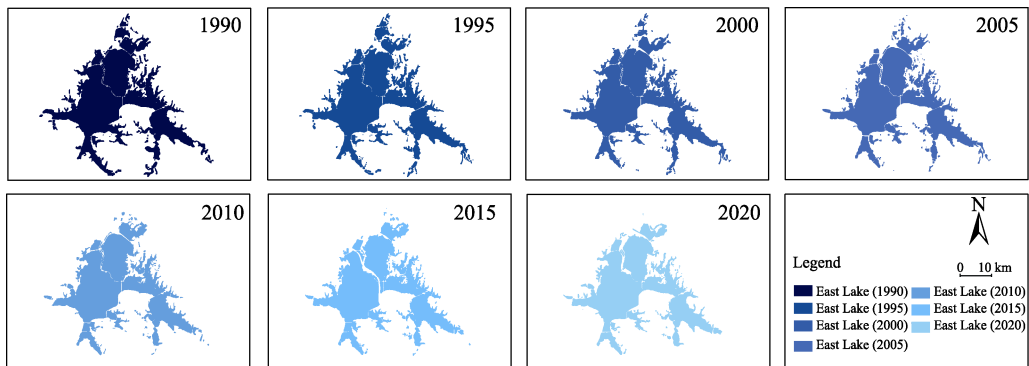| Items	Descriptions
Dataset full name	Dataset of water changes in East Lake of Wuhan (1990–2020)
Dataset short name	EastLake_1990-2020
Authors	Liu, X. Q., School of Environmental Studies, China University of Geosciences, Wuhan, dancy_cug@163.com
	Ma, B. W., School of Geography and Information Engineering, China University of Geosciences, Wuhan, m.bowen@foxmail.com
	Wang, X., School of Geography and Information Engineering, China University of Geosciences, Wuhan, jorrywangxu@163.com
	Li, D., Institute of Geography and Tourism, Guangdong University of Finance & Economics, danl_163@163.com
	Chen, K. L., School of Physical Education, China University of Geosciences, Wuhan, chenkl@cug.edu.cn
Geographical region	Hongshan district of Wuhan city Year 1990–2020
Spatial resolution	30 m Data format .shp
Data size	1.91 MB (compressed to 1 file, 1.07 MB)
Data files	Water data of East Lake in 1990/09/02, 1995/08/31, 2000/09/13, 2005/09/11, 2010/12/30, 2015/10/25 and 2020/08/03
Foundation(s)	Ministry of Education of P. R. China (CUG2018123)
Data computing environment	ENVI and ArcGIS
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[9]
Data and paper retrieval system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

4 Data Results

This dataset contains seven periods of water body data of East Lake of Wuhan in 1990, 1995, 2000, 2005, 2010, 2015 and 2020, which show the water body changes of the East Lake during the most recent 30 years.

The dataset indicates that the water area of Wuhan East Lake had changed significantly from 1990 to 2020 (Table 2, Figure 1), it shrunk from 35.57 km^2 in 1990 to 30.48 km^2 in 2020, and the lake area decreased by 14% (5.1 km^2) from 1990 to 2020. In addition, the shoreline length of East Lake had been decreasing in the past 30 years and increasing in some years. The shoreline length was 198.58 km

Table 2 Area and Perimeter Shoreline Length of East Lake (1990–2020)

Year	Area (km^2)	Perimeter (km)
1990	35.57	198.58
1995	34.40	201.08
2000	33.40	181.18
2005	32.27	179.19
2010	31.61	175.44
2015	31.27	178.52
2020	30.48	155.11

in 1990 and reduced to 155.11 km in 2020. Up to 2020, the shoreline length of East Lake had decreased by 22% (43.47 km). In general, the decrease of shoreline mainly occurred in 1995–2000 and 2015–2020.

Figure 1   Maps of morphological evolution of East Lake (1990–2020)

From 1990 to 1995, the area of East Lake decreased from 35.57 km^2 to 34.40 km^2, with a decrease rate of 3% (1.17 km^2), and the shoreline length increased slightly from 198.58 km to 201.08 km. During this period, a small amount of water body of East Lake was occupied, which reduced the water area in the north and southeast. The occupied part of the water body made the shoreline of East Lake more complex and the water bodies more fragmented.

From 1995 to 2000, the area of East Lake decreased from 34.40 km^2 to 33.40 km^2, with a reduction rate of 3% (1 km^2), and the shoreline length also decreased from 201.08 km to 181.18km, with a reduction rate of 10% (19.90 km). During this period, the area decrease mainly occurred in the northeast coastal area of East Lake, and the occupied part of the water body was mainly in sheet shape, making the shoreline of the northeast part of the water body tend to be simpler.

From 2000 to 2005, the area of East Lake decreased from 33.40 km^2 to 32.27 km^2, with a reduction rate of 3% (1.13 km^2), and the shoreline length slightly decreased from 181.18 km to 179.19 km, with a reduction rate of 1% (1.99 km). During the past 5 years, the area of East Lake decreased sporadically in coastal villages, which occupied a small amount of East Lake water, reducing the area of East Lake water and shortening the shoreline.

From 2005 to 2010, the area of East Lake decreased from 32.27 km^2 to 31.61 km^2, with a decrease rate of 1% (0.66 km^2), and the shoreline length decreased from 175.44 km to 175.44 km, with a decrease rate of 2% (3.75 km). During this period, the water body in the north and southeast of the East Lake was obviously encroached, which reduced the area and shoreline length of East Lake.

From 2010 to 2015, the area of East Lake reduced from 31.61 km^2 to 31.27 km^2 and the reduction rate is 1% (0.34 km^2). The shoreline length increased from 179.19 km to 178.52 km, with a growth rate of 2% (3.08 km). During this period, the water body along the north bank of East Lake continued to be occupied, and the shape of the water body changed due to the construction of tunnels in the lake.

From 2015 to 2020, the area of East Lake reduced from 31.27 km^2 to 30.48 km^2, with a decrease rate of 1.4% (5.10 km^2), and the length of shoreline reduced from 178.52 km to 155.11 km, with a decrease rate of 22% (23.41 km). During this period, the change of water body of East Lake mainly occurred in the outer boundary of the water area, which reduced the area and simplified the shoreline.

5 Conclusion

As the most typical urban lake in the Yangtze River Basin and even in China, East Lake plays an important role in the urban development, flood control and storage, and even

ecological security of Wuhan[12,13]. It is more necessary to understand the evolution of East Lake morphology. Based on Landsat remote sensing images and Google Earth images from 1990 to 2020, we extracted the water data of East Lake with ENVI and ArcGIS platforms. On this basis, the water area and shoreline length of East Lake in different years were calculated to determine the water changes of East Lake. The dataset of East Lake water changes in Wuhan plays a vital role in studying the morphological evolution of East Lake, understanding the characteristics of urban development stage in Wuhan, analyzing the ecological security pattern of East Lake and its surrounding areas and regional environment protection, and is also an indispensable geographical basic data.

Author Contributions
Liu, X. Q., and Chen, K. L. designed the algorithms of dataset. Ma, B. W., Wang, X., and Li, D. contributed to the data collection. Liu, X. Q., and Ma, B. W. contributed to the data processing and analysis. Liu, X. Q. wrote the data paper. Chen, K. L. revised the data paper.

Conflicts of Interest
The authors declare no conflicts of interest.

References

[1]   Chen, K. L., Qi, M., Wang, X., *et al*. Study of urban lake landscape ecological security pattern evolution in Wuhan, 1995–2015 [J]. *Acta Ecologica Sinica*, 2019, 39(5): 1725–1734.
[2]   Chen, K. L., Liu, X. Q., Chen, X., *et al*. Spatial characteristics and driving forces of the morphological evolution of East Lake, Wuhan [J]. *Journal of Geographical Sciences*, 2020, 30(4): 583–600.
[3]   Xie, Q. J., Liu, J. H. Spatio-temporal dynamics of lake distribution and their impact on ecosystem service values in Wuhan urbanized area during 1987–2016 [J]. *Acta Ecologica Sinica*, 2020, 40(21): 7840–7850.
[4]   Liang, C. M., Zhang, X., Li, Z. L., *et al*. Temporal and spatial evolution characteristics of river and lake system in the urbanization process of Wuhan city [J]. *Journal of North China University of Water Resources and Electric Power* (*Natural Science Edition*), 2019, 167(6): 65–72.
[5]   Kong, L. Q., Zhang, L., Zheng, H., *et al*. Driving forces behind ecosystem spatial changes in the Yangtze River Basin [J]. *Acta Ecologica Sinica*, 2018, 38(3): 741–749.
[6]   Chen, K. L., Wang, X., Li, D., *et al*. Driving force of the morphological change of the urban lake ecosystem: A case study of Wuhan, 1990–2013[J]. Ecological Modelling, 2015, 318: 204–209.
[7]   Liu X. Q., Ma B. W., Wang X., *et al*. Time series dataset of Wuhan East Lake changes (1990–2020) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2021. http://doi.org/10.3974/geodb. 2021.04.06.V1. https://cstr.escience.org.cn/CSTR:20146.11.2021.04.06.V1.
[8]   Li, J. L., Tian, P., Shan, S. Y., *et al*. East China sea coastline dataset (1990–2015) [J]. *Journal of Global Change Data* & *Discovery*, 2019, 11(3): 50–56. https://doi.org/10.3974/geodp.2019.03.05.
[9]   GCdataPR Editorial Office. GCdataPR data sharing policy [OL]. http://doi.org/10.3974/10.3974/dp.policy. 2014.05 (Updated 2017).
[10]   Chen, K. L., Xu, H. M., Li, Z. G., *et al*. The spatial characteristics and formation mechanism of urban rainstorm waterlogging under the influence of human activities in Wuhan [J]. *Economic Geography*, 2020, 267(5): 132–138, 222.
[11]   Xu, Q. H. A study on information extraction of water body with the modified normalized difference water Index (MNDWI) [J]. *Journal of Remote Sensing*, 2005, 9(5): 79–85.
[12]   Zhou, W. C., Shi, Y. H., Pan, L., *et al*. Evaluation of final service value of Donghu Lake wetland ecosystem in Wuhan city in 2017 [J]. *Wetland Science*, 2019, 17(3): 60–65.
[13]   Du, N., Ottens, H., Sliuzas, R. Spatial impact of urban expansion on surface water bodies—a case study of Wuhan, China [J]. *Landscape and Urban Planning*, 2010, 94(3/4): 175–185.