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The Analysis of water security and challenges in Guangdong-Hong Kong-Macao Greater Bay Area based on RS and GIS

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XVIII WORLD WATER CONGRESS Water for All Harmony between Humans and Nature

第18届 世界水资源大会 水与万物: 人与自然和谐共生

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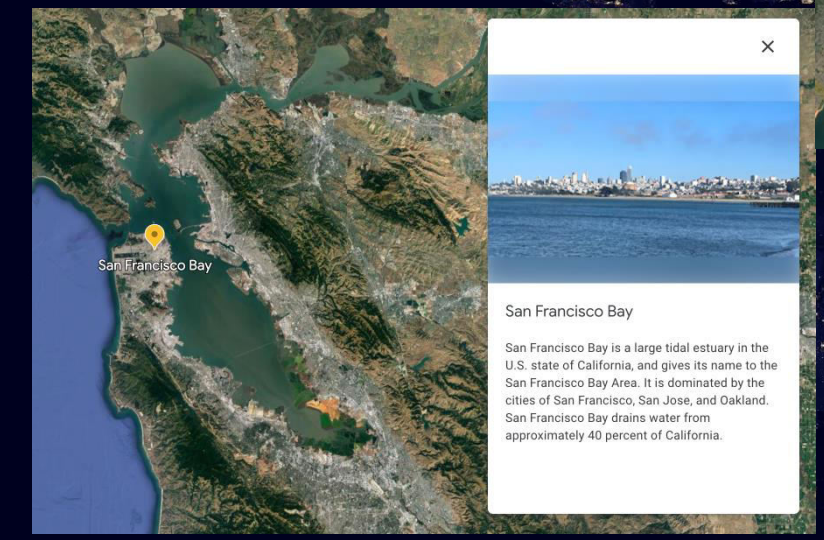
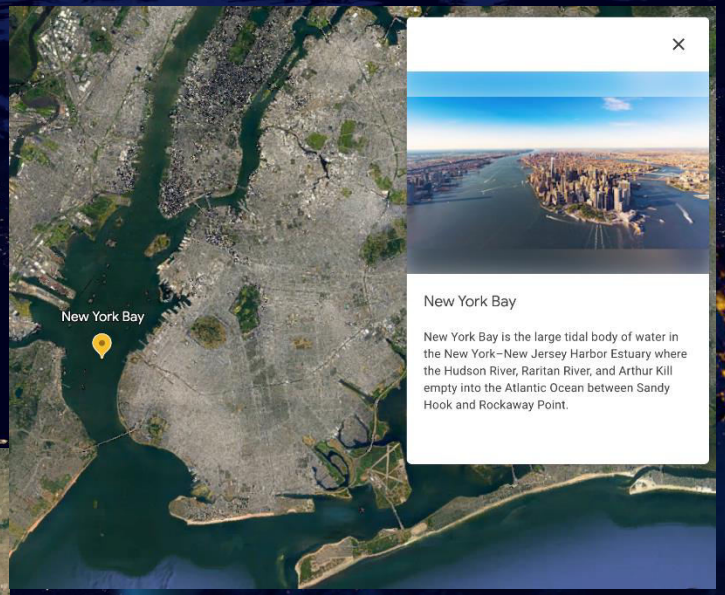
Content



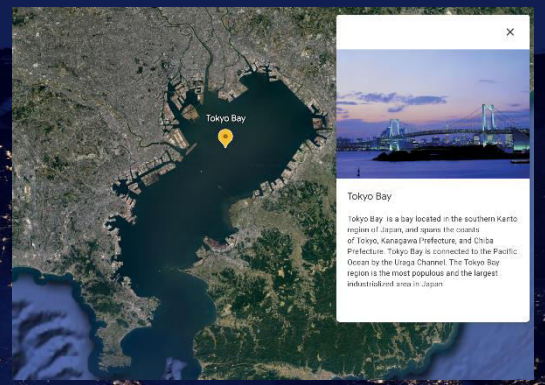
San Francisco Bay

San Francisco Bay is a large tidal estuary in the U.S. state of California, and gives its name to the San Francisco Bay Area. It is dominated by the cities of San Francisco, San Jose, and Oakland. San Francisco Bay drains water from approximately 40 percent of California.



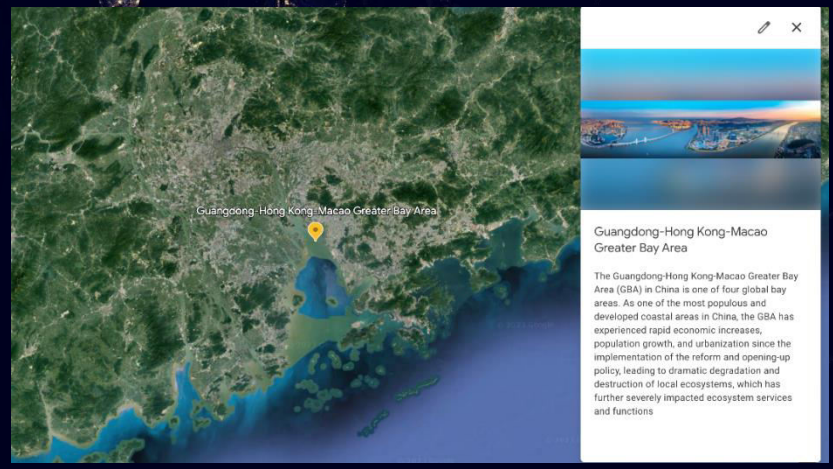
New York Bay

New York Bay is the large tidal body of water in the New York–New Jersey Harbor Estuary where the Hudson River, Raritan River, and Arthur Kill empty into the Atlantic Ocean between Sandy Hook and Rockaway Point.



Tokyo Bay

Tokyo Bay is a bay located in the southern Kanto region of Japan, and spans the coasts of Tokyo, Kanagawa Prefecture, and Chiba Prefecture. Tokyo Bay is connected to the Pacific Ocean by the Uraga Channel. The Tokyo Bay region is the most populous and the largest industrialized area in Japan.



Guangdong-Hong Kong-Macao Greater Bay Area

The Guangdong-Hong Kong-Macao Greater Bay Area (GBA) in China is one of four global bay areas. As one of the most populous and developed coastal areas in China, the GBA has experienced rapid economic increases, population growth, and urbanization since the implementation of the reform and opening-up policy, leading to dramatic degradation and destruction of local ecosystems, which has further severely impacted ecosystem services and functions

Introduction

Location.

The Greater Bay Area is located in Guangdong Province (21° 25' N-24° 30' N, 111° 12' E-115° 35' E), and its urban cluster consists of nine prefecture-level cities - Guangzhou, Shenzhen, Zhuhai, Foshan, Dongguan, Zhongshan, Huizhou, Jiangmen and Zhaoqing - and two special administrative regions - Hong Kong and Macau - located in the lower reaches of the Pearl River.

Climate.

The climate of the region is a southern subtropical maritime monsoon climate, with an annual average temperature of about 22 ℃. It has rainy summers and frequent typhoons, and is unpredictable cold and warm in winter.

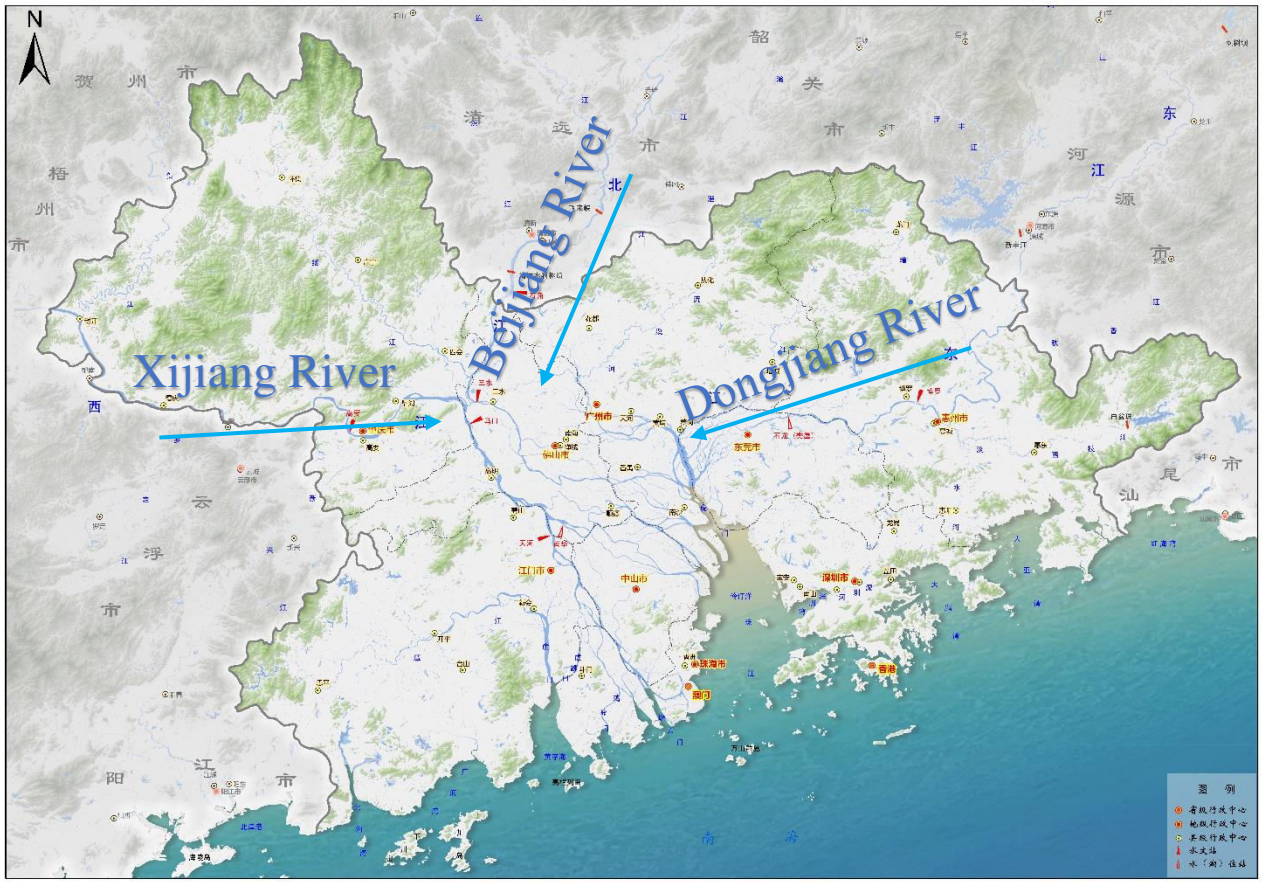
Economic.

As one of the three national development strategies, the Guangdong-Hong Kong-Macao Greater Bay Area accounts for 0.6% of China's total land area, 5% of the country's population, while 15% of the country's GDP, making it an important pole of economic growth in.

Study Area

Introduction

The water situation characteristics of the GBA



The water system is complicated

Water scarcity

Frequent disasters

Biological diversity

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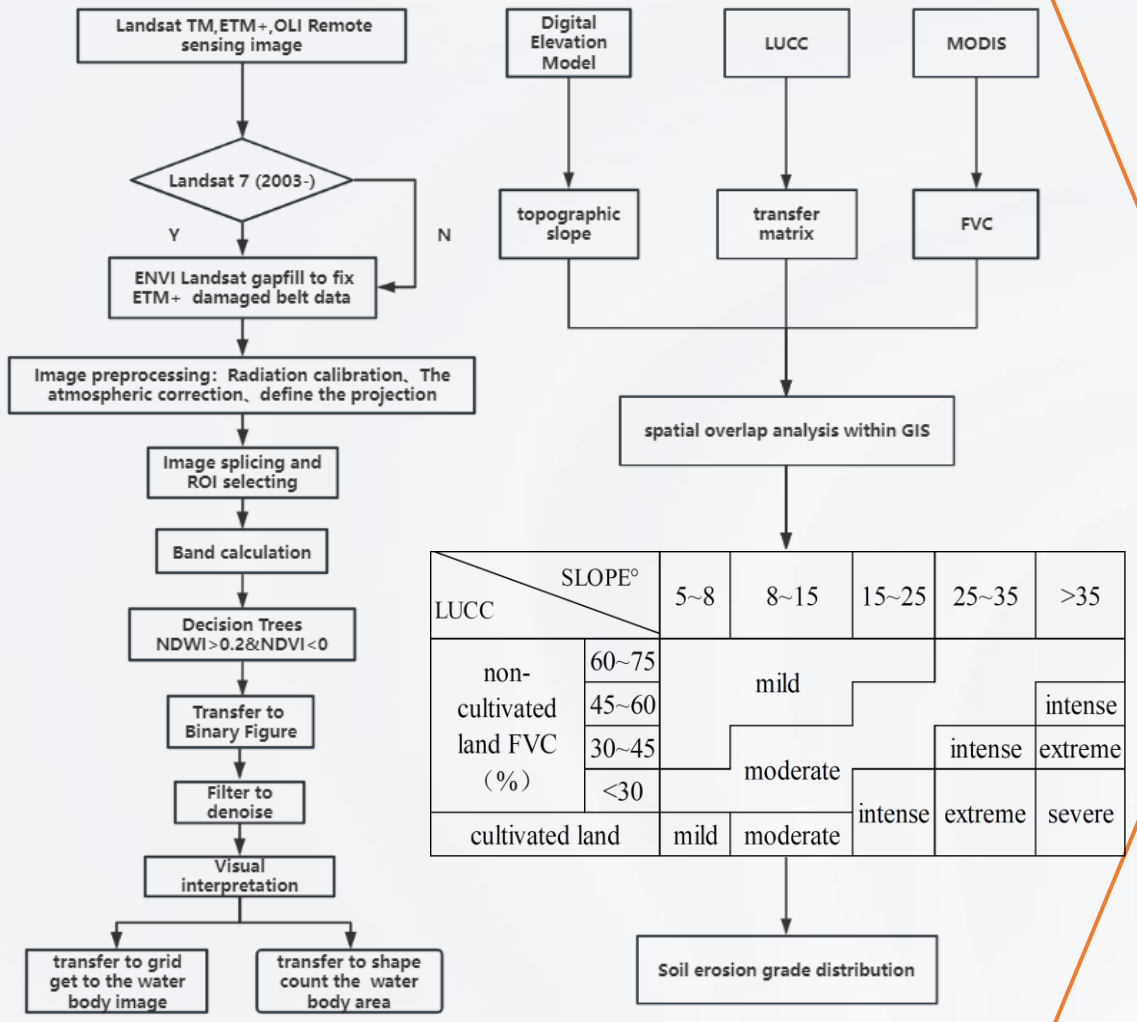
Method

Multi-source Data

- **Landsat 7\8 (track numbers : [122, 44], [121, 45], [122, 45], [122, 45])with a spatial resolution of 30m and open access is selected. The images with less than 20% cloud coverage were screened and data were obtained from the U.S. Geological Survey;**
- **LUCC data were obtained from the European Space Agency, and Digital Elevation Model data were obtained from the Institute of Geographical Sciences and Resources, Chinese Academy of Sciences;**
- **MOD13Q1 product released by NASA Space Center, the orbital number is h28v06, the temporal resolution is 16d,**
- **A total of five years of above remote sense images from 2000, 2005, 2010, 2015 and 2018 were selected.**

Technichal Route



LUCC \ SLOPE°		5~8	8~15	15~25	25~35	>35
non-cultivated land FVC (%)	60~75	mild	mild	mild	mild	intense
	45~60				intense	extreme
	30~45		moderate	moderate		
	<30			intense	extreme	severe
cultivated land		mild	moderate			

Method

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Waterbody Extraction

The water body index method is based on the inter-spectral feature relationship, and enhances the contrast degree between water bodies and other features to identify water body information through the ratio operation between feature bands.

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

NDWI (normalized difference water index) is based on green/near infrared band composition, which can highlight the water information in the image and suppress the vegetation information to the maximum extent, with positive values for water and zero or negative values for vegetation and soil.

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

NDVI (Normalized Difference Vegetation Index) is one of the most important indicators in vegetation monitoring, through which different covers such as vegetation, soil and water bodies can be distinguished, with more than 0.2 indicating vegetation and less than 0 indicating water bodies.

Water and Soil Erosion Analysis

Make full use of remote sensing image interpretation, vegetation coverage inversion, topographic slope factor calculation, multi-factor spatial superposition analysis and other technologies and methods, and utilizes multi-factor comprehensive discrimination to complete the classification of soil and water loss intensity.

$$VFC = (NDVI - NDVIsoil) / (NDVIveg - NDVIsoil)$$

Vegetation coverage (FVC) is defined as the percentage of vertical projected area of vegetation (including leaves, stems, and branches) per unit area. It is one of the most important indicators to measure the status of surface vegetation and indicate the change of ecological environment.

land-use transfer matrix

The land use transfer matrix can reflect the dynamic process of inter-class transformation in the beginning and end of the study period, including the area and direction of inter-class transformation.

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Analysis and Discussion

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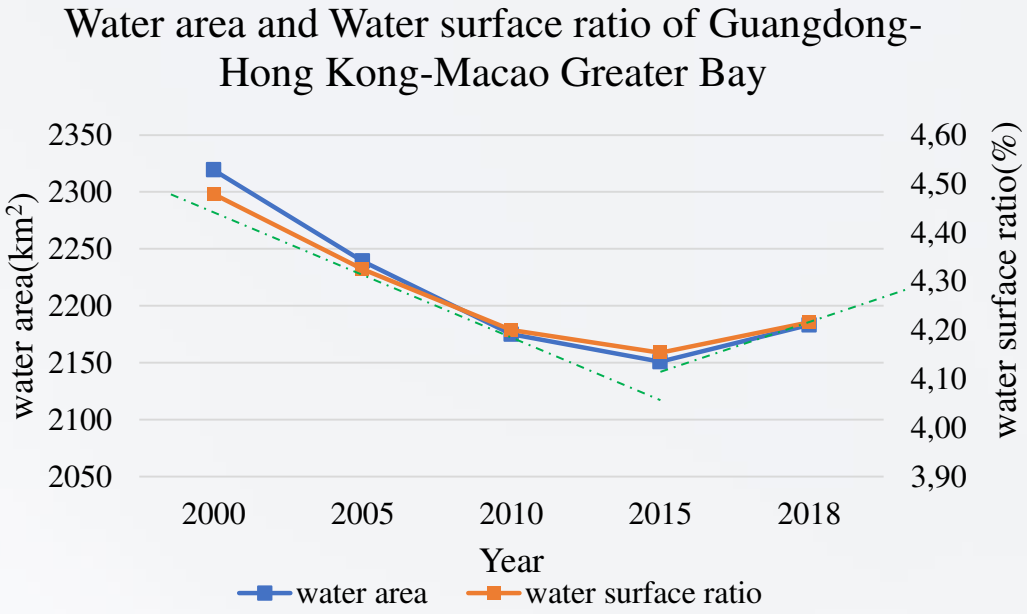
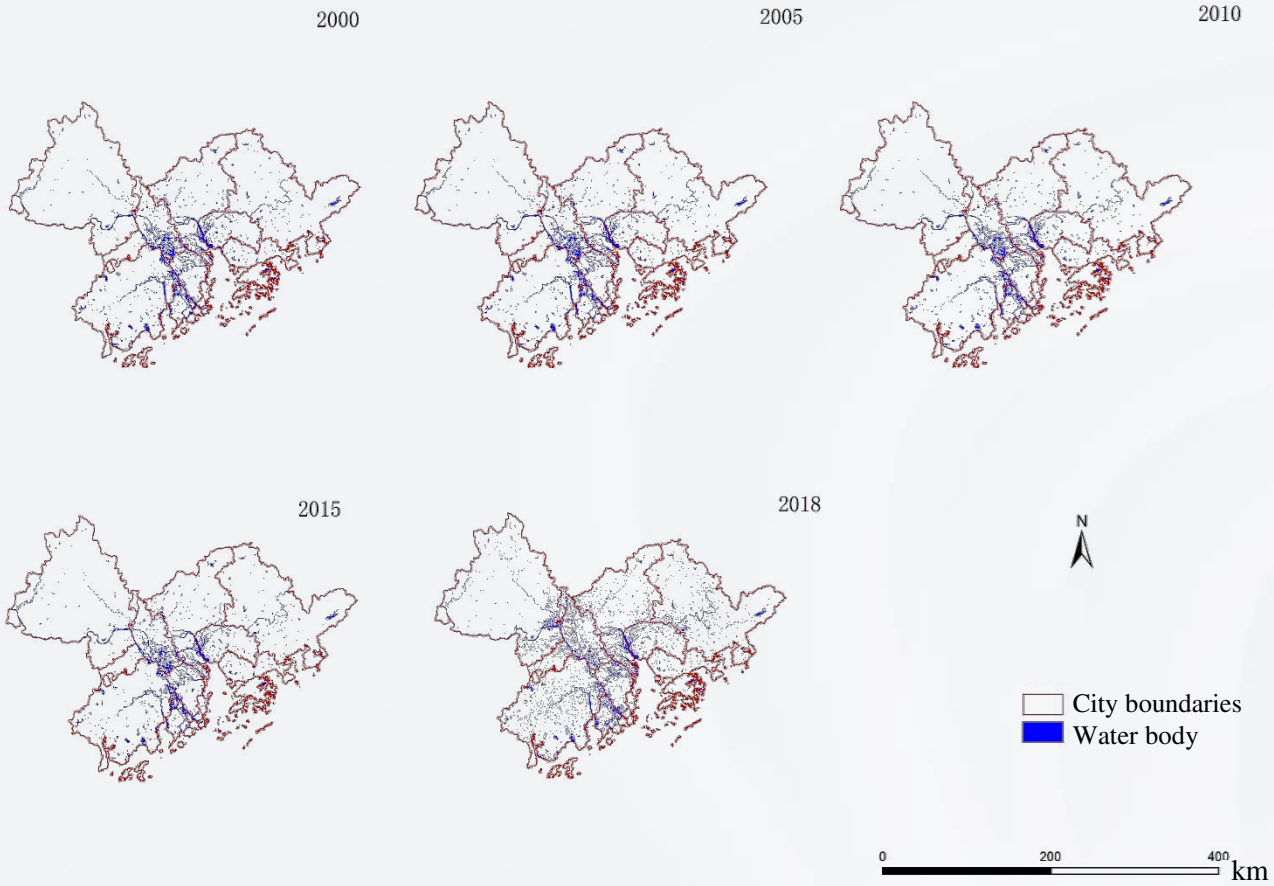
Overall, the water area of GBA in the past 20 years has generally decreased and then increased. The total water area has decreased about 200km^2 from 2000 to 2018, and then has an slightly increasing trend. The water surface ratio decreased from 4.48% to 4.15% and then increased to 4.22%.





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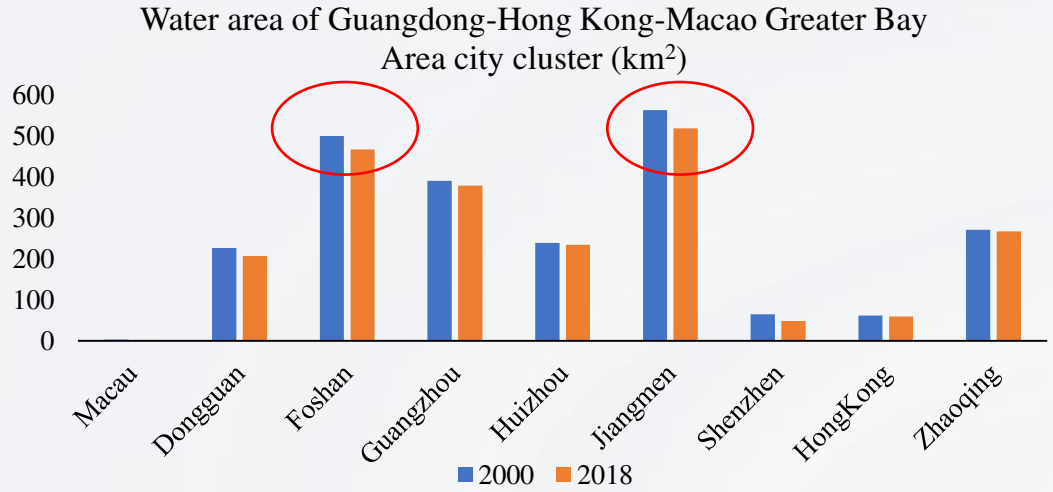
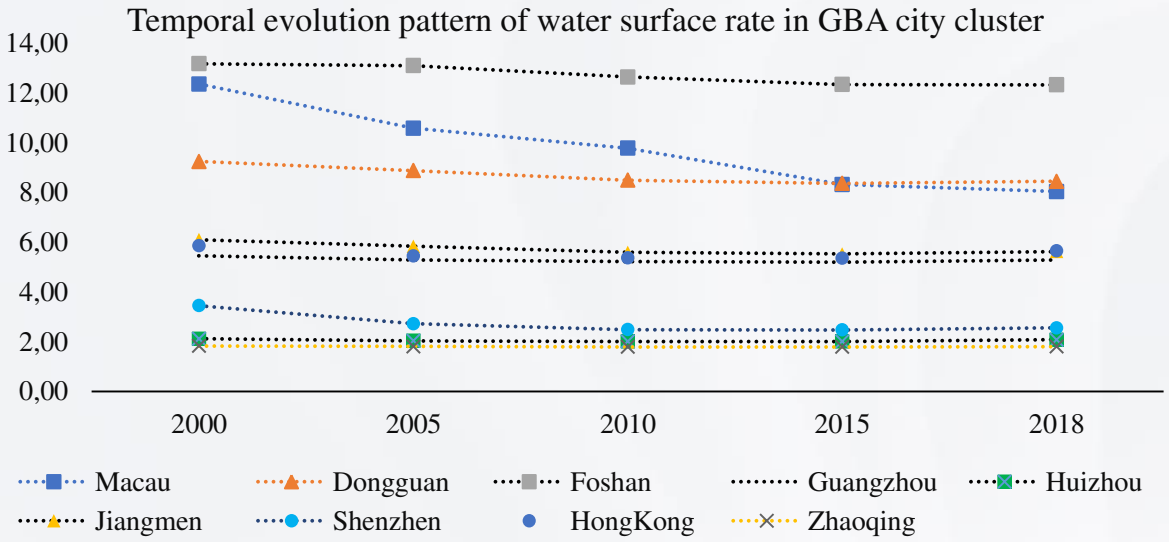
When comparing the water area of GBA in 2000 and 2018, we found that, in general, the water area of all cities had shown a decreasing trend in the past 20 years. Among them, the water area of Jiangmen decreased the most, with a decreased of 44.20 km². The second one was Foshan which was decreased by 32.34 km². And the water area of remaining cities was decreased by no more than 20 km².

From the analysis of the changes in the water surface ratio of various cities from 2000 to 2018, the water surface ratio of Macao and Foshan continued to decrease. The water surface ratio of Macao was decreased most, and the reduction rate was -0.24%/a. As for the water surface ratio of Foshan, the reduction rate was -0.04%/a. The water surface rates of remaining cities have increased from 2015.





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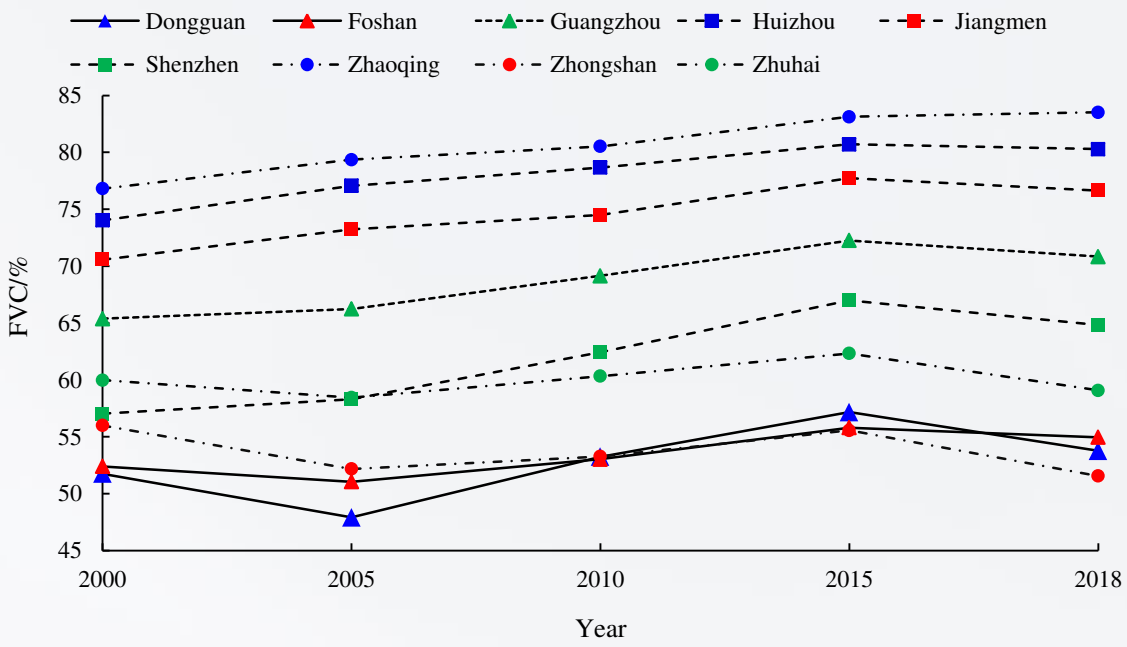
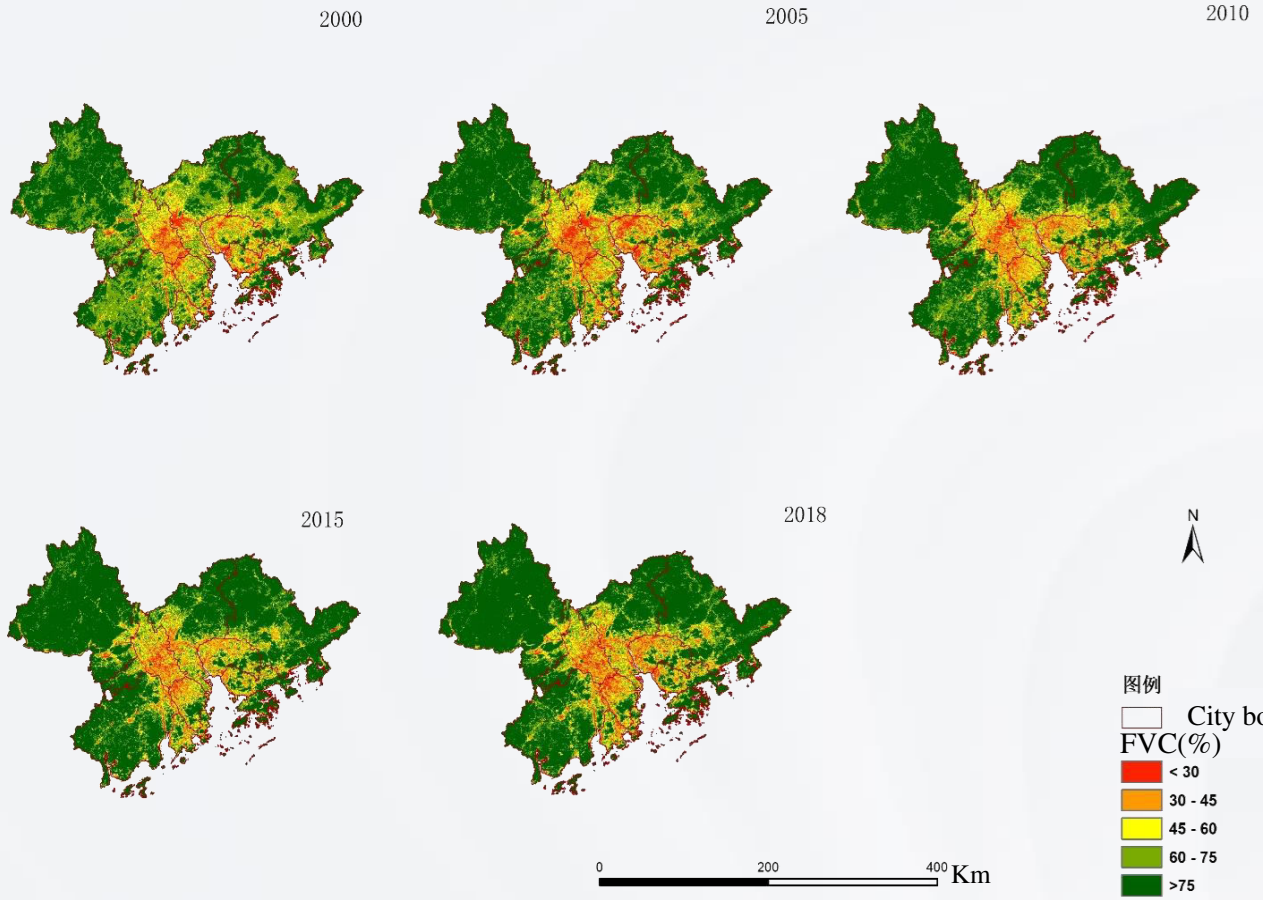
The GBA has become "green" as a whole, and vegetation cover has shown a significant increase trend. The average vegetation cover of the Bay Area has increased from 61.68% in 2000 to 65.54% in 2018. The vegetation coverage of prefecture-level cities showed a significant increase trend before 2015, with an average growth slope of 0.39%/a, but a slight decline trend after 2015;





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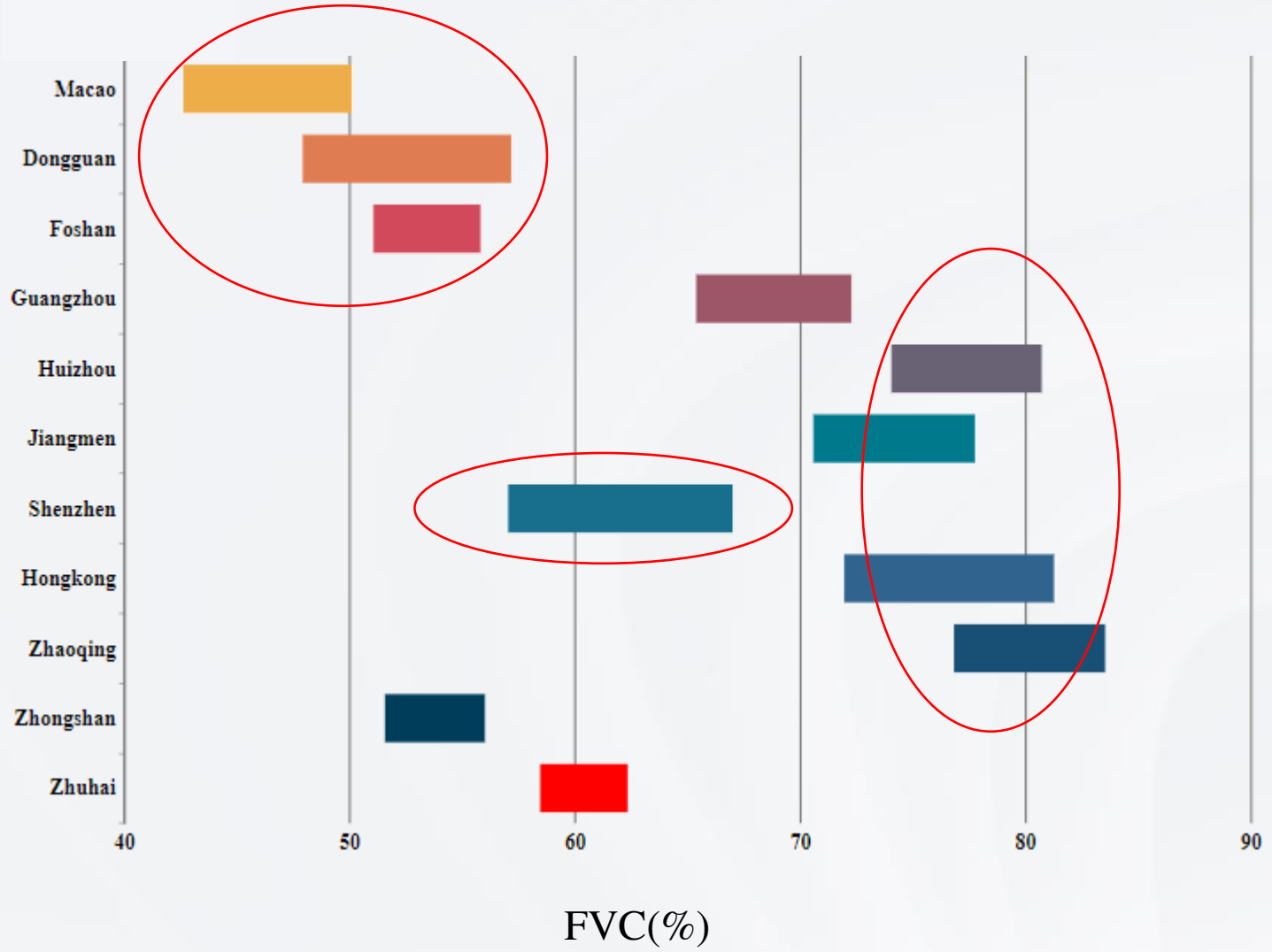
- **The vegetation coverage of Zhaoqing, HongKong, Huizhou are relatively high, and the vegetation coverage are ranging from 70% to 85% in the past 20 years, and all reach more than 80% in 2018.**

The vegetation coverage in Foshan, Zhongshan and Dongguan and Macao are relatively low, with no more than 55% vegetation coverage in 2018.

Compared with other cities, the vegetation coverage of Shenzhen city increased faster, with an average growth rate of 0.52%/a.



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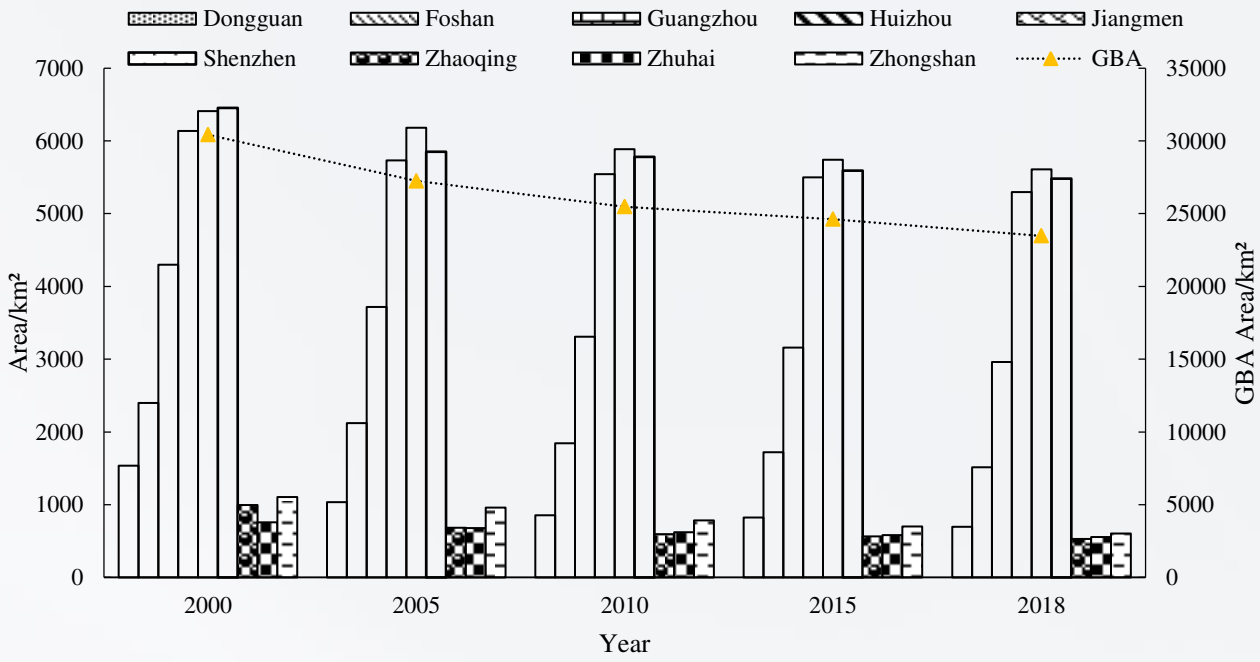
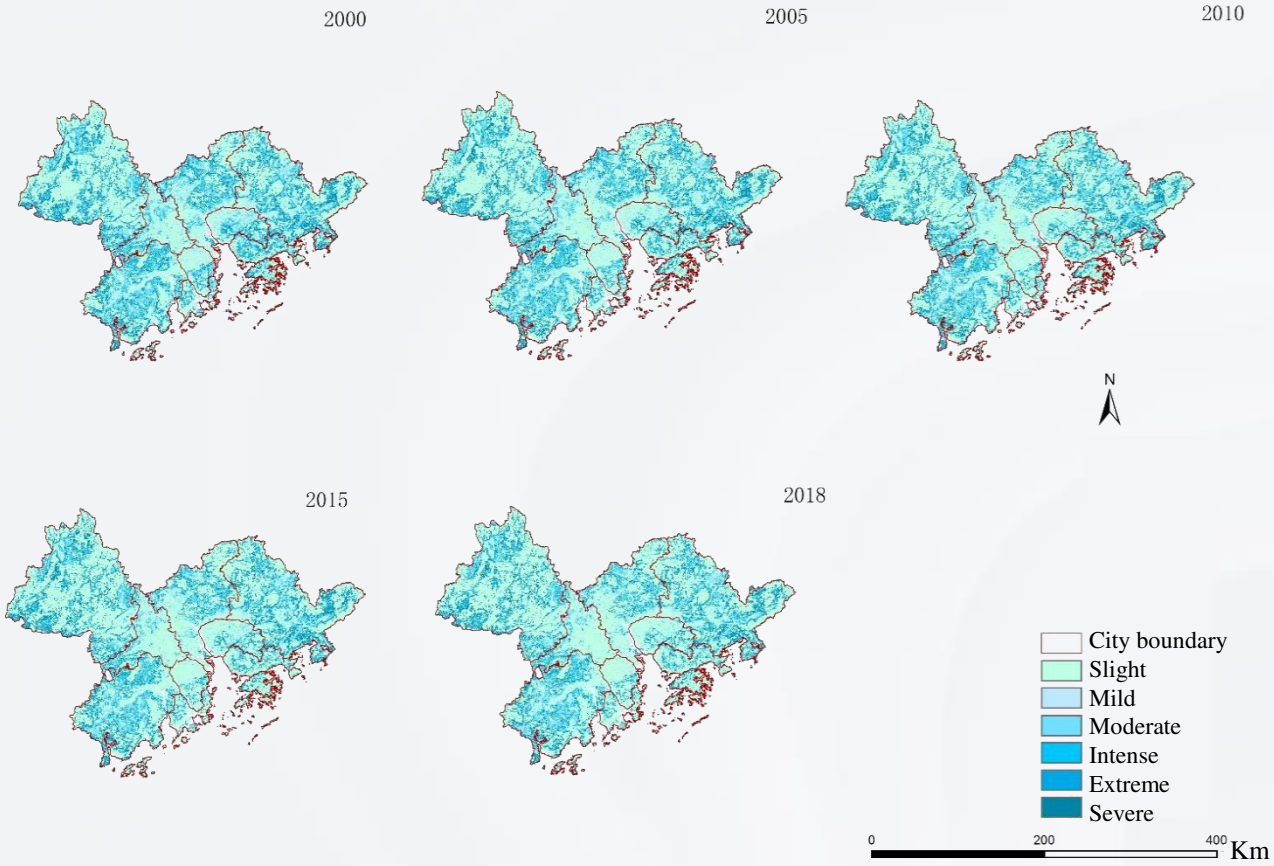
In the past 20 years, the area of soil and water loss in the Guangdong-Hong Kong-Macao Greater Bay Area has generally shown a decreasing trend, and the total area of soil and water loss has decreased about 7000 km², with a reduction rate of -385km²/a. The proportion of soil and water loss in China's total land area decreased from 55.78% to 43.06%.





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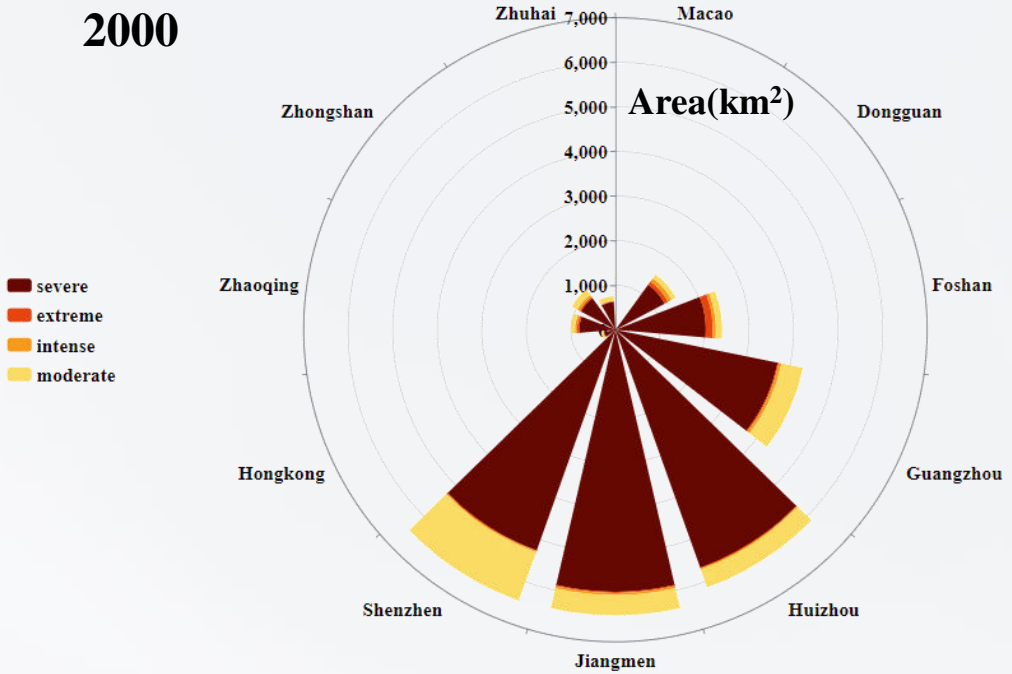
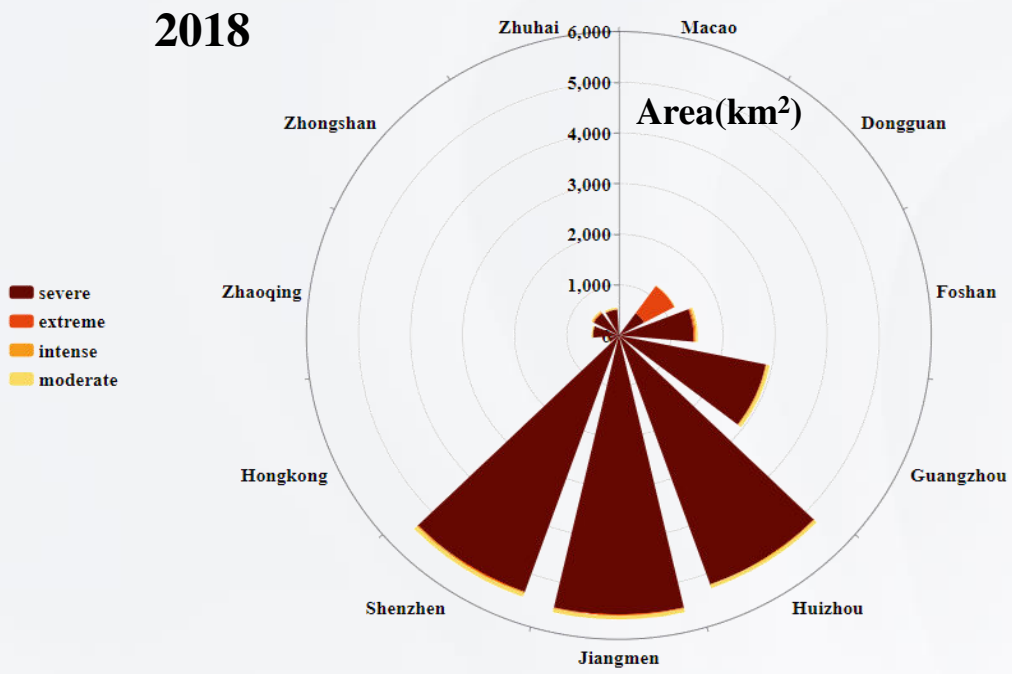
From the perspective of soil erosion intensity level change: In the Guangdong-Hong Kong-Macao Greater Bay Area, soil erosion of different degrees has shown a decreasing trend in recent 20 years. Moderate and severe soil erosion are the main erosion types, and moderate soil erosion has been the most significantly improved, decreasing by 4% of the land area. The changes of other soil erosion areas were stable. In prefecture-level cities, moderate or severe erosion was dominant, and the erosion area showed a decreasing trend, and the moderate erosion area decreased the fastest. Shenzhen, Jiangmen, Huizhou still have more areas of severe erosion of soil and water area. The improvement of soil and water loss control is the most significant in Guangzhou, where the reduction rate is -59.06%/a.





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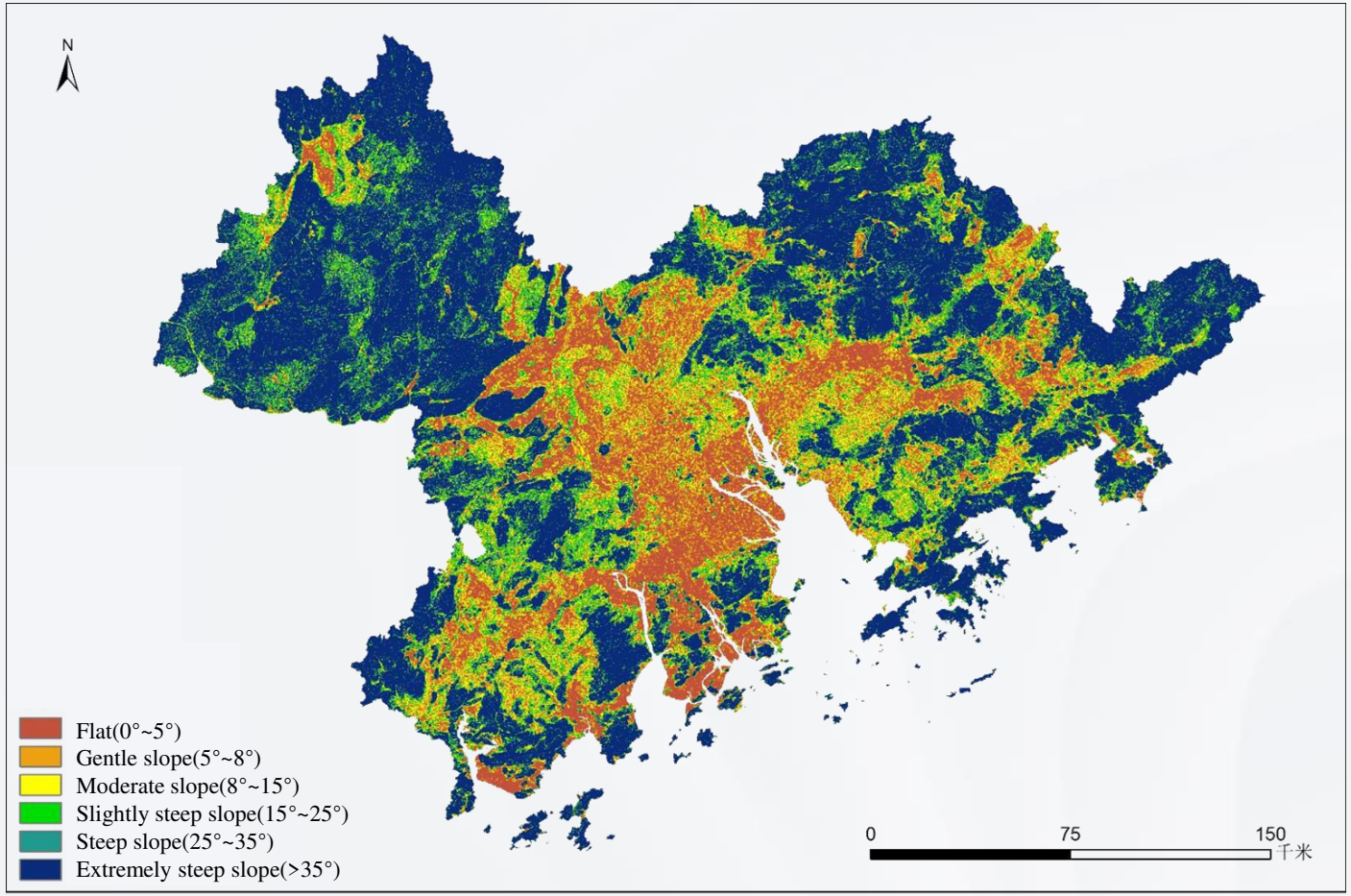
In Guangdong-Hong Kong-Macao Greater Bay Area, the soil loss in sloping land above 25° is 2-3 times higher than that in ordinary sloping land. In terms of spatial distribution, steep slopes in the GBA are concentrated, mainly in non-urban central areas in the northeast and northwest of the Bay Area, while the Pearl River Delta region is relatively flat.



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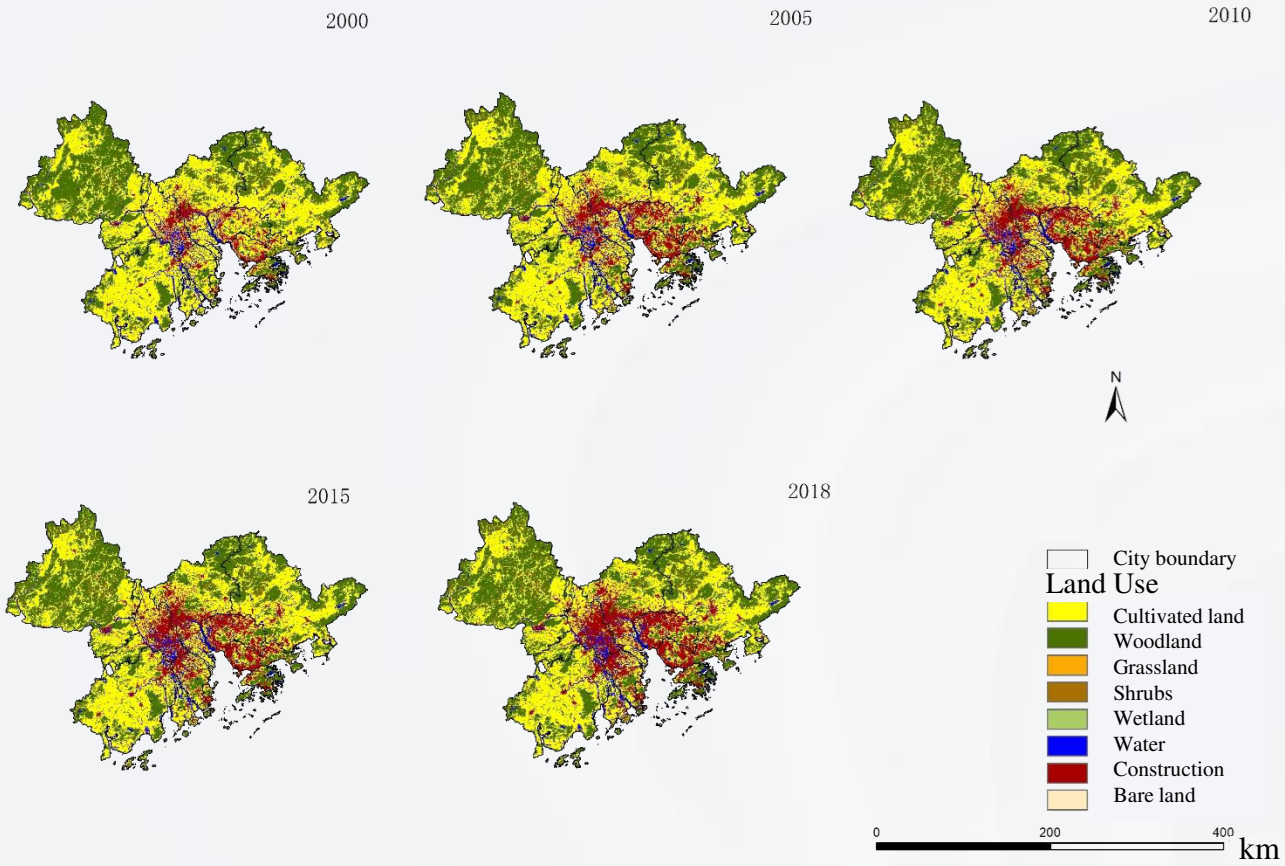
The main types of land usage in the GBA are divided into cultivated land, woodland, grassland, shrubs, wetland, water area, construction land, and bare land. Among them, cultivated land accounts for 42% of the total land area, followed by woodland which accounts for 36% of the total land area.

In the past 20 years, the area of cultivated land and grassland have been reduced significantly, and the reduced area accounted for 6.35% and 1.3% of the total land area respectively. The area of construction land increased significantly, and the increased area accounted for 7.9% of the total land area.



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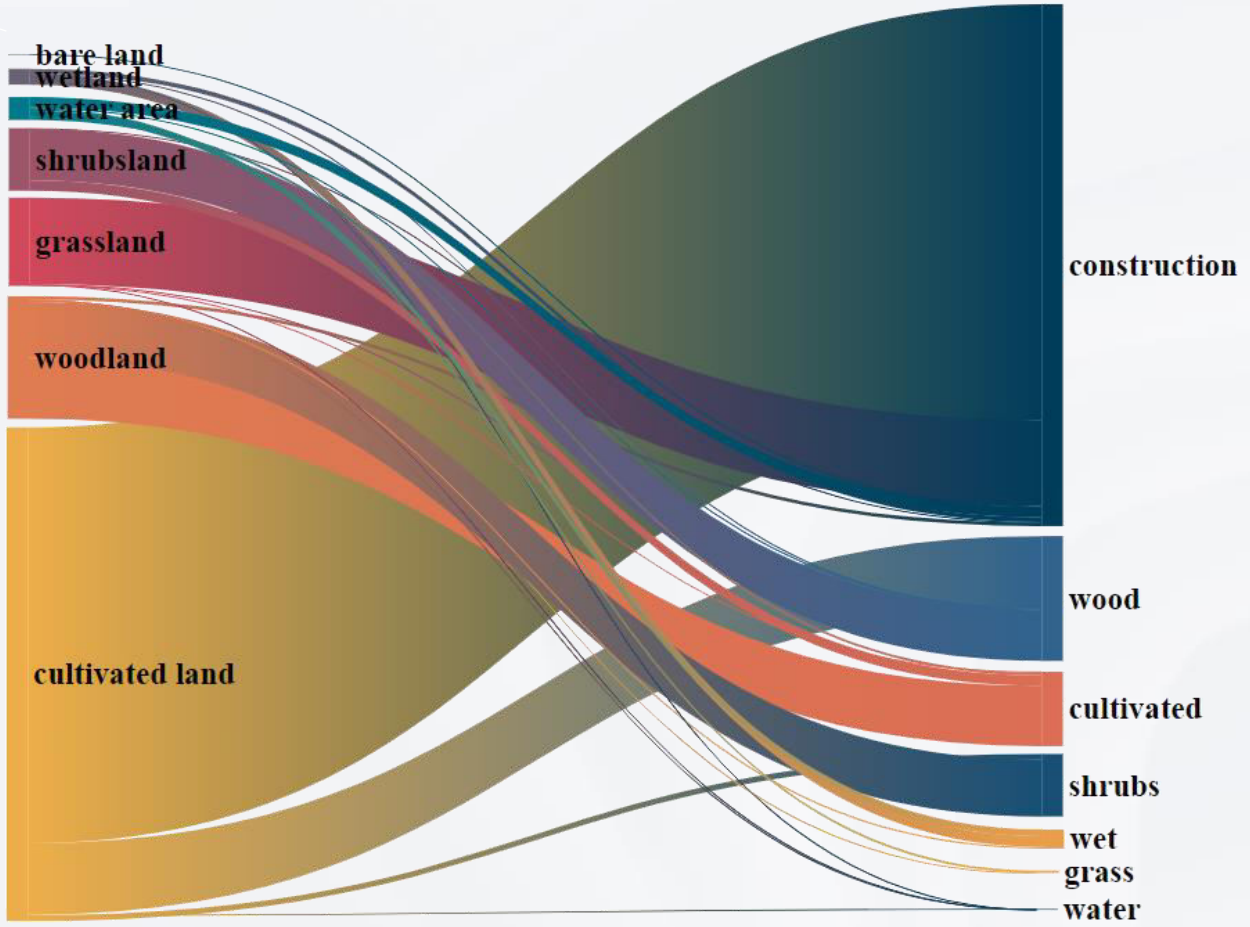
There are internal transformations among these different land usage types. The main conversion direction of all types of land is construction land. The area of cultivated land and grassland converted to construction land were the most, followed by the area of wetland and water area converted to construction land.

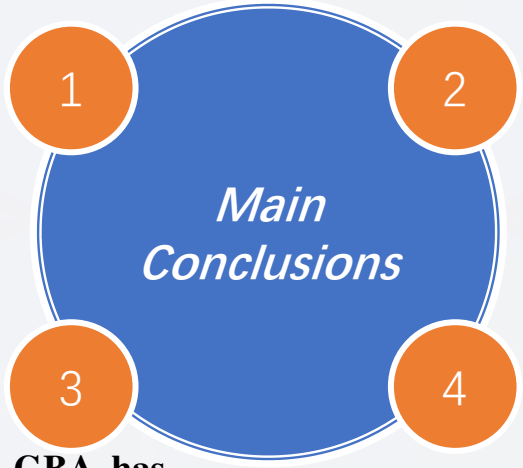
We can see clearly that over the past 20 years, urban expansion and the increase in construction land have encroached on a mass of cultivated land, grassland, shrubs and even water space.



Conclusion

Water surface ratio

The water area of GBA and its hinterlands in past 20 years has generally decreased first and then increased. The water surface ratio of Jiangmen and Foshan City decreased the most.



Vegetation coverage

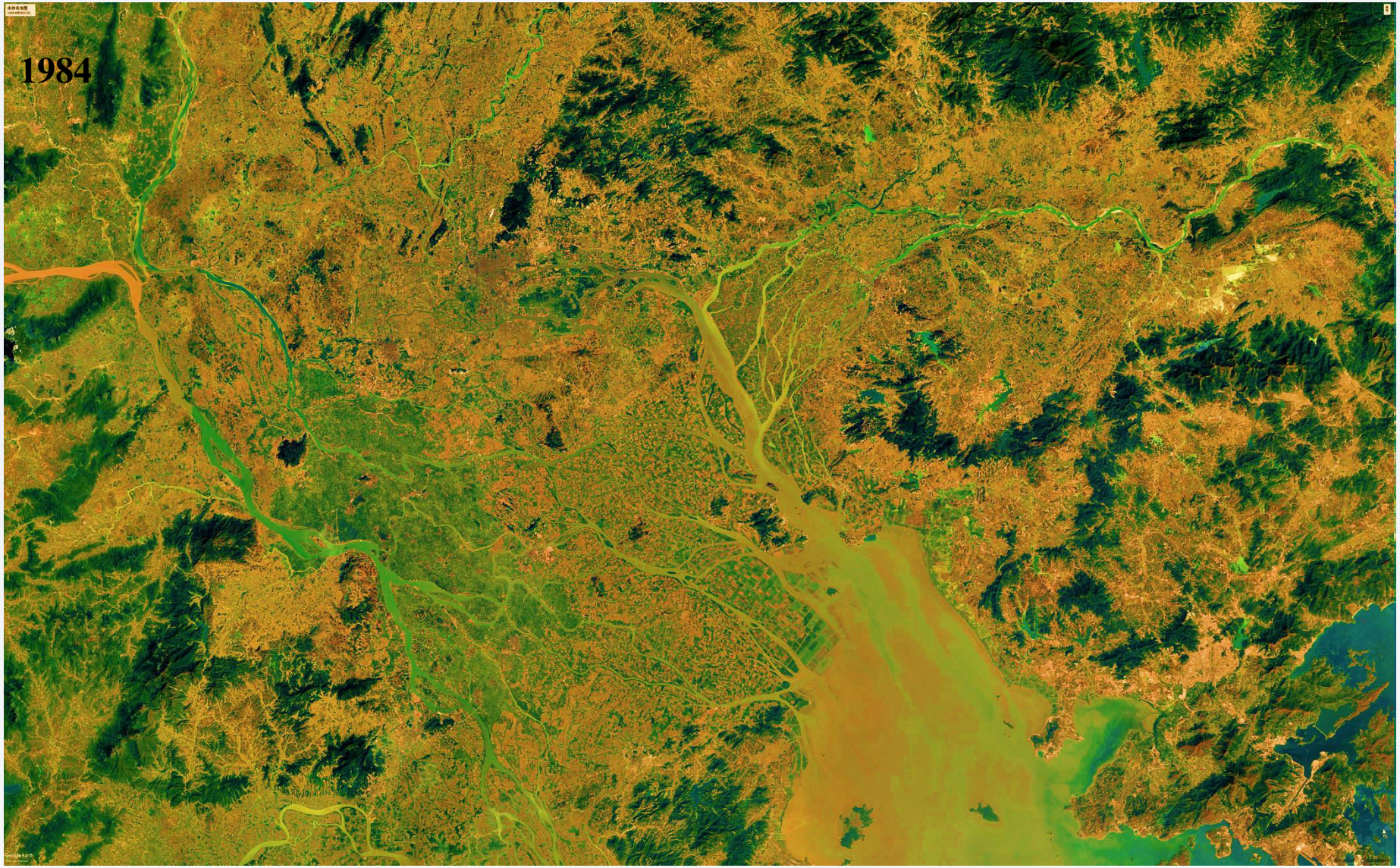
The vegetation coverage of prefecture-level cities in the GBA showed an increasing trend. Among the cities, the vegetation coverage of Zhaoqing, Huizhou and Jiangmen was relatively high, while that of Foshan, Zhongshan and Dongguan was relatively low. The vegetation coverage of Shenzhen increased the fastest.

Water and soil erosion

The soil erosion in prefecture-level cities in the GBA has been significantly improved, and the soil erosion area of different degrees has shown a decreasing trend. Among all the cities, Jiangmen, Shenzhen and Huizhou have more serious soil erosion, and Guangzhou has the most significant control effect.

Land use transform

The area of cultivated land and grassland in the GBA has decreased significantly, while the area of construction land has increased significantly. The main conversion direction of most land use types is construction land. Urban expansion encroaches on the original territorial spatial pattern.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