Changes of Urban Greenness Based on Sentinel Data and Landsat Data

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Abstract. With the rapid growth of the global economy, environmental resources have also been severely consumed and destroyed. With the rapid growth of China's economy, domestic environmental pollution and environmental damage have become increasingly serious. In order to understand the changes in the urban greenness of Chinese cities, the changes in the urban greenness of coastal cities in China in the past five years have been explored by using Landsat satellite remote sensing image data from multiple periods since 1973. The reason for choosing coastal cities as the research objects is that the coastal cities have relatively developed economy and have certain demonstrative significance for both themselves and the development of inland cities. This article first popularizes the domestic urban environmental conditions and knowledge of remote sensing technology, and then analyzes the process of obtaining urban greenness sentinel data and Landsat data of coastal cities from remote sensing data, and finally analyzes the urban greenness of coastal cities in the past 5 years. The increase change and the average increase change are analyzed and compared, and corresponding conclusions are given based on the analysis results.

1. Introduction
With the rapid growth of the world economy, resources have been extremely consumed while the economy has grown rapidly, and the environment has been severely damaged [1]. Whether it is a developed or a developing country, countries in the world have put on the agenda the issue of exploring economic development methods that suit their national conditions. China is currently in a new normal of economic transformation. China's economic growth model has been called gray growth in the past, which means that the consumption of resources is large, the pollution and waste emissions are large, and the corresponding output is low, which is an extensive and uncontrolled development. In order to achieve economic growth in a green manner, the mode of economic development needs to be changed rapidly, and the efficiency of resource use urgently needs to be improved, and how to coordinate the relationship between the development process and environmental resources is also a top priority [2]. The 2014 China Development Forum Green Conference emphasized the new growth mode of China's economy, from the black and gray growth in the past to the green development with sustainable and clean growth. Faced with increasingly serious environmental protection and environmental resource problems, the government has also realized the importance of changing from black to green. As a new economic development model that is environmentally friendly, avoids the reduction of biodiversity, and pursues sustainable development, green growth will become the goal of the future economic development of Chinese society and the world [3].

Chinese scholar Tang Xianglong believes that with the rapid growth of the national economy and the major changes in the awareness of the ecological environment in the entire society, our country is
paying more and more attention to the governance and protection of the ecological environment. In urban development, urban green is essential to beautify the urban landscape and improve people's lives. The living environment plays an irreplaceable role in promoting the sustainable development of cities, and has attracted more and more attention from all walks of life [4]. Huang Yunfeng and others believe that in the process of rapid global urbanization, the contradiction between urban economic development and resources and environment is becoming more and more serious, and urban green transformation is imperative. Evaluating the degree of green city development is an important part of building a green city. The green city evaluation index system can reflect the growth potential and existing problems of green cities. How to choose evaluation indexes and determine the index weights is the main scientific problem of green city evaluation [5]. Xiong Wenyuan believes that the creation of a garden city is a social system plan, and it is also in line with the social and economic development that the current sustainable development macroeconomic strategy must achieve. Urban green is an important part of creating a garden city, and it is also the foundation of building an urban ecosystem. With the continuous improvement of the level of urbanization in our country, the functionality and ecology of cities are gradually improving [6].

The concept of urban greenness has received attention and recognition from all quarters since its inception. Due to the economic recession and environmental problems brought about by the financial crisis and ecological crisis, more national governments have embarked on the path of urban greenness growth, and have promulgated relevant policies and decrees to promote the realization of urban greenness growth [7]. Scholars at home and abroad have made their own research and contributions in exploring the connotation of urban greenness growth and related theories. Although they have not yet reached a consensus definition, they all agree that urban greenness growth is the pursuit of economic development. Able to realize the sustainable development of the ecological environment and natural resources. The research on coastal cities has the following shortcomings. Research on coastal cities at home and abroad mainly focuses on ecological safety assessment, energy calculation and climate and environmental issues. Because of its unique geographical conditions, coastal cities are easily affected by surrounding environmental factors, and their research focuses on ecology and geography. In addition, the research samples of coastal cities mostly select a single city or a few cities in a certain area, and the research lacks horizontal comparison, and there are few studies on the measurement of the urban greenness growth efficiency of coastal cities.

2. Changes of Urban Greenness Based on Sentinel Data and Landsat Data

2.1. Sentinel Data and Landsat Data

Since the 1970s, satellite remote sensing technology has developed extremely rapidly. With its wide range of monitoring, fast speed, intuitiveness, and synchronization, it has been widely used in large-scale urban greenness change identification and urban greenness changes. Monitoring, urban greenness change survey, etc. [8]. In recent decades, many data generated by optical satellite sensors, such as sentinel data and Landsat data, have been widely used to obtain urban greenness information. Optical sensors generally have multiple bands, rich spectral information, and use optics. The extraction of urban greenness information from remote sensing images mainly involves technologies such as band selection, calculation, and image classification; optical remote sensing images have long electromagnetic waves and have the ability to penetrate clouds and fog, and are widely used in the extraction of urban greenness information. Therefore, sentinel data and Landsat data provide convenience for the study of urban greenness changes [9]. When selecting remote sensing data, the first thing to consider is the high spatial resolution of remote sensing data. The spatial resolution of NOAA/AVRR and MODIS9 (1km) data exceeds 1km. For a relatively small research area, the accuracy is Unable to meet the requirements, it does not reflect the actual situation of the area well, and obviously does not meet the research requirements. The spatial resolution of Landsat8 is relatively high, and the Landsat series has excellent performance in terms of cost-effectiveness and image update. Therefore, this paper will use Landsat8 as the research remote sensing data source.
2.2. Urban Greenness
The rapid growth of the world economy, the ensuing environmental problems and scarcity of resources, and the pollution and disasters caused by the rapid expansion of cities have made more and more countries and organizations aware of the importance of green growth. The traditional method of primitive economic growth is: Without the capacity for sustainable development, there will be an ecological crisis and many environmental risks. The idea of "urban greenness" is widely disseminated and recognized, but as a concept, the theoretical framework of urban greenness is still being built, and the connotation of the concept has not been fully defined in the process of exploration, and there is no official concept. Its definition has not been unified and standardized [10]. With the rapid development of my country's economy, the acceleration of urbanization and urban modernization have caused greater pollution to the urban environment, urban greening has received more and more attention, and urban landscaping must closely follow urban development. The pace requires a more standardized and scientific approach to landscaping planning and management [11]. With traditional urban greening management models, it is difficult to quickly collect information on urban greenness, and it is difficult to consult and update urban greening-related materials in a timely manner. With the development of science and technology, sentinel data and Landsat data generated by remote sensors are gradually applied to all levels of urban management, which profoundly affects social management methods and provides new solutions for urban greening management.

2.3. Significance of Research
Coastal cities seek a greener, environmentally friendly, and sustainable economic development mode is an urgent problem that needs to be solved at the moment. On the one hand, the rapid economic development of coastal cities has caused excessive consumption of resources and excessive destruction of the environment. It is imperative to resolve the contradiction between the economy and resources and the environment. The development of Lucheng cities has a certain demonstration significance [12]. Based on the study of urban greenness, this paper selects coastal cities for analysis and research, and measures the urban greenness growth efficiency of the research objects. The construction of the above-mentioned urban greenness evaluation method will enrich and improve the green correlation and urban greenness theory, help to better evaluate the green development and growth of these coastal cities, and provide basis and basis for the implementation of the green growth policy of the city.

3. Research Data and Preprocessing of Urban Greenness Changes Based on Sentinel Data and Landsat Data

3.1. Remote Sensing Image Preprocessing
The original image taken by any remote sensing system is from three-dimensional projection to two-dimensional projection, so there will be different degrees of geometric distortion and other phenomena. These distortions may cause serious degradation of image quality and affect the results during use, so they must be processed to eliminate them before use. This paper applies relevant software to preprocess all the downloaded remote sensing images, such as band synthesis, image mosaic and cropping, so as to obtain remote sensing images to be interpreted and inverted. Band synthesis is to select different bands of the image for synthesis according to different purposes. Different band synthesis displays can enhance different features. Due to the need of visual interpretation, this article selects the 432 band for standard false color synthesis. The standard false-color composite image contains rich, clear, and high-level features, which are used for vegetation classification and water recognition. Image mosaic is to combine the images of two or more scenes in the study area into one image. Image cropping is to crop one scene or multiple scenes according to the scope of the study area, and remove the parts outside the study area.
3.2. Radiometric Correction of Remote Sensing Images
Observations, reflectivity, and radiation values obtained from satellite sensors are different. The reasons for these differences include certain characteristics of the sensor itself, the height of the sun when the image was taken, the topography of the study area, and the local atmospheric conditions. Therefore, if you want to obtain the true reflectance value or radiation intensity value of the observed ground object, these differences must be eliminated to the greatest extent before relevant applications. This process is called radiation correction. The electromagnetic wave signal collected by the satellite sensor is first converted into an electric signal, and after quantization, it becomes an obvious gray value. The size in the image has only a relative meaning, not a strict physical meaning. Therefore, in this case, it is necessary to perform a relative correction in the sensor, that is, the calibration of the radiation. The calibration process is to convert the observation value received from the remote sensing sensor into an absolute brightness or relative value related to the spectral reflection on the earth's surface. The data after radiometric calibration can be radiation or reflectance data. The radiation value is the dimensionality, and the spectral surface reflectance data is the relative percentage value. The radiation calibration completed in this paper is to convert the gray pixel value of the image into the radiation value. For the TM sensor, the calculation formula between the radiation received by the satellite and the DN value of the image is:

$$L = Gain \cdot DN + Bias$$ (1)

After processing with the formula, the satellite image obtained is as follows:

![Remote sensing image obtained after formula processing](https://image.baidu.com)

3.3. Spectral Characteristics of Urban Greenness
Green can absorb more incident solar radiation energy. In the spectral range of most remote sensing images, green will show low reflectance characteristics, and the reflectance value will gradually decrease with the increase of wavelength. The structural composition of urban greenness itself determines its spectral characteristics. At the same time, the difference in urban greenness status will also affect the spectral characteristics to a certain extent. The reflection value of urban greenness varies with the change of the sun's altitude angle, and the variation range is 4% to 5%. The spectral characteristics of urban greenness and the corresponding spectral characteristics of vegetation and soil have formed a very obvious difference. Therefore, there are significant differences between visible and near-infrared regions, vegetation, soil and other urban greening spectral characteristics. There are
many factors that affect the greenness of a city, and the main factor is related to the type of underground surface. The subject of this research is coastal cities. It can be considered that the surface features are composed of buildings, water bodies and vegetation. Because the water coverage area of coastal cities is relatively small compared with the areas covered by other land features, it has little impact on the greenness changes of coastal cities. The main features of the surface that affect the greenness of cities are urban buildings and vegetation. This paper uses the normalized vegetation index and normalized building index to reflect the density of urban buildings and vegetation coverage, and analyzes it through regression analysis, using SPSS software to quantitatively analyze the correlation between vegetation, building coverage and ground temperature, where NDVI and NDBI are used to describe vegetation density and building density, respectively, and the formula is as follows:

$$NDVI = \frac{\rho_4 - \rho_3}{\rho_4 + \rho_3} \quad (2)$$

$$NDBI = \frac{\rho_5 - \rho_4}{\rho_5 + \rho_4} \quad (3)$$

4. Greenness Changes of Chinese Coastal Cities Based on Sentinel Data and Landsat Data

4.1. Changes in the Average Increase in Urban Greenness of China's Coastal Cities From 2016 to 2020

| City       | Tianjin | Qingdao | Nantong | Ningbo | Fuzhou |
|------------|---------|---------|---------|--------|--------|
| Average increase in urban greenness | 1       | 0.98    | 0.79    | 0.88   | 0.86   |

According to Table 1, the average increase in urban greenness of our country's coastal cities from 2016 to 2020 is 0.906. This data shows that there is a 9.4% gap between each city and the doubling of urban greenness every year. Among them, the average increase in urban greenness of Tianjin during the inspection period is 1, which shows that it has done a very good job in the growth of urban greenness and successfully doubled the urban greenness. The average green efficiency of Qingdao is between 0.9-1. Although the greenness of the city has not doubled, the work on the greenness of the
city is not bad. Among the coastal cities, there are still 3 cities with an average green increase value of less than 0.9, namely Nantong, Ningbo and Fuzhou. Nantong has the lowest average green increase value, and the average increase value in five years is 0.79, there is still a big gap of 21% from the goal of doubling the city's greenness value. According to Figure 2, we can intuitively know that the total green area of each city in my country's coastal cities will increase year by year from 2016 to 2020. Among them, Tianjin's total green area has always been in the leading position, while Nantong's total green area has always been in the leading position. At the lowest level, the development process of urban green space in Nantong City needs to be improved.

4.2. Changes in Urban Greenness Growth of China's Coastal Cities From 2016 to 2020

Table 2. Changes in urban greenness of coastal cities from 2016 to 2020

| City   | 2016 | 2017  | 2018  | 2019  | 2020  |
|--------|------|-------|-------|-------|-------|
| Tianjin| 1    | 1     | 1     | 1     | 1     |
| Qingdao| 1    | 0.987 | 1     | 0.809 | 0.98  |
| Nantong| 0.777| 0.953 | 0.910 | 0.838 | 0.967 |
| Ningbo | 0.797| 0.9   | 0.925 | 0.896 | 0.795 |
| Fuzhou | 1    | 0.969 | 0.77  | 0.647 | 0.825 |

According to Table 2 and Figure 3, we can see that Fuzhou, Ningbo, and Nantong have a lower greenness increase value than other coastal cities in five years, especially in Nantong, where the average increase in five years is only 0.79, which is 21% lower than Tianjin's full effective rate of return. This is because Tianjin's industrial development has entered a stable stage and the demand for environmental resources is relatively small, while Nantong's development still has a lot of room for development. At the same time, it will inevitably cause a certain degree of damage to the environment. In the first two years of the inspection period, Nantong's green growth rate was very slow, but it will continue in the future. On the other hand, Jiangsu Province is extremely concerned about the development of coastal areas, and Nantong City will enter a stage of accelerated industrial development. During this period, some enterprises in the eastern developed coastal areas that have caused great damage to the environment have moved to the underdeveloped coastal areas, which will
cause many environmental problems, and the increase in environmental damage will also reduce the urban greenness value of coastal cities.

5. Conclusions
In this paper, Landsat8 is used as the remote sensing data source, and the coastal cities in China are used as the research object. The sentinel data of the urban greenness direction of the coastal cities in the past 5 years is obtained through remote sensing image preprocessing, radiation correction and spectral characteristics analysis. And Landsat data, through the data obtained to study the changes in the greenness of coastal cities. The research in this article supplements and develops the original theories and methods of urban greenness changes. At the same time, through research, it is hoped that the theoretical and practical basis for further increasing the value of urban greenness in China's coastal cities and inland cities is provided.

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