Environmental Detection and Management Based on Multi-source Remote Sensing Data from Baiyangdian Lake

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Abstract

Baiyangdian lake is located in the northern China, inside the special economic zone Xiongan district, which is paid more attention by governors. This research, using Orbita Hyperspectral Satellite (OHS), Landsat 8 and Google Earth data, creates seven types of ecological indexes, builds BP network, temperature retrieval and radiation transfer models to detect and analyze the environment situation comprehensively. Combined with Baiyangdian lake developing plan, providing some detailed Baiyangdian lake management advice. The results show that: KT_3 index has a better performance in buildings-plants mixed area than NDWI and GNDWI index; Most of the ecologic index indicate that the buildings have damaged the comprehensive environment; The temperature of the buildings areas reveal 4 ℃ higher than water region, while mean temperature is lower than the urban area; The percentage of buildings is decreasing; The concentration of suspended sediment and chlorophyll have a similar distribution, which is close to residential areas and the bank of fields, indicating the environment is seriously affected by human beings. In conclusion, the ecological environment still needs to improve. Following the government's planning with 500m protected area, none of the buildings can exist in the lake area. These results can provide a good theoretical support for governments' planning, such as monitoring polluted source.

Keywords: Baiyangdian lake, ecological index, hyperspectral data, environmental management, pollution monitoring

1 STUDYING AREA AND DATA SOURCE

1.1 STUDYING AREA

In 2017, Chinese government planed to construct a special economic zone called Called Xiongan New Area, the 100 sq km (38.6sq mile) zone is expected to eventually expand to 2,000sq km.

Baiyangdian Lake, located in Xiongan New Area, Hebei province, is the largest natural freshwater body in North China and one of China's biggest wetlands. It is also an essential natural wetland for groundwater replenishment, flood control and biodiversity preservation in this region(Wenhui Li et al., 2012). Chinese government hopes to developed it to world class standards, with a focus on ecological protection and well-being.

1.2 DATA SOURCE

In order to analyze the ecological environment comprehensively, three kinds of data source are used in this research, including Zhuhai-1 Constellation Orbita hyperspectral image, Landsat 8 OLI and Google Earth high spatial resolution image.

Orbita is deploying the “Zhuhai-1” remote sensing micro-nano satellite constellation (Orbita, 2019). The satellite holds three Complementary Metal Oxide Semiconductors (CMOS) sensors. Each piece contains 5056×2968 pixels. In each CMOS sensor, the spectral average of 400–1000nm is divided into 32 spectral segments through a filter, and each spectral segment occupies ≤ 2968/32=92 rows on the sensor (Yong-hua, Jiang et al., 2017). This research uses five image took from September, 2018 to May, 2019 with 10m spatial resolution.

Landsat 8 OLI operates at nine wavelengths in the range of 0.433-2.300 μm and provides images with a maximum resolution of 15m. This research uses the image took in October, 2017 and October, 2018.

Google Earth is a free program to view the Earth through high-resolution graphics and satellite images. This research uses the image with 0.93m and 0.3m Spatial resolution.

2 METHOD

2.1 PREPROCESSING

In order to operate the raw image and obtain the correct image, the data preprocessing method listed behind are operated:

- Radiation Calibration
- Flaash Atmospheric Correction
- RPC Orthorectification
- Image Clipping
- Vectorization

2.2 INDEX ANALYSIS

Seven types of ecological indexes listed behind are the key method to evaluate the ecological environment system.

- Normalized Difference Vegetation Index (NDVI)
- Normalized Difference Water Index (NDWI)
- Gaussian Normalized Difference Water Index (GNDWI)
- KT_3 Wetness Index
- The Normalized Differential Build-up and Bare Soil Index (NDBSI)
- Land Surface Temperature (LST)
- Remote-sensed Ecological Index (RSEI)

2.3 MODEL ANALYSIS

Based on the basic ecological index, three models are used to detect the land use and pollution situation as listed:

- Time-series Change Monitoring Model
- BP Neural Network Classification Model
- Suspended Sediment and Chlorophyll Reverse Model

3 RESULTS

3.1 INDEX ANALYSIS

RSEI is a comprehensive index which calculate by four measure including 1. green index, represented by NDVI; 2. Wetness Index, represented by NDWI, GNDWI and KT_3; dry index, represented by NDBSI; hot index, represented by LST. From the results of Figure 1 and Table 1, it reveals that NDWI and GNDWI is hard to distinguish the building and water area but KT3 has a great performance. The building has a negative effect on the environment from the results of NDBSI, LST and RESI.

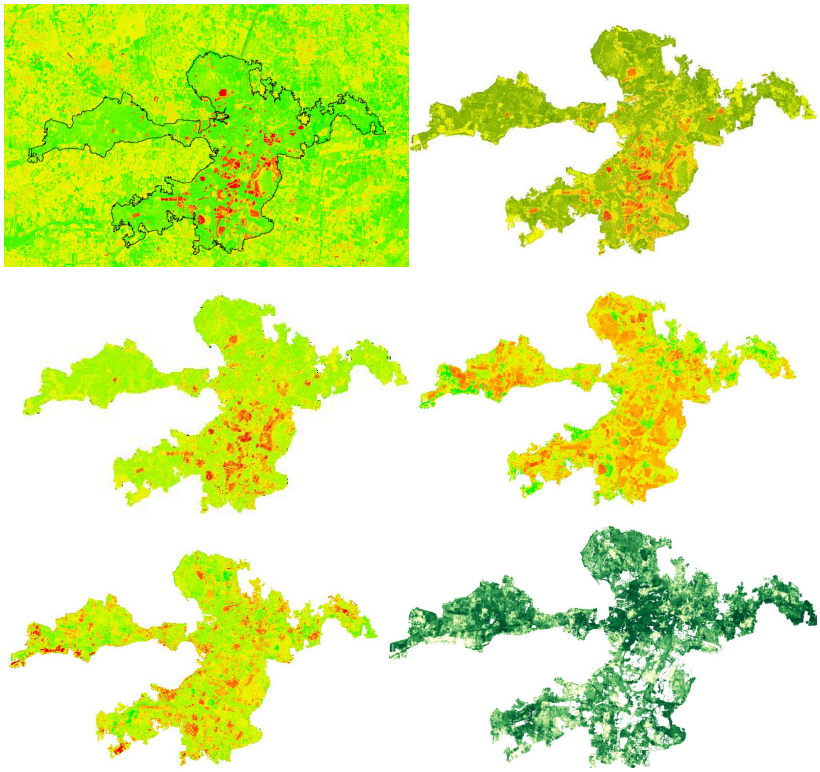

Figure 1. Ecological Index (left top: NDVI; right top: NDWI; left middle: GNDWI; right middle: KT_3; left bottom: NDBSI; right bottom: RESI)

Table 1. RESI weights

Index	Weights
Green Index	0.552
Wetness Index	0.201
Dry Index	-0.236
Hot Index	-0.402
Constant	0.354

3.2 MODEL ANALYSIS

The results of Figure 2 shows that the temperature of lake area is lower than urban area. The buildings have 4℃ higher than the fields and the fields have 3℃ higher than the water on average. The concentration of suspended sediment and chlorophyll have a similar distribution, which is close to residential areas and the bank of fields, indicating the environment is seriously affected by human beings. From 2018 to 2019, the percentage of the buildings reduce 4% because of the natural protected policy.

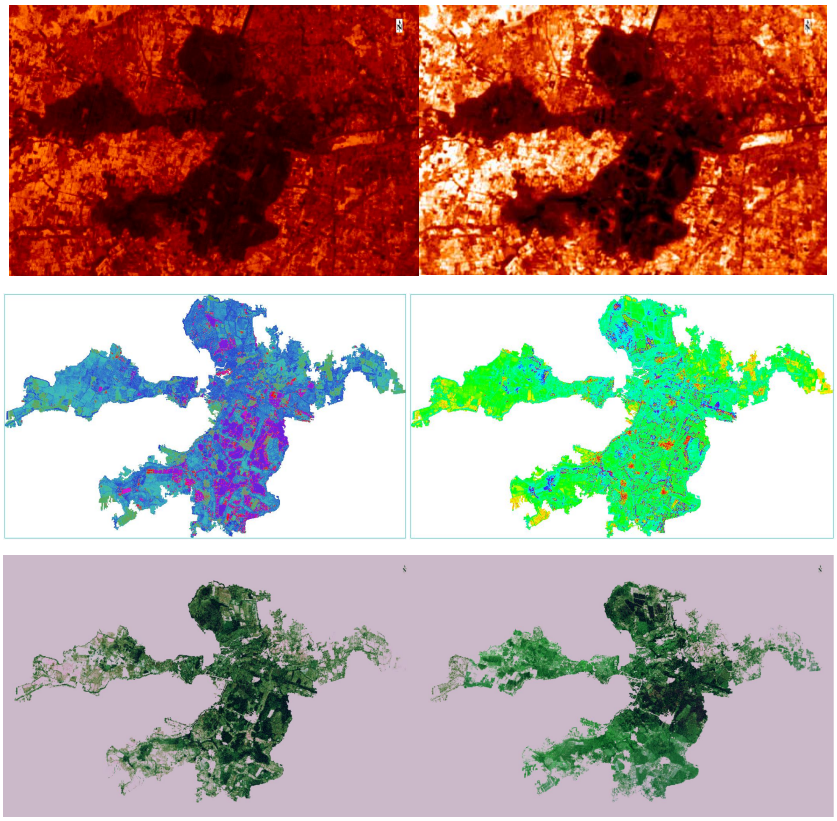

Figure 2. left top: vegetation coverage LST; right top: atmospheric correction LST; left middle: suspended sediment reverse; right middle: chlorophyll reverse; left bottom: BP neural classification on Oct 23th 2018; right bottom: BP neural classification on May 9th 2019

4 CONCLUSION

According to the results, the ecological environment is not good enough because the buildings still have a highly negative effect. The distribution of the pollution proves directly that human behavior is the main source of the pollution, it means that the protected work still needs to improve. Housing demolition has initial effect but there are still more than 20% of buildings left in the protected zone. The trace of the pollution source can guide the housing demolition order when considering the economic effect.

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