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Exploring the Correlation between Population Distribution and Urban Heat Island under Urban Data: Taking Shenzhen Urban Heat Island as an Example

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Abstract**—**Shenzhen is a modern city of China's reform and opening-up policy, the development of urban morphology has been established on the administration of the Chinese government. This city`s planning paradigm is primarily affected by the spatial structure and human behavior. The subjective urban agglomeration center is divided into several groups and centers. In comparisons of this effect, the city development law has better to be neglected. With the continuous development of the internet, extensive data technology has been introduced in China. Data mining and data analysis has become important tools in municipal research. Data mining has been utilized to improve data cleaning such as receiving business data, traffic data and population data. Prior to data mining, government data were collected by traditional means, then were analyzed using city-relationship research, delaying the timeliness of urban development, especially for the contemporary city. Data update speed is very fast and based on the Internet. The city's point of interest (POI) in the excavation serves as data source affecting the city design, while satellite remote sensing is used as a reference object, city analysis is conducted in both directions, the administrative paradigm of government is broken and urban research is restored. Therefore, the use of data mining in urban analysis is very important. The satellite remote sensing data of the Shenzhen city in July 2018 were measured by the satellite Modis sensor and can be utilized to perform land surface temperature inversion, and analyze city heat island distribution of Shenzhen. This article acquired and classified the data from Shenzhen by using Data crawler technology. Data of Shenzhen heat island and interest points were simulated and analyzed in the GIS platform to discover the main features of functional equivalent distribution influence. Shenzhen is located in the east-west area of China. The city's main streets are also determined according to the direction of city development. Therefore, it is determined that the functional area of the city is also distributed in the east-west direction. The urban heat island can express the heat map according to the functional urban area. Regional POI has correspondence. The research result clearly explains that the distribution of the urban heat island and the distribution of urban POIs are one-to-one correspondence. Urban heat island is primarily influenced by the properties of the underlying surface, avoiding the impact of urban climate. Using urban POIs as analysis object, the distribution of municipal POIs and population aggregation are closely connected, so that the distribution of the population corresponded with the distribution of the urban heat island.

Keywords**—**POI, satellite remote sensing, the population distribution, urban heat island thermal map.

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I. Introduction

THIS study mainly focuses on the way of predicting the distribution of airborne microorganisms through the distribution of urban population which is based on the urban heat island inversion with remote sensing satellite data and the urban interest point data.

Remote sensing satellite data for the inversion of urban heat islands have been part of the essential methods to study the urban heat island effect. Using remote sensing satellite data to invert the urban heat island, the distribution status of urban heat islands can be found, the urban heat islands underlying surface can be determined. Furthermore, the functional properties in the area can be understood. As an intensive urban spatial structure, the city's area function is a definite city structural system between urban development and its closely related environment [1]. Due to the spatial scale of the opinion is not at the same level between satellite and urban space, the information of urban area which is obtained by satellite is not completed. In order to carry out cross-scale research on these two vertical relationships, the urban interest point data are used as a tool to explore the relevance between two spatial scales. Urban interest points are comprehensive collection [2], which can be expressed in the shape of a point, or can be embodied in a two-dimensional form of architecture or a three-dimensional data model; the internal information of an interesting point is diversified. It uses coordinate information as geography. Positioning can represent building information, shop information or functional information about the area [3], the information is obtained based on reliability and obtaining by using extensive data mining.

This study mainly tends to know the distribution of functional plans in urban areas by using the point expressions of municipal interest points. The functional distribution of urban areas has a close link with the population distribution. Through the functional layout of the regions, it is known that different regional functions have different environmental impacts, thus the prediction of urban airborne microbes are made on this difference.

II. Urban Heat Island (UHI) and POI

The data inversion of remote sensing satellite is based on data from the satellite of Modis. The data processing cycle of Modis is one day so that the influence of cloudiness can be eliminated in a short period while Modis satellite data are more complete than other satellite data. There is no requirement to

perform related satellite image synthesis; therefore, the loss of satellite data in the satellite image synthesis process can be reduced. The Modis satellite data are used to invert the surface temperature firstly. In this process, the window algorithm can be utilized. Then the urban heat island synthesis can be performed on the basis of the land surface temperature. For urban interest points, it is mainly to use data mining techniques to collect urban commerce, services, public and other places that can represent densely populated areas, so that the distribution of urban population can be basically predicted.

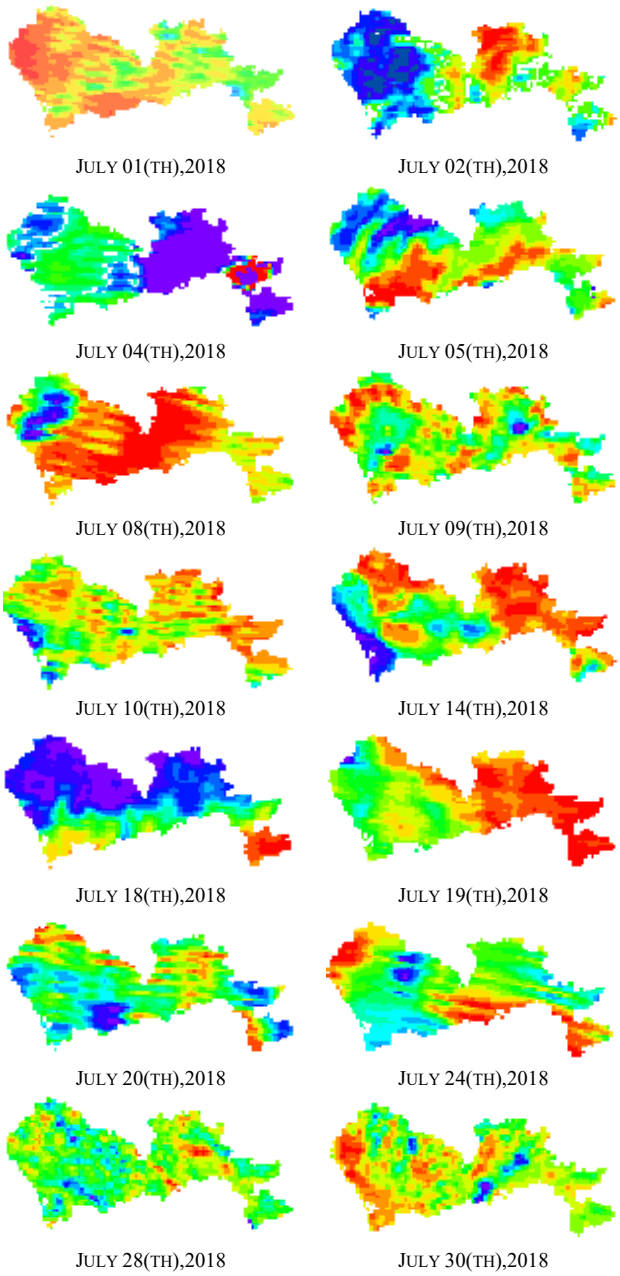

Fig. 1 Data of Modis14 Shenzhen urban heat islands in July 2018

A. Urban Heat Island

Urban Heat Island Intensity in summer is higher than in other quarters. Therefore, it is also necessary to exclude the influence of weather in July 2018 and select the appropriate data for inversion finally. The Modis satellite data are used to invert the urban heat island through split window algorithm. The data have a large number of infrared bands and shares 8 bands, which is more advantageous for split window algorithm. The infrared channel data establish an equation to invert the land surface temperature. The operation is mainly using the technical means provided by ESRI to invert the urban heat island [4]-[6]. Excluding rainy and cloudy weather, Modis data of Shenzhen City in July 2018 have 14 available data (Fig. 1). Through these data, the trend of space-time evolvement of urban heat islands in Shenzhen can be found.

B. Point of Interest

The POI are mainly based on data mining in the context of Big data; the data of city are very complexes, and the data used this time are publicly available data [7], which are sufficient for preliminary analysis the relevance between distribution and its urban airborne microbes. These data are mainly based on the "Baidu Data Intelligence" ("Baidu number of intellectual platform - Baidu large data intelligence forces" 2018) platform for data mining, which has acquired various interest points (Fig. 2) of Shenzhen city's real estate community, shopping, infrastructure, education school and so on. Compare these POIs with cities map; the correct location of the POI on the map can be determined. In this operation process, the GIS platform is mainly used to effectively manage various POI data, paving the way for later data analysis.

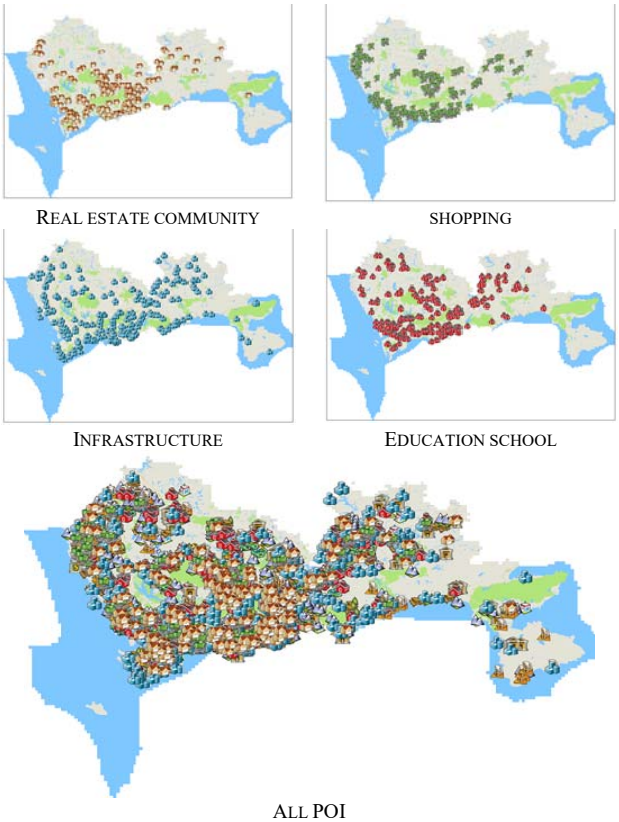

Fig. 2 Shenzhen city's POI

III. Study Details

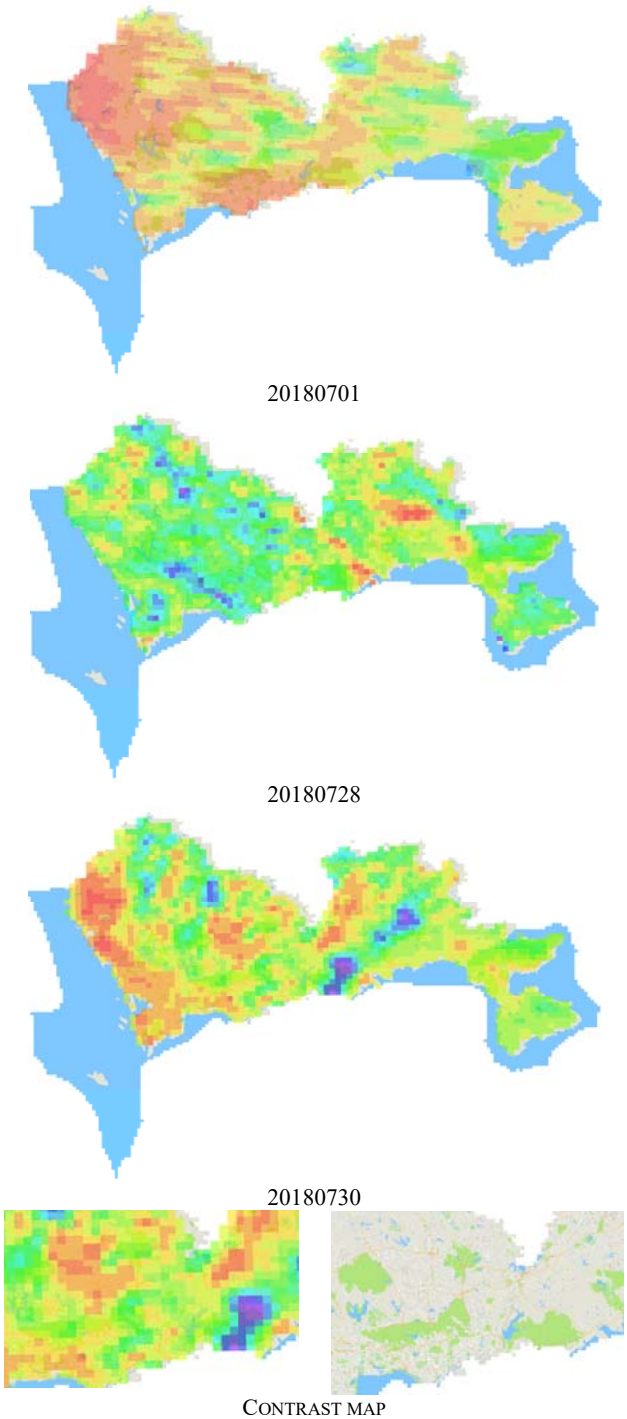

Fig. 1 Surface temperature map and city map stack

Urban Heat By superimposing the data, which is inverting the series of urban heat islands in Shenzhen in July through Modis satellite data, with urban geographic, it can be found that the land surface temperature is closely related to the function of the urban area, the correlation between these data mainly lies in the sub-regional functional block. According to the superposition of land surface temperature map and city map (Fig. 3) on July 01(th), July 28(th), and July 30(th), 2018, we can see that there is a one-to-one correspondence between the mountain map, large-scale parks, some larger reservoirs and the degrade of land surface temperature. In Fig. 3, the reservoir is corresponding to the blue area that means low surface temperature; the mountain is shown by the green area. In a word, the surface temperature has the same trend with regional function, but it cannot be stated that the surface temperature is related to the population density [8]. Therefore, it is necessary to find the internal relationship between them through using the urban interest points to correlate with the surface temperature.

A. Island Time and Space Evolution

Characteristics of Shenzhen's urban development are mainly focused on the east and west side, which is related to the geographical location of Shenzhen. In order to expand the Shenzhen city, a large number of reclamation will be carried out in initial stages, and the development of the north and south will start later. The spatial and temporal evolution of urban heat islands is conducive to understanding the changes in the underlying surface of Shenzhen's cities so that the overall progress of Shenzhen's urban functional areas can be seen. The data of space-time evolution are mainly based on July 2018. It is no longer a generalized annual analysis. The most important is that the distribution of airborne microbes is related to the thermal environment. Therefore, the article chose the data from MODIS remote in July 2018 as the evolution basis, to understand the overall distribution of urban heat islands in Shenzhen (Fig. 1).

B. Urban Heat Island and POI Overlay

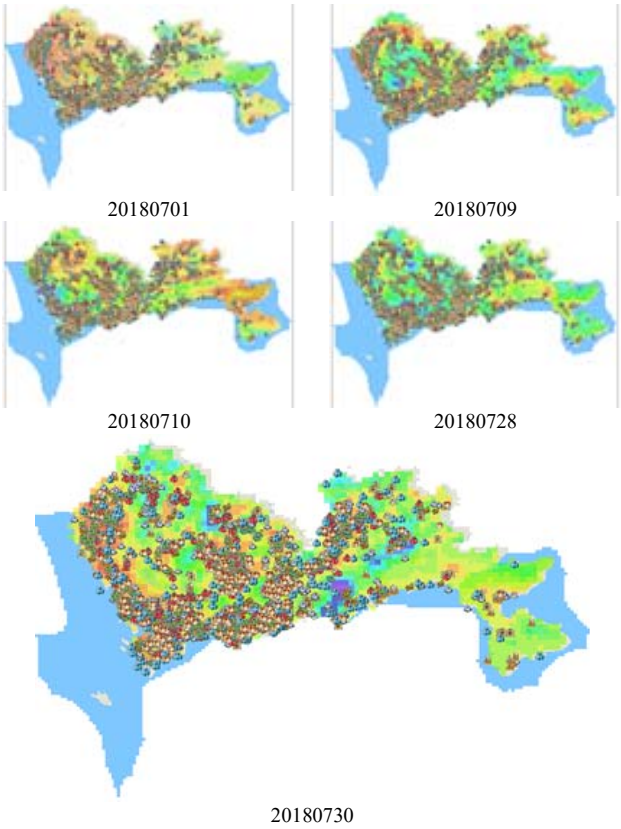

Fig. 4 City POI and surface temperature overlay

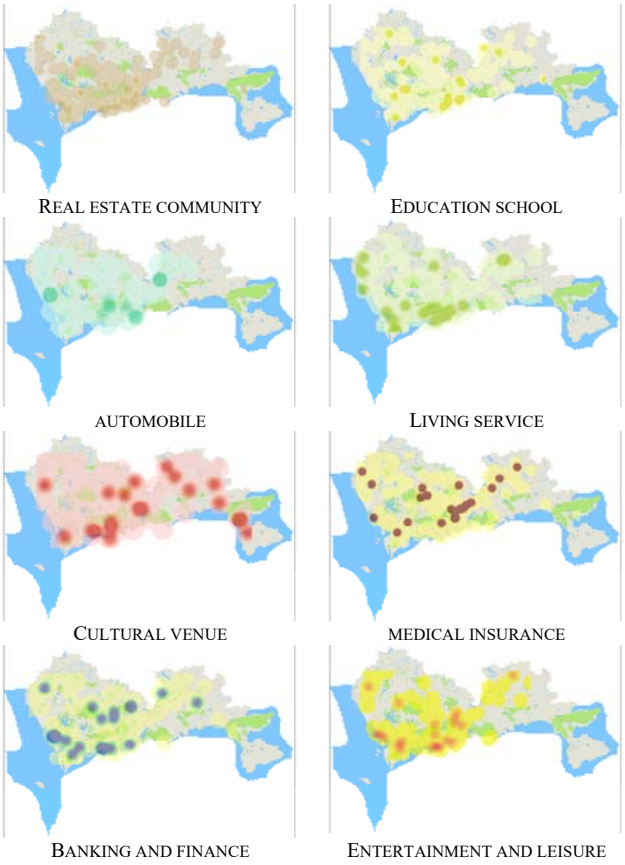

Fig. 2 POIs density map

By using the inversion of the urban heat island map and the distribution of interest points, it can be found that the distribution of POI has a corresponding relationship with the trend of the surface temperature distribution. This feature can be observed in July 01(th), July 09(th), July 10(th), July 28(th), and July 30(th), 2018 (Fig. 4). In particular, features of the 20180730 overlay are very obvious, but it is not obvious to specify this feature to the urban area. Therefore, it is necessary to conduct density analysis POIs to obtain the weight relationship of specific areas in Shenzhen. Density analysis is carried out through POIs of different functions of the city. Due to the distribution of different functional POIs are discrete, there has a certain influence on the urban planning and urban functional layout of Shenzhen. Overall, Shenzhen's urban POIs are generally biased towards the southwest of the city, which coincides with the development of the Shenzhen city (Fig. 5).

C. Urban Heat Islands and Population Density

Density map of Shenzhen urban POIs can display the proportion of functions contained in different regions, therefore, the population distribution in the region can be identified. Although POIs are not dynamically distributed, the spatial distribution of population aggregates can be identified within a certain period of time [9]. The urban POIs density map is superimposed with the Shenzhen municipal heat island map to find the most important functional areas of population distribution. An abundance of airborne microbes in these areas is under a definite relationship. Therefore, the urban heat island map is factorized, and different surface temperatures are squared (Fig. 6), after that, the core areas can be found by combining the POIs density map. In this figure, it can be observed that the core density of real estate, shopping, living services, health care, banking finance, entertainment, and leisure facilities are all located in Nanshan District, Futian District, Luohu District and Yantian District of Shenzhen. These areas are densely populated, which is mainly due to the surrounding area of Hong Kong, meanwhile, there is another case that many foreign tourists who are going to Hong Kong need to cross the border. At the same time, the urban heat island grade in these regions is a one-to-one correspondence. The urban heat island distribution map is proportionate to the population density distribution.

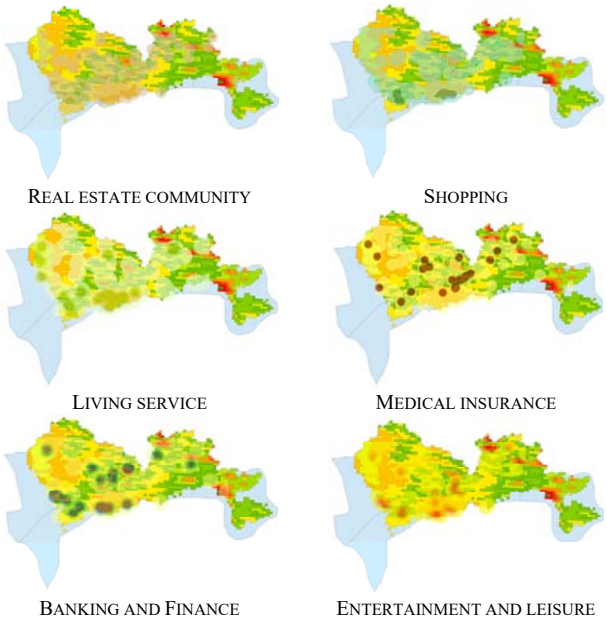

Fig. 6 Urban Heat Island map vector processing density map superimposed POI

IV. Discussion

The research mainly combines massive data mining technology and remote sensing satellite inversion technology for this study. It uses data mining technology to search a large number of functional attribute and related store information of Shenzhen city. This information comes from all kinds of software on the internet. Relevant statistic from these software has formed data information, such as 58 real estate stores, the US Mission, Taobao APP, and various mobile phone GPS, etc. This information is not completely open to the public, so network technology is required for collecting information.

Crawling for data analysis and data mining, combined with Baidu API information, can maximize the comprehensive statistic of information and strengthen the integrity of the data. These data are numerous and contain the functional attribute of various industries, which is helpful in understanding the distribution of the entire city function of Shenzhen. These

functions are distributed in areas with a larger population, such as schools, hospitals, business, etc., so to a certain extent, the population distribution states can be found out.

Data in data mining are expressed in the form of points. These points are determined according to the latitude and longitude in the actual area, and each point contains its function-related information, telephone, function-specific name, etc. Position can be measured in the study area and managed through these points. The study manages these POIs containing information through the GIS platform [10], locating the latitude and longitude coordinates of these points on the Shenzhen city map, which is beneficial to analyze the distribution of interest points on the map to determine the distribution trend of the POI. From the distribution of all POIs on the map, it can be seen that all functional layouts are located in the west of Shenzhen city, beside the sea, or in the southwest direction of Hong Kong area. This distribution reveals inherent laws. These POI are concentrated in the main blocks of Shenzhen city and the main roads of the city, which means that the functional layout of the city is closely related to the streets, especially the commercial and living services are basically concentrated in the vicinity of Hong Kong; these areas are the foreign trade areas of Shenzhen during the reform and opening up period, and the region has a large population. For example, because of electronic commerce, Hua Qiang Bei has higher human-population density. Therefore, from the distribution of the POI on the map, it can be concluded that the static distribution of the population has a one-to-one correspondence with the functional distribution of the POI. However, other factors are not precluded. Although data mining can collect functional information through various means, the collected information is basically formally registered or published online. There is still large of information not online or formally registered, especially some of the operative information in Shenzhen is difficult to obtain due to confidentiality, but the distribution trend of functional areas in Shenzhen is correct and reasonable. Finally, we can see that new attempts and reflections are made from different spatial scales. Urban interest points have a strong correlation with population distribution, but these POI are not able to replace the entire Shenzhen urban functional area, so there is a certain error. According to the POI combined with the GIS platform, it can be seen that the distribution of urban functions is basically the same with population distribution, and whether the distribution of the population is related to the distribution of urban heat islands needs to be explored by using remote sensing satellite data and POI data.

This time, remote sensing data of MODIS satellite 1KM in NASA products were used, and the urban heat island inversion in July was carried out through the data. The main cause of urban heat islands is the burning of fossil fuel and the impact of urban underlying surfaces. In recent years, in order to promote new energy motor vehicles in Shenzhen, taxis and buses in urban areas have been updated to green electric vehicles, and the government has promoted and popularized new energy vehicles for private cars. In addition, urban afforestation has begun to be undertaken in Shenzhen. Besides, the Shenzhen government planted lots of green trees, which lower the urban air pollution and the urban heat island effect of Shenzhen. With the city expansion and economic development, the Shenzhen city gradually expanded northward from the original reclamation, which has a certain impact on the change of land properties and these have a close relationship with the urban function, because of the change of functional attributes. It is a change in the unique attributes of urban lands, such as the conversion of the original farmland to a commercial house [11]. Changes in the functional attributes of these cities eventually led to changes in the underlying surface of the city. With a large number of functions in Shenzhen City, a large number of factories began to migrate northward, such as the electronics industry, the automotive industry, etc., so the surface temperature in the northern part of Shenzhen is becoming higher than other areas. It can be observed in the retrieval of urban heat island in July 2018 that the area with a relatively high surface temperature is the northern part of Shenzhen except for the area near Hong Kong. Inversion time in July belongs to Shenzhen Summer Day. Due to the sea breeze and rainfall in Shenzhen Summer, this has a certain influence on the surface temperature. As a spatio-temporal analysis of the continuity of remote sensing information, the distribution tendency of the temperature of the entire heat island in the urban heat island of Shenzhen is reasonable and effective. Therefore, it can be seen from the distribution of the heat island map that the temperature of the urban heat islands are mainly affected by the urban function, and the western part of the Shenzhen is distributed with a large number of complex functional forms, the south is close to the Hong Kong area, and the northeastern part of the city is high in temperature; these areas are basically commercial, factory, residential and other areas. Urban POI obtained by data mining is superimposed with the urban heat island temperature. A large number of POI is basically consistent with the distribution of urban heat islands, and the red temperature of the urban heat island is closely related to the principal street of the city. For instance, the distribution of urban heat islands and POI density maps are consistent with the distribution of July 01(th), July 09(th), July 10(th) and July 28(th), 2018 especially for public facilities POI and urban heat islands. This shows that the functional layout of the city is consistent with the distribution law of the urban heat island, and the urban functional layout is basically consistent with the urban population distribution. It can be observed that the distribution law of the population is fundamentally consistent with the distribution law of the urban heat island.

Exploring the relationship between urban heat island and population distribution has a very complicated analysis process [12]. The foremost reason is that the population distribution is dynamic, especially affected by surrounding influence factors, which make the analysis more difficult. Distribution of urban air microbes in cities is more complicated than population distribution. Therefore the current research primarily uses the population distribution and different functional attributes of land as the research basis. Using the combination of urban heat islands and urban interest points, the population distribution is studied, so that the association of municipal air microbes is

basically feasible and reasonable.

V. Conclusion

Combing with the remote sensing satellite data, this article inverse analyzed the temperature of urban heat islands, understood the distribution trend of the urban population in Shenzhen, and confirmed that there is a certain correlation between the population distribution and the surface temperature of urban heat island by mining the data from urban interest points. The result is that the surface temperature of urban heat island is proportional to the population distribution density, which paves the way for the research about urban air microbiology in the future.

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