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AIR QUALITY COMPARISON BETWEEN FOSHAN AND KOK-KOLA

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ABSTRACT

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With the development of industry and transportation, the pollution caused by human activities has become more serious, and the air quality is getting worse today. Environmental problems have become an issue that people pay attention to. Nowadays, humans have also found that the quality of air affects human health and life. All countries in the world have begun to pay attention to environmental problems, and there are local problems in various regions for different reasons, which are related to the economic, political and cultural development of various regions. This thesis is about the air quality of Foshan and Kokkola. This thesis explores the causes of air pollution in Foshan by studying the development of industry, geography and industry in Foshan City and Kokkola City, and discussing the current status of the ceramic industry. In addition, the air quality index (AQI) is used in this thesis to compare the air quality of the two cities.

Key words
Geography, ceramic industry, air pollution sources and hazards, air quality index(AQI).

ABSTRACT

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1 INTRODUCTION

People cannot live without air, so air quality has a profound impact on people's lives. Air quality reflects the degree of air pollution and is judged by the concentration of pollutants in the air. Air pollution is largely caused by the development of industry and transportation. Industrial exhaust gas and vehicle exhaust is the main source of air pollution. And the exhaust pollution of ceramic industry is prominent in Foshan.

Foshan is located in southern China and has a long history. It is a second-tier city. During the Tang and Song Dynasties, the handicraft industry, commerce and culture in Foshan were very prosperous. During the Ming and Qing Dynasties, due to the development of industry and commerce, Foshan became a gathering place for businessmen. The folk art in Foshan is famous, and ceramics are also well-known in China. (Zhao 2018.) Today, Foshan ceramics plays an important role in China. It brings economic benefits, but the ceramic industry has also caused pollution to the environment. If industrial production is not properly managed, it will cause serious impact on the environment, including the destruction of the ecological environment, the destruction of mineral resources and environmental pollution. (Liu 2013.) According to statistics from the environmental protection department, in addition to the high consumption of water and fuel, the pollutant emissions of the ceramic industry are also very large. In the ceramic production process, the green body should be greened at a high temperature of about 1000℃. The firing temperature of daily-use ceramics and electric porcelain needs to be above 1300 ℃, and various machinery and electrical appliances must be used. It can be seen that a large amount of energy is consumed in the ceramic production process.

Kokkola has a long history and was granted the city charter by King Gustav II of Sweden in 1620. Kokkola is Finland's western seaport. The main function in Kokkola was to serve as a shipping port for tar trade. The city is also an important shipbuilding center in Finland. It is precisely because of these two industries that economy of Kokkola prospered and Kokkola was once the richest city in Finland. Later, Kokkola also suffered from fire and war. In 1885, Kokkola opened the railway, and then entered a period of development. Nowadays, industrial industries such as metal processing industry, foundry industry, textile industry, plastic industry, food industry and wood industry are gradually developing. The chemical industry has become a pillar industry of Kokkola.

2 OVERVIEW OF FOSHAN

During the Ming and Qing Dynasties, the prosperity of foreign trade promoted the economic development of Guangdong Province and drove the development of many parts of Guangdong Province. In 1951, the Foshan Municipal People's Government was established. It was only in 1983 that the prefecture-level city of Foshan was established. Foshan, referred to as "Chan" for short, is Chinese second-tier city with a long history and a national historical and cultural city. At the same time, Foshan is known for its pottery, martial arts, and Cantonese opera. It is the core area of Guangfu culture, with a strong Lingnan culture. Since ancient times, Foshan has had a developed economy and a prosperous business. It is one of the "Four Famous Towns" and "Four Great Gatherings" famous throughout the Ming and Qing Dynasties. In addition, the river network in Foshan is densely covered and the ecological environment is good. It is a unique water town in Lingnan and has many tourist attractions worth watching.

2.1 Foshan geography

Guangdong Province is located in the southernmost part of mainland China shown in Figure 1. Guangdong Province belongs to the East Asian monsoon region and is one of the regions with the most abundant light, heat and water resources in China. From north to south, the average annual sunshine hours increase from less than 1500 hours to more than 2300 hours, and the total annual solar radiation is between 4200 to 5400 MJ/m^2. Foshan is located in the central and southern part of Guangdong Province and is the hinterland of the Pearl River Delta.

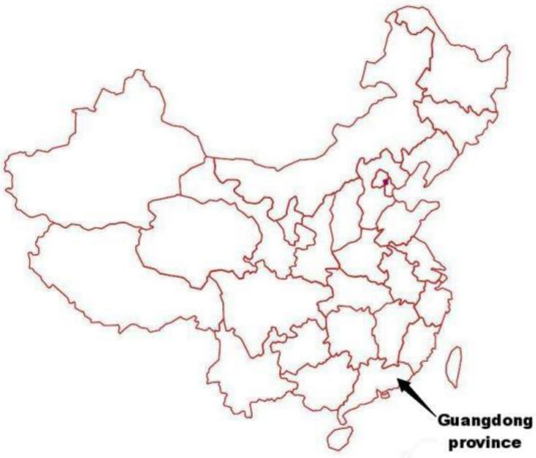

Figure 1 Location of Guangdong Province in China (Yibai Document Network. 2020.)

Foshan is located in the east of Guangzhou shown in Figure 2. The geographic resources is rich. The whole area is between 22 °38 '~ 23 °34' north latitude and 112 °22 '~ 113 °23' east longitude. It is near the ocean, warm and rainy, and has a subtropical monsoon humid climate. The climate is mild, and the average annual temperature is between 21.2 ~ 22.2℃, the rainfall is 1490.6 mm, the annual sunshine hours are about 1800 hours, and the frost-free period is more than 350 days. The land is fertile, and there are red soil, lateritic red soil, and a small amount of yellow soil in low mountain hills. There were paddy soil and stacked soil on the plain. The natural resources are mainly clay, glass sand, rare metals and rice, sugar cane, and a wide variety of fruits, flowers, and rivers. The aquatic resources are evergreen all year round and have been a rich land of fish and rice since ancient times. The distance from east to west and north-south in Foshan is about 103 kilometers, which is roughly in the shape of a "人" and has a total area of 3,813.64 square kilometers. (Liu 2013.)

Figure 2 Location of Foshan in Guangdong Province (Liu, Li& Yin 2009.)

2.2 The history and development of Foshan industry

During the Tang (618-907) and Song Dynasties, a small number of primitive industries and commerce gradually formed in Foshan. In the Song Dynasty (690-1127), it was called Foshan Fort. In the early Ming Dynasty (1368-1644), residents in Foshan still used farming as their main livelihood. In the middle and late Ming Dynasty, the rapid development of commodity economy in the Pearl River Delta and the prosperity and development of Guangzhou, which is adjacent to Foshan, also prompted Foshan to transform from an agricultural village to a commercial town. Due to the market demand in Guangzhou, Foshan began to form a large-scale iron smelting industry, and attracted the attention of the government. In the middle of the Ming Dynasty, Foshan became an industrial base for the iron industry smelted by the government. The government of the Ming Dynasty stipulated that all iron ore in Guangdong should be transported to Foshan for unified smelting. Since then, Foshan has become an iron smelting industry industrial base, and many farmers have gradually become specialized iron shop operators. In the Qing Dynasty (1636-1912), the development of Guangzhou's urban economy further promoted the prosperity of manufacturing industry in Foshan. As for the late Qing Dynasty (1840), the scale of the city expanded and the demand for iron products further. In addition to the iron smelting industry, the developed foreign trade of Guangzhou has promoted the development of other handicraft industries in Foshan, such as ceramics and textiles. (Zhu 2019.)

Today, Foshan is a famous manufacturing city with industry as the leading industry and coordinated development of the Industry, agriculture, service industry. After years of development, the industry in

Foshan is mainly driven by private capital and has formed ten major industries: household appliances, mechanical equipment, metal materials processing and products, ceramic building materials, textiles and clothing, electronic information, food and beverage, plastic products, fine chemicals and Medicine, household goods manufacturing. The output value of these industries accounts for more than 80% of the total industrial output value in Foshan.(How is the development trend of the global ceramic industry 2014.)

3 OVERVIEW OF KOKKOLA

Finland is a highly industrialized and liberalized market economy. The main pillar of the economy is manufacturing, mainly wood, metal, engineering, telecommunications and electronics industries. (Ji & Yu 2014.) Industry has developed rapidly in the 1990s, changing from labor force and capital-intensive to technology-intensive. Wood processing, papermaking and forestry machinery manufacturing based on forests are the mainstay of the economy and are at the leading level in the world. The output of the forest industry accounts for 5% of the world's total output, the world's second largest exporter of paper and paperboard (accounting for 25% of the world's exports) and the world's fourth largest exporter of pulp. There are two nuclear power plants (four nuclear reactors), and the fifth reactor is under construction. (Lina & Allen. 2007.) During World War II, the main industrial policy of the Finnish government was to invest in important industrial facilities on the west coast and as far away as possible from the Soviet border. Kokkola was located on the west coast of Finland. Therefore, the Kokkola Industrial Park was established. Among them, the production of cobalt and zinc is the largest in the world. Since the port of Kokkola is located near the Kokkola Industrial Park, a large part of the products produced in the park are exported to all parts of the world.(Kokkola Industrial Park 2020)

3.1 Kokkola geography

As the Figure 3 shows, Kokkola is a harbour in western Finland. The coverage rate of forest in Finland is about 80%, about 22.82 million hectares, 4.2 hectares per capita, and timber storage is 2.189 billion cubic meters. The mineral resources are mainly copper, and a small amount of iron, nickel, vanadium, cobalt.Peat resources are abundant, with proven reserves of about 69.09 billion cubic meters, equivalent to 4 billion tons of oil. The cold winter is long and the summer is mild and short, belonging to a temperate maritime climate. The average temperature in January is about -4 ~ -16 ℃; July temperature is 16 ~ 13 ℃. The annual precipitation is about 400-600 mm.(Huang 2003.)

Figure 3 Location of Kokkola in Finland (Dreamstime. 2020.)

3.2 Kokkola industry

Many factories operate in Kokkola Industrial Park. The Kokkola Industrial Park (KIP) is the largest concentration of inorganic chemical industry in Northern Europe. The park is vast and there are many companies with leading technology in the industry. The large number of employees and the high quality of the products produced make it famous. At present, there are already 15 production plants and nearly 60 service companies in the park. This industrial park has many advantages. The park has advanced expertise and has invested a lot in training and high-level research. In addition, KIP has been equipped with good public equipment, including pipeline bridges, fiber optic connections, sewage treatment, and conditions required by various industries in the park. At the same time, the Kokkola Industrial Park is actively developing circular economy, and industrial companies will further process the by-products generated in the production process to play a synergistic role and reduce process waste. The park is considered to be the pioneer of circular economy in Finland and throughout Europe. In 1945, Rikkihappo Oy established a sulfuric acid plant and super phosphate plant near the port of Kokkola. In 1971, the company changed its name to Kemira. In the 1990s, the company established several new factories in the area. The closest institution is the phosphate feed factory in 1994. Today, Kemira no longer construct factories in industrial parks. After the war, the mining company Outokumpu also developed. Later, due to industrial policies, Outokumpu established metallurgical plants in several coastal cities. In 1967, the Kokkola cobalt plant was established, and in 1969, a zinc plant was established. Today, Outokumpu has become the leading stainless steel producer in the world, with large output and good products, promoting sustainable development in the world. (Kokkola Industrial Park 2020.)

4 AIR POLLUTION CAUSES AND HAZARDS

Air pollutants are the cause of air pollution, mainly including smoke from industry, domestic stoves and heating boilers, transportation and forest fires. (Yang 2019.) Industrial production is an main source of air pollution. There are many types of pollutants discharged into the atmosphere from industrial production, including soot, sulfur oxides, nitrogen oxides, organic compounds, halides and carbon compounds. In addition, a large number of urban life stoves and heating boilers in cities need to consume a large amount of coal. During the combustion process, coal release a large amount of dust, sulfur dioxide, carbon monoxide, and other harmful substances to pollute the atmosphere. Exhaust gas from burning coal or petroleum is also present in modern commonly used transportation vehicles, which is also a major source of pollutants. The cars in cities are concentrated and the number of cars is large. And the pollutants emitted by the exhaust gas will directly affect the health of urban residents. The exhaust gas emitted by cars is mainly carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO & NO_2) and hydrocarbons, and the first three substances are very harmful. The main primary pollutants in automobile exhaust, fuel oil boilers and petrochemical industry are carbon monoxide (CO), nitrogen oxides (NO & NO_2) and hydrocarbons. These atmospheric pollutants can cause photochemical reactions under sunlight to generate secondary pollutants such as ozone, aldehyde, ketone, peroxyacetyl nitrate and other substances with strong oxidizing properties. (Mai, Li & He 2019.)

4.1 Air quality and its evaluation method

Air refers to the gas surrounding the earth, which maintains the survival of humans and living beings. It is the troposphere that plays an important role in the survival of humans and living beings within 12 kilometers of the ground. One of the necessary conditions for human survival is clean air. If someone do not breath air more than 5 minutes, he will suffocate to death. At the same time, the atmosphere has a certain self-purification ability, and some pollutants that enter the atmosphere can be removed from the atmosphere through the self-purification process of the atmosphere. The quality of air reflects the degree of air pollution. It is evaluated based on the level of pollutants in the air. Ambient air quality standards in China are also divided into three levels: Class I zones implement Class I standards, Class II zones implement Class II standards, and Class III zones implement Class III standards. To measure the air quality of a certain area to achieve several levels of standards is mainly to assess that the concentration of various pollutants in the air such as inhalable particulate matter (PM10), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) reaches which levels of standards.

Ambient air quality evaluation methods can be divided into simple evaluation of single factor and single index and comprehensive evaluation of multiple factors and multiple indexes. It includes index method and complex mathematical model evaluation method, and index method can be divided into single factor index method. The evaluation methods of complex mathematical models include: fuzzy comprehensive evaluation method, gray system method, matter element analysis method and artificial neural network (ANNS) evaluation method. (Chen & Yu 2014.) The environmental quality assessment methods in China mainly include Air Pollution Index Method (API), Air Quality Index (AQI) and Air Quality Comprehensive Index. (Yang & Luo 2017.) Among them, the air pollution index is to simplify the concentration of several air pollutants routinely monitored into a single conceptual numerical form, and to characterize the status of air quality and the degree of air pollution in stages. The results are concise and intuitive, easy to use, and suitable for indicating the short-term air quality status and changing trends of the country. The air pollution index is based on the environmental air quality standards and the impact of various pollutants on human health and the ecological environment to determine the classification of the pollution index and the corresponding pollutant concentration limits. (Chen & Yu 2014.)

4.2 Types and hazards of air pollution

The types of air pollution can be divided into reduction pollution, oxidation pollution, petroleum pollution and other special pollution. Among them, reducing pollution often occurs in areas where coal and oil are the main sources. The main pollutants are sulfur dioxide, carbon monoxide and particulate matter. Oxidative pollution refers to automobile exhaust pollution and its photochemical pollution. Petroleum pollution mainly comes from automobile emissions, petroleum smelting and petrochemical plant emissions, such as nitrogen dioxide. Other special pollution is mainly various chemical substances discharged from various industrial enterprises.(Hao, Ma & Wang 2010.)

Sulfur dioxide in the atmosphere combines with water in the air to form acidic substances, causing acid rain. Acid rain can cause damage to plants and buildings, seriously harm the environment, and cause serious environmental problems such as forest degradation, lake acidification, aquatic population reduction, and soil acidification. At the same time, after the conformation of acid rain, sulfur dioxide may also penetrate the soil and water sources with the precipitation of rainwater, thereby causing secondary pollution hazards. The sulfur dioxide in the air mainly comes from the combustion of fossil fuels, the smelting of sulfur-bearing ores, and the industrial waste gas produced by the production of sulfuric acid and pulp. And Foshan is one of the areas with severe acid rain pollution in Guangdong Province, with a wide range, high intensity and high frequency. (Huang 2003.) When the concentration of sulfur dioxide is 5ppm, inhalation can cause heart palpitations, difficult to breath and other cardiopulmonary diseases. In severe cases, suffocation may occur. The harm of carbon monoxide mainly lies in the impact on human health. Carbon monoxide can poison people and cause severe hypoxia. When the concentration of carbon monoxide is 10ppm, people will feel headache and fatigue. Nitrogen oxides can form acid rain and cause photochemical smog pollution. In addition, nitrogen oxides are corrosive to buildings and harm crops. At the same time, nitrogen dioxide is highly toxic in nitrogen oxides, mainly affecting the human respiratory tract. The toxicity is manifested as deep respiratory tract injury, muscular nervous system damage, and ear blood system damage. (Gao 1991.)

5 CERAMIC INDUSTRY STATUS

After decades of development, the division of labour in the global ceramic industry has become relatively clear. Most ceramic manufacturers outside of China are engaged in a certain link or process of the ceramic industry based on their core capabilities and advantageous resources. Due to the limitation of energy and raw materials, as well as the year-on-year increase in labor force costs, developed countries and regions have gradually transferred technology and production capacity to developing countries. (Modern Technical Ceramics 2014.) With the increasing demand, the ceramic industry has developed rapidly, but because the ceramic industry is a high-energy-consumption and high-pollution industry. It has also caused environmental pollution. (Zhang 2006.)

5.1 Chinese ceramic industry status

Chinese building ceramics industry is developing rapidly. From 1995 to 2000, the output of Chinese building ceramics was between 1.5 billion and 1.8 billion square meters. It exceeded 2.1 billion square meters in 2001, 3.25 billion square meters in 2003, 4.1 billion square meters in 2005, more than 5 billion square meters in 2007, 6.6 billion square meters in 2009, and nearly 8 billion square meters in 2010. Its output ranks first in the world. Today, there are more than 3800 Chinese building and sanitary ceramic enterprises. The regional concentration of ceramic enterprises is very high. But the environmental pollution caused by China's building ceramics industry mainly includes exhaust gas pollution, solid waste pollution, waste water and noise pollution, especially exhaust gas and waste water pollution, and these problems need to be solved. (Wu, Liu & Liu 2013.)

At present, the overall development level of Chinese ceramic industry is still low. Most of the construction ceramics production enterprises are small in scale, weak in technical strength, and environmental protection measures are not in place. Clean production is far from being realized. Therefore, the main pollution of waste gas is in the construction of ceramic factories and their surroundings. It is dust and fuel smoke. Pollution sources of waste gas in the ceramic industry have the characteristics of many emission points, wide distribution, coexistence of fixed emission sources and no fixed emission sources.

Exhaust gas with fixed emission sources mainly comes from equipment such as spray drying towers, drying lines and roller kilns, dust spots without fixed emissions are mainly scattered from the raw material yard and various sections of the production workshop, including raw material loading and unloading, batching, and dry powder discharge, transshipment, transportation and other processes. (Wu, Liu & Liu 2013.)

Chinese building ceramic enterprises should implement clean production, use clean energy and raw materials, and reduce the input of sulfur and fluorine from the source, on the other hand, they should strengthen end control and improve pollution control measures. According to different flue gas characteristics, the pulse box dust removal and lye spray dust removal and desulfurization system can be used to purify the gas box to purify the flue gas of the spray drying tower. The integrated dedusting and desulfurization / defluorination device is used to purify the roller kiln flue gas, so that various pollutants can reach the standard emission and reduce the impact on the environment. At present, because there are no examples of denitrification devices in the building ceramic industry, and the cost of denitrification devices and their operation is relatively large. Therefore, the application experiment of denitrification technology in the building ceramic industry should be carried out as soon as possible, and vigorously develop and promote new energy-saving technologies to reduce emissions of nitrogen oxides. (Wang 2014.)

5.2 Foshan ceramic industry status

At present, the fuel used by the Foshan ceramics industry is relatively complex. According to relevant government departments, ceramic factories conduct environmental testing, including medium and heavy diesel, mixed oil, water gas, and sulfur dioxide emissions rank second in many industries, accounting for about 25% of total emissions. The single discharge of ceramics is exceed to the standard, but the total discharge exceeds the standard, resulting in the pH value of Foshan ceramic acid rain between 4.3 and 4.6. (Huang 2003.) There is a lot of dust around the ceramic factory and it emits a pungent smell from time to time, which is very uncomfortable. The air pollution of the ceramic factory mainly comes from the waste gas and dust in the calcining kiln, the heating furnace of the polishing workshop and other places. Calcining kilns and heating furnaces use diesel and heavy oil as combustion fuel. The flue gas emitted contains sulfides such as dust, sulfur dioxide, arsenic trioxide and nitrogen oxides, hydroxides and toxic chemicals. When fuel is not sufficiently burned, toxic compounds such as carbon monoxide and nitrogen oxides are produced. Because there are often cars coming and going in the factory, the dust in the factory is flying, which is mixed with fluttering dust. Since the main pollutants are sulfur dioxide and nitrogen oxides, it can be seen that the ceramic industry is one of the reasons for the pollution.(Huang 2003.)

6 AIR QUALITY INDEX(AQI)

The Air Quality Index, also known as the Air Index or Air Pollution Index, is to simplify the concentration of several air pollutants routinely monitored into a single conceptual index based on the ambient air quality standards and the impact of various pollutants on human health, ecology, and the environment. The main pollutants included in the air quality assessment are PM2.5, PM10, SO_2, NO_2, O_3, and CO. The air quality index only indicates the degree of pollution of pollutants, not the concentration of specific pollutants. At the same time, the concentration limits of the six pollutants evaluated by the air quality index are different, and the corresponding pollutant concentration limits at the time of evaluation are converted into the air quality index AQI. (Chen & Yu 2014.)

6.1 Air quality index calculation steps

To calculate the air quality index, the observation point must first be determined. The pollutant concentration at each observation point at each moment need to be measured and recorded. To calculate the air quality index based on the measurement results, the first step is to find the average value of each pollutant (SO_2, NO_2, PM10, O_3, PM2.5, CO) in Foshan at a certain time according to Equation 1. Then find the daily average value of each pollutant (SO_2, NO_2, PM10, O_3, PM2.5, CO) according to Formula (2). Then, according to Equation 3, the average daily value of each pollutant is substituted into the basic calculation formula of AQI to obtain the index of each pollutant. Finally, the maximum value of the API index is selected as API of the city.

$$\overline{C_1} = \sum_{i=1}^{n} C_i / n \qquad (1)$$

$$\overline{C} = \sum_{f=1}^{l} \overline{C_{1f}} / l \qquad (2)$$

$$I = \frac{I_h - I_1}{C_h - C_1}(C - C_1) + I_1 \qquad (3)$$

6.2 Foshan air quality index

According to the above air quality index calculation steps, Wanliang, Huacai Vocational Middle School, Nanhai Meteorological Bureau, Shugang, Sugang, Ronggui Subdistrict Office, Gaoming Kongtang, Sanshui Monitoring Station, and Sanshui Yundonghai are the observation points in Foshan City. From these data, Table 1 can be summarized. Table 1 is the air pollutant data at 0:00 on February 29, 2020 in Foshan, and the average concentration of each pollutant in Foshan at this moment can also be calculated. (China Air Quality Online Monitoring and Analysis Platform 2020)

Table 1 February 29, 2020 0:00 Foshan Air Pollutant Data (China Air Quality Online Monitoring and Analysis Platform 2020)

	SO_2(μg/m³)	**NO_2(μg/m³)**	**PM_{10}(μg/m³)**	**O_3(μg/m³)**	**$PM_{2.5}$(μg/m³)**	**CO(mg/m³)**
Wanliang	8	68	60	24	25	0.7
Huacai Vocational School	7	40	39	36	25	0.7
Nanhai Meteorological Bureau	5	53	46	28	28	0.7
Shunde Sugang	6	64	47	10	26	0.7
Ronggui Sub-district Office	5	33	48	43	27	0.7
Gao Ming Kong Tang	4	21	28	55	19	0.5
Sanshui monitoring station	9	80	82	3	43	0.8
Sanshui Yundong-hai	4	50	73	10	39	0.8
$\bar{C} = \sum_{i=1}^{8} Ci/8$	6	51	52	26	29	0.7

According to the same method, the average concentration of pollutants at other time can be obtained. The data can be collected to obtain a line chart of the concentration data of various pollutants in Foshan on February 29, 2020.

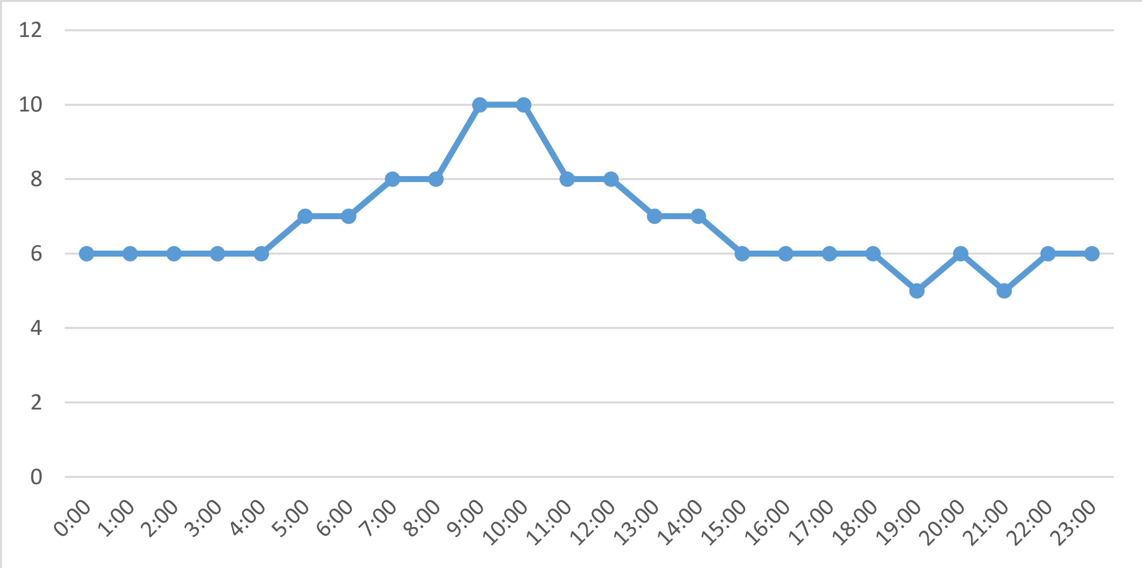

Figure 4 The concentration of SO_2(μg/m^3) on February 29, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to Figure 4, the highest value of SO_2 concentration can be obtained from 9 to 10 in the morning. The highest concentration is 10μg / m^3, the average concentration is 7μg / m^3.

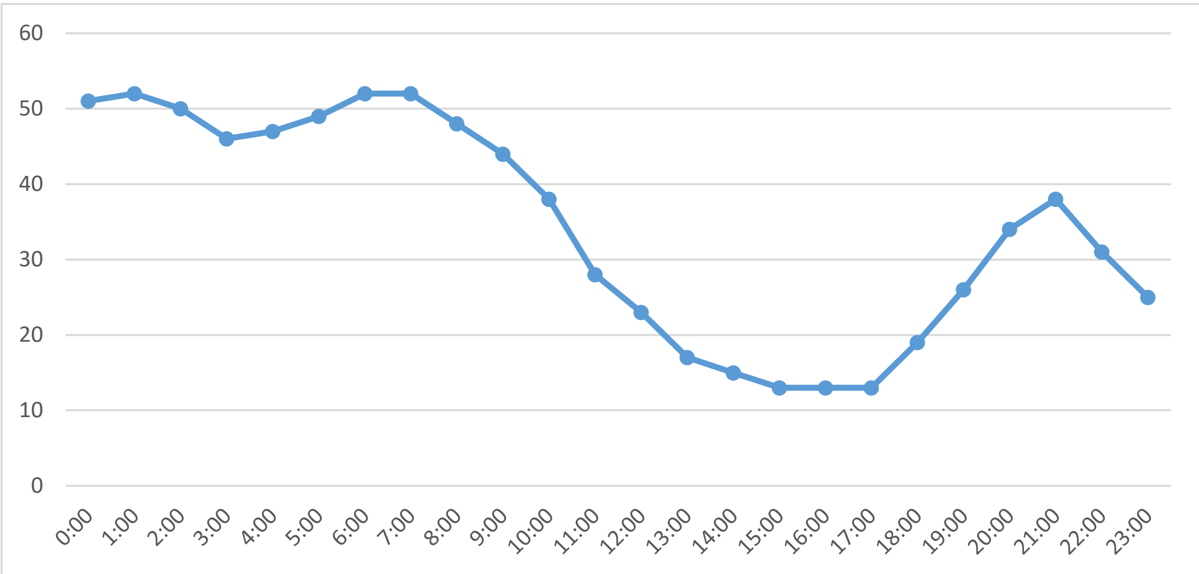

Figure 5 The concentration of NO_2 (μg/m^3) on February 29, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to Figure 5, the highest value of NO_2 concentration can be obtained from 0 to 7 in the morning, the highest concentration is 52μg / m^3, the minimum value is from 15 to 17 in the afternoon, the lowest concentration is 13μg / m$_3$, and the average concentration is 34μg / m^3.

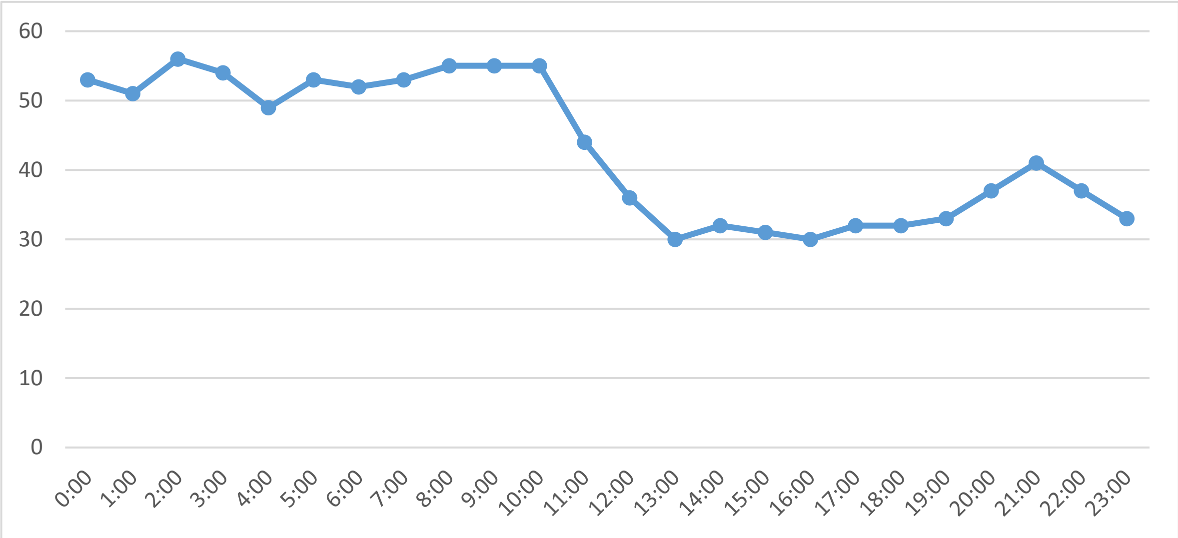

Figure 6 The concentration of PM10(μg/m^3) on February 29, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to Figure 6, it can be seen that PM10 has a higher concentration from early morning to morning, and a lower concentration from afternoon to evening. The highest concentration is 56μg / m^3, and the lowest concentration It is 30μg / m^3, and the average concentration is 43μg / m^3.

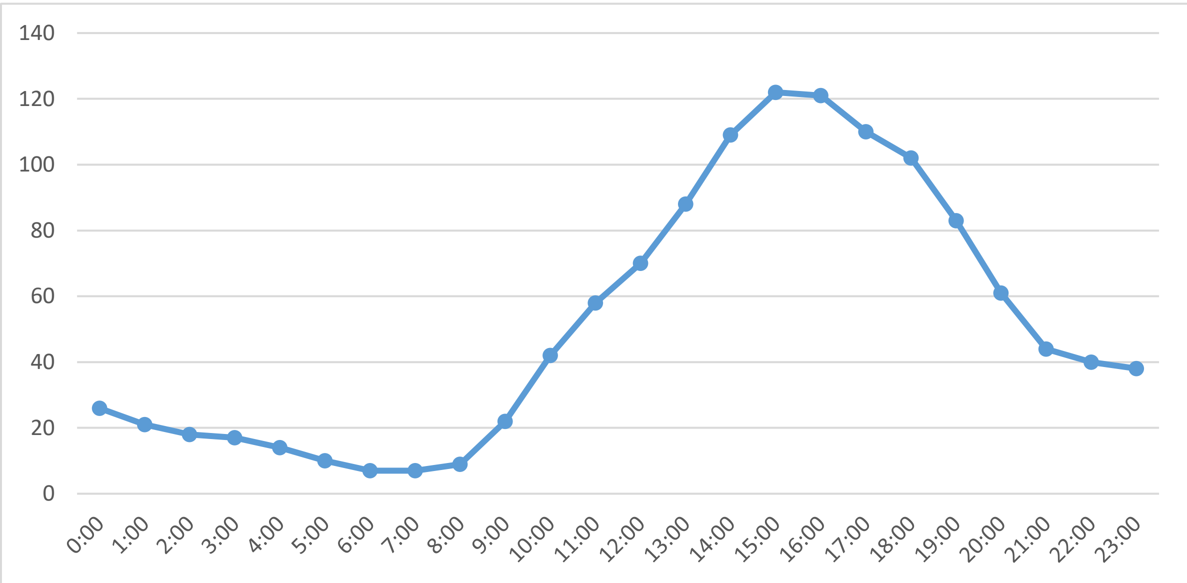

Figure 7 The concentration of O_3(μg/m^3) on February 29, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to Figure 7, the concentration of O_3 is lowat night and is high during the daytime. The highest concentration is 122μg / m^3, the lowest concentration in the morning, and the lowest concentration is 7μg / m^3. The average concentration is 102μg / m^3.

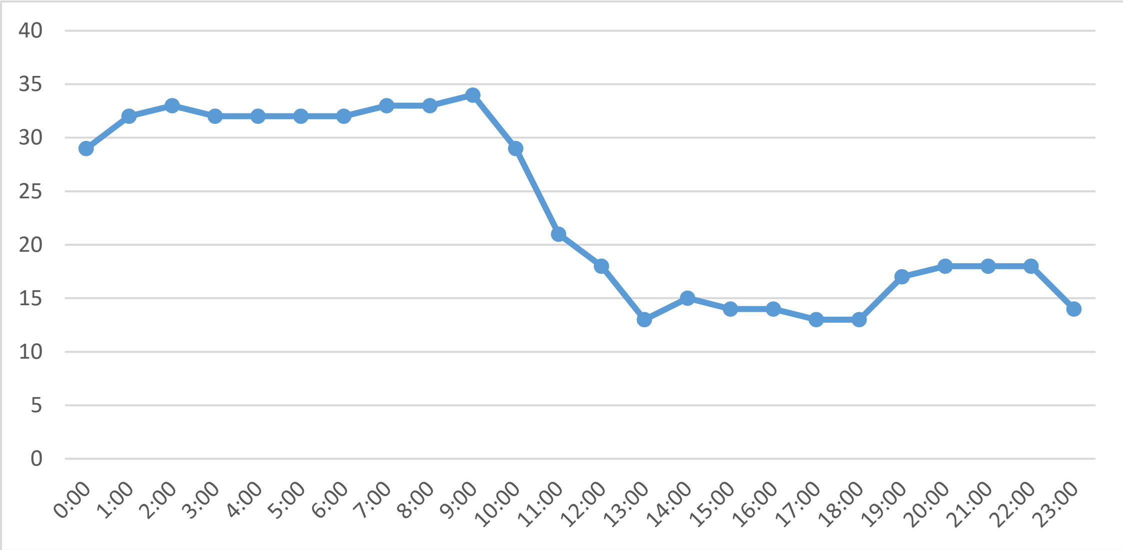

Figure 8 The concentration of PM2.5(μg/m^3) on February 29, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to Figure 8, the concentration of PM2.5 is higher in the early morning, the highest concentration is 34μg / m^3, the afternoon to night concentration is lower, and the lowest concentration is 13μg / m^3. The average concentration is 23μg / m^3.

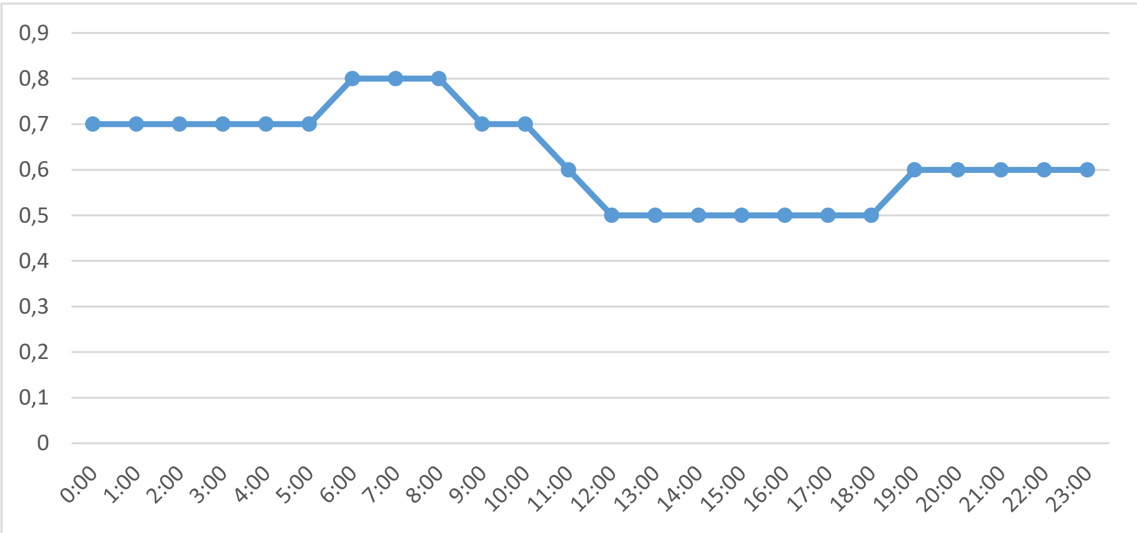

Figure 9 The concentration of CO(mg/m^3)on February 29, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to Figure 9, concentration of CO for one day is insignificant, the maximum in the morning, the highest concentration of 0.8mg / m^3, the minimum in the afternoon, the lowest concentration of 0.5mg / m^3, the average concentration of 0.6mg / m^3.

Table 2 Pollutant concentration limit corresponding of the air quality index (Chen & Yu 2014.)

AQI	**SO_2 (μg/m³)**	**NO_2 (μg/m³)**	**PM_{10} (μg/m³)**	**O_3 (μg/m³)**	**$PM_{2.5}$ (μg/m³)**	**CO (μg/m³)**
50	50	40	50	160	35	5
100	150	80	150	200	75	10
150	475	180	250	300	115	35
200	800	280	350	400	150	60
300	1600	565	420	800	250	90
400	2100	750	500	1000	350	120
500	2620	940	600	1200	500	150

From Equation 3 above, the AQI corresponding to each pollutant can be calculated based on the measured average value of each pollutant concentration $\bar{C}$ and the pollutant concentration limit data in Table 2. Available AQI (SO_2) = 7; AQI (NO_2) = 43; AQI (PM10) = 43; AQI (O_3) = 32; AQI (PM2.5) = 33; AQI (CO) = 6. It can be obtained that the AQI of Foshan on February 29, 2020 is 43, and the main pollutants are NO_2 and PM10.

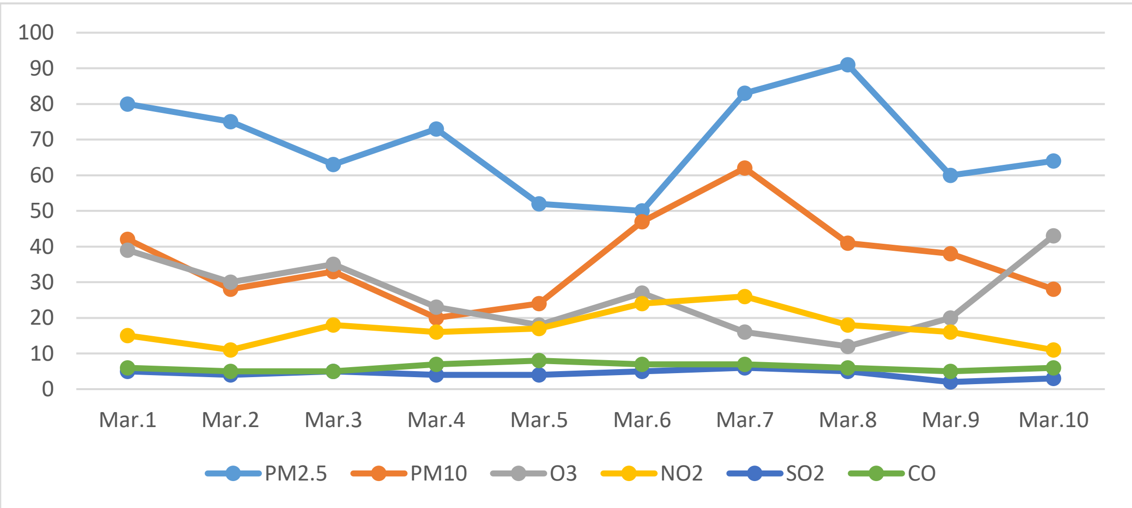

Figure 10 AQI of Foshan from March 1 to 10, 2020 (China Air Quality Online Monitoring and Analysis Platform 2020)

According to the same method, more data can be obtained, and Figure 10 is a line chart of the air quality index of pollutants in Foshan from March 1-10, 2020. It can be seen that the main pollution in Foshan is PM2.5 pollution. CO and SO_2 The pollution is relatively small.

6.3 Kokkola air quality index

Using the same method, the air quality index of Kokkola can be obtained. Due to the large climate difference between Kokkola and Foshan,The dates in Figures 5 to 9 are March 1st to March 10th, and the average temperature of Foshan City between 1 and 10 March is 19.4 ℃. The average temperature of Kokkola from July 7th to July 16th, 2019 is similar to that of Foshan. So the data at this time is chosen for comparison. Figure 11 shows the air quality index of Kokkola at this time.

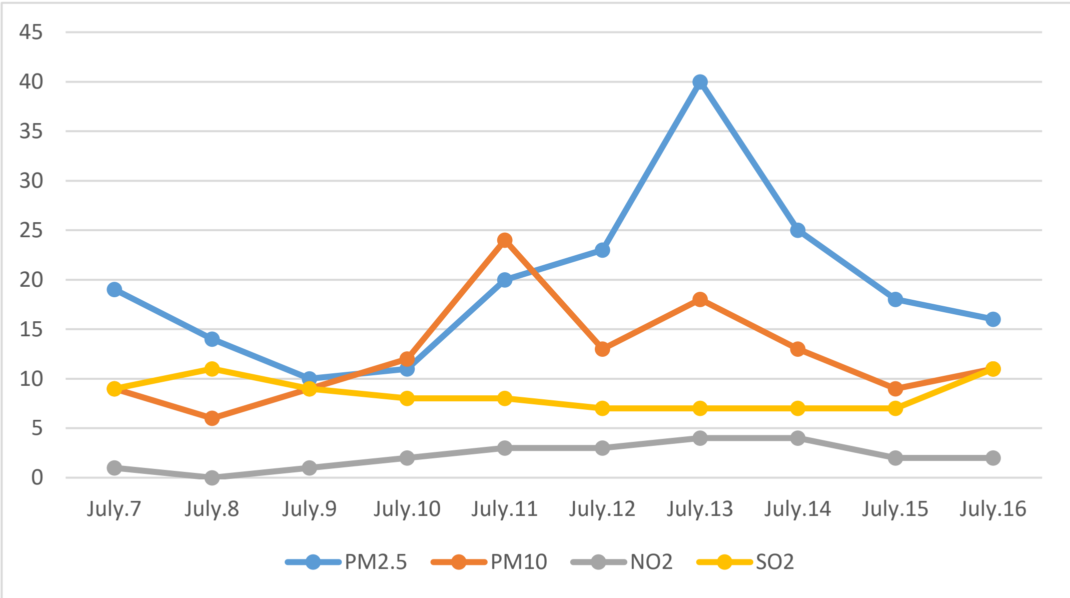

Figure 11 AQI of Kokkola from July 7 to 16, 2019 (FINNISH METEOROLOGICAL INSTITUTE 2020.)

6.4 Comparison of Foshan and Kokkola air quality index

It can be seen from the data above that the primary pollutant in Foshan is mainly PM2.5. And according to the Table 3, the AQI of Foshan during this period is between 50 to 91, the air quality status is in good condition. It has no impact on human health, only a few abnormally sensitive people need to reduce outdoor activities. The main pollutants of Kokkola are mainly PM2.5 and PM10. During this period, the AQI is between 10 to 40. The air quality is excellent, the air is very good, and there is basically no air pollution. All kinds of people can move normally. (Air Quality Index Scale and Color Legend 2020.)

Table 3 Air quality index range and corresponding air quality categories (Air Quality Index Scale and Color Legend 2020.)

AQI	Air Pollution Level	Health Implications	Cautionary Statement (for PM2.5)
0-50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.	None
51-100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
151-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.
201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.
300+	Hazardous	Health alert: everyone may experience more serious health effects.	Everyone should avoid all outdoor exertion.

At the same time, according to previous data, air quality and temperature are closely related. In winter, the air quality indexes of PM2.5, PM10, SO_2, NO_2, and CO are mostly higher than in summer, while O_3 is higher in summer. When there is no major change in the amount of pollution source emissions, temperature and wind speed will directly affect the quality of the air quality and cause a certain difference in the air pollution index. (Tang & Zhu 2011.) Under certain conditions, such as the passing of cold air, the temperature will increase with the increase of altitude, resulting in high air density higher. This phenomenon is called inversion, and the inversion of the atmosphere is called thermal inversion layer. Generally speaking, thermal inversion layer is stronger and thicker in winter and lasts longer. In summer, it is relatively weak. Under the temperature inversion phenomenon, the lower atmosphere is relatively stable, which is not conducive to the diffusion of pollutants, resulting in a high air quality index. As the surface temperature rises in summer, the inversion layer gradually disappears, enhancing the vertical convection of the atmosphere and facilitating the diffusion of pollutants. The temperature of the lower atmosphere is high, and the temperature of the upper atmosphere is low. The density of the air in the upper and lower layers is different. The atmosphere is unstable. The air rolls up and down to form a convection, which disperses the pollutants and dust in the lower layer to the upper air, so that the pollution of the lower layer of the atmosphere is reduced. (Chen, Gao, Hu & Peng 2017.)

In addition, the concentration of pollutants is also related to the wind speed. Generally, the greater the wind speed, the better the dilution and diffusion of pollutants in the air. If the wind speed is small for a long time, it will inhibit the diffusion of pollutants, increase the pollutants near the ground, and thus increase the pollution and increase the air quality index. But sometimes the wind can also raise sand and dust. Due to Kokkola is a harbour city, the wind speed is relatively high. And the air pollutants are easy to be spread. However, Foshan is an inland city, so the wind speed is not as high as that of Kokkola. (Chen, Gao, Hu & Peng 2017.)

The winter monsoon refers to the wind blown by the cold continental high pressure in the monsoon region in winter. The most typical winter monsoon is the East Asian winter monsoon, which is stronger than the summer monsoon. China is in the East Asian monsoon region, and the monsoon has a great impact on Chinese climate change. When strong winter monsoon prevails, the atmosphere with high ozone content in high latitudes is transported to low latitudes through monsoon activities, resulting in a decrease in the ozone content in Foshan. (Mai, Li & He 2019.)

7 CONCLUSION

The main reason for affecting the urban air quality is the excessive discharge of pollutants from various sources in the city. Foshan has a high population density, and the pressure of people's transportation on the environment is also greater, while Kokkola has a smaller population density and less pollution. Compared with Kokkola, there are also more factories in Foshan and more sewage. At the same time, meteorological conditions are also an important reason for affecting the urban air quality. Foshan pollutants are dominated by PM2.5. The frequency of temperature inversion in spring and winter is high, so the atmospheric stratification is relatively stable, which is not conducive to the diffusion of atmospheric pollutants. The concentration of pollutants in spring and winter is relatively high. In summer and autumn, the wind speed is higher, the diffusion rate of the pollutant is fast and the range of the pollutant is wide, so the concentration of pollutants decreases. The wet precipitation is also the reason for the rapid decline of pollutants in the short term. (Chen, Gao, Hu & Peng 2017.) Compared with Kokkola, the government of Foshan needs to pay more attention to air pollution. Firstly, the government should strictly control industrial emissions. The industry can learn some new technologies. Foshan ceramic enterprises should implement cleaner production, use clean energy and raw materials, and reduce the input of sulfur and fluorine from the beginning. They should strengthen end control and improve pollution control measures to make various pollutants discharged to meet the standards, reduce the impact on the environment (Wang 2014.) , strengthen the transformation of existing emission reduction processes, strengthen the application of advanced emission reduction processes for new enterprises, and implement key industries such as "ultra-low emissions" in accordance with provincial plans in a step-by-step manner. (Yang 2019.)

With the continuous development of industry and transportation, a large amount of harmful substances are discharged into the air, which changes the normal composition of the air and deteriorates the air quality.When people live with polluted air, the health of people will be affected. The population of China is large. In recent decades, China has faced serious air pollution problems. (Rui & Zheng 2019.) Foshan also has a large population and serious air pollution. Foshan ceramic industry pollution is one of the main causes of air pollution. (Huang 2003.)

Public participation in air pollution control is lacking, and air pollution environmental quality management has not reached the best state. The joint control of regional air pollution prevention is insufficient. (Xie 2015.) At present, since there are no examples of denitrification devices used in the building ceramic industry, but the cost of denitrification devices and their operation is relatively large. Therefore, the application experiments of denitrification technologies in the building ceramic industry should be conducted as soon as possible. And new energy-saving technologies should be developed to reduce nitrogen oxide emissions. (Wang 2014.) National and local governments need to establish an air quality information publishing system, making full use of television, newspapers, the Internet, mobile phones and other media to release data monitored in accordance with new standards in a timely manner, so that the public can obtain ambient air quality information from various channels easily and quickly. It is necessary to establish a regional atmospheric environment quality forecasting system to improve the ability to judge and to warn risk information. At present, people must pay attention to strengthening the early warning and monitoring of the haze weather in autumn and winter. When there is continuous heavy pollution, government must start the emergency mechanism in time to guide people to arrange travel and life in a reasonable manner. (Xie 2015.)

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