Li-yun ZENG, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 11, Issue 5, (Series-V) May 2021, pp. 05-18

RESEARCH ARTICLE OPEN ACCESS

Research on Influencing Factors of Air Quality in Index Industrial Cities Based on Mountain Topography

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ABSTRACT:
The main reasons for Panzhihua's local pollution are the large amount of coal burned, steelmaking, and scattered non-point sources. At the same time, meteorological factors and topographical characteristics also play a significant role in air quality. This paper analyses and evaluates the air quality in Panzhihua City based on the Air Quality Index (AQI). Through the use of Train Collectors Tool to capture the air quality monitoring data in recent years, and use the visualization software to analyze the data. It is concluded that climatic factors, industrial layout, mountain topography characteristics and industrial land layout are the main causes of air pollution in mountainous cities, and air pollution control measures are proposed for the air quality in Panzhihua City.

KEYWORDS: topographic features; meteorological features; industrial distribution; air quality index

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Date of Submission: 12-05-2021 Date of Acceptance: 25-05-2021

I. INTRODUCTION

Mountain terrain has many regional particularities and complexities in cities. Many small and medium-sized cities in our country are located in mountainous areas. The mountainous terrain has an impact on the temperature, moisture and movement of the atmosphere, due to the undulation and unevenness of the terrain. The diffusion of air pollutants will be more complicated, the residence time of pollutants is longer than that of plain cities, and the impact will be greater. After the mountainous resource-based cities have entered a period of rapid development, industry, as the driving force of urban economic development, has developed particularly rapidly. With that, industrial pollution, waste gas and wastewater affect the urban environment at any time.

According to the data obtained by the Sichuan Provincial Department of Ecology and Environment, in October 2020, the average proportion of days with good ambient air quality in 183 counties (cities, districts) in Sichuan Province was 99.1%, a year-on-year decrease of 0.6%. O3, SO2 and NO2 pollutants decreased by 17.9%, 11.1% and 5.3% year-on-year, respectively; the PM2.5 concentration remained the same year-on-year; the concentrations of CO and PM10 pollutants increased by 12.5% and 3.1% year-on-year, respectively. A total of 179 counties (cities, districts) in the province meet the environmental air quality standards. The top 10 are Muli County, Xiaojin County and Xiangcheng County (tied), Litang County and Ganzi County (tied), Danba County. , Ruoergai County, Baiyu County, Yajiang County, Songpan County, and Daofu County (tied); the bottom 10 places are East District of Panzhihua City, Jinkouhe District of Leshan City, West District of Panzhihua City, Ebian Yi Autonomous County, Lu County Chengdu Chenghua District, Chengdu Qingyang District, Dachuan District of Dazhou City, Cuiping District of Yibin City, Jinniu District of Chengdu City. Among them, the poor air in Panzhihua City covers two areas. Also, Panzhihua is a typical mountain resource-based industrial city and is developing and transforming into a healthy and livable city. Under this situation, it is urgent to study the ecological environment problems of mountainous resource-based cities. Based on the AQI index and other data, this paper adopts a Spatio-temporal analysis of the mountainous city Panzhihua's topographic and industrial structure changes and other factors to analyze the air quality in Panzhihua. Analysis.

II. RESEARCH OBJECT

Panzhihua City is located at the southernmost tip of Sichuan in southwestern China, at the junction of Sichuan and Yunnan. It is located in the middle-south section of the Panxi Rift Valley. The north and south have the characteristics of high

mountains and deep valleys, and the staggered distribution of basins. Panzhihua is a resource-based city with rare vanadium ilmenite. It has been developed under the strong support of the state. There are a large number of industries. Pollutants in the industry such as waste gas and wastewater discharge. All of these affect the air in the city. In addition, Panzhihua has a complex mountainous terrain and is located in the valleys on both sides of the mountains. The blocking of the mountains has a significant impact on the exhaust gas generated in industrial manufacturing and the circulation of urban air.

III. RESEARCH METHODS

3.1 Big data visualization technology

The main data source is based on the software "train collector" to capture the big data of the National Air Quality Monitoring Network, China Weather, Sichuan Meteorological Bureau, Sichuan Provincial Department of Ecology and Environment, Panzhihua Environmental Protection Bureau and other web pages, and classify the data sort out.

3.2 Chart analysis method

Analyze and compare air quality index data based on software such as Excel.

3.3 ArcGIS map analysis method

Based on GIS, analyze the topography, aspect and slope of Panzhihua.

3.4 Spatio-temporal analysis method

At the level of temporal and spatial analysis, the air quality of Panzhihua City from 2014 to 2020 was analysed, and the air quality changes in different months and the temporal change characteristics of different air pollutants were discussed. This discusses the changing law of the air quality in Panzhihua City in the time dimension.

3.5 At the level of spatial analysis

(1) The natural topography of Panzhihua City was analyzed; (3) The air quality and land use planning in different areas of Panzhihua City were compared. This analyzes the relationship between air quality and mountain topography, urban planning and urban development.

IV. AIR QUALITY EVALUATION SYSTEM

Regarding the definition of air quality index AQI, Zhang Jianzhong and others pointed out that AQI is based on 6 pollutants (SO2, NO2, PM10, PM2.5, O3, CO) in "The Temporal and Spatial Distribution Characteristics of Air Quality Index in Beijing Area and Its Relationship with Meteorological Conditions".) In the basic items, choose the highest air quality index as the air quality index. Zhu Xin and Yang Shan defined AQI as the result obtained by comprehensive calculation based on the concentration of air pollutants in "Research and Analysis of Air Quality Data in Chengdu". The AQI's six pollutant separate evaluation standards are called the air quality sub-index. The air quality index standards are shown in Table 1.

Table 1 Air Quality Index Standard

Air quality index	Air quality index level	Air Quality Index category	Impact on health	Suggestion
0～50	1	excellent	Satisfactory air quality, basically no air pollution	Normal activities for all kinds of people
51～100	2	good	The air quality is acceptable, but certain pollutants may have a weaker impact on the health of a very small number of extremely sensitive people	A very small number of extremely sensitive people should reduce outdoor activities
101～150	3	Light pollution	Symptoms of susceptible people are mildly aggravated, and healthy people have irritation symptoms	Children, the elderly, and patients with heart and respiratory diseases should reduce long-term, high-intensity outdoor exercise

151～200	4	Moderately polluted	Further aggravate the symptoms of susceptible people, which may affect the heart and respiratory system of healthy people	Children, the elderly, and patients with heart and respiratory diseases should avoid long, high-intensity outdoor exercises, and the general population should reduce outdoor exercises appropriately
201～300	5	Heavy pollution	Symptoms of heart and lung disease patients are significantly worsened, exercise tolerance is reduced, and symptoms are common in healthy people	Children, the elderly, and patients with heart and lung diseases should stay indoors, stop outdoor sports, and reduce outdoor sports for the general population
＞300	6	Serious pollution	Healthy people have reduced exercise tolerance, have obvious strong symptoms, and some diseases appear early	Children, the elderly and the sick should stay indoors to avoid physical exertion, and the general population should avoid outdoor activities

Data souce：https://www.aqistudy.cn/

V. SPATIO-TEMPORAL ANALYSIS OF AIR QUALITY IN PANZHIHUA CITY

According to research, the factors that affect the air quality of a region and its pollution process can be divided into natural effects and artificial effects. The former mainly refers to the influence caused by natural background conditions such as local topography and climatic factors; the latter can be divided into artificial environmental influences and artificial activities influences [1-2]. The air pollution problems in cities are based on natural influences, mainly caused by artificial influences [3]. From the perspective of urban and rural planning, the natural environment determines the overall ventilation of the city [1], and also affects the physical and chemical reactions of pollutants [4]. Under the intervention of artificial influence, firstly, artificial activities have brought about a large amount of pollutant emissions, resulting in different pollution situations in different periods [5-6]; secondly, the development of cities will lead to changes in urban surface heat and power processes. [7]. For example, with the development of cities, the density of buildings increases, the urban ventilation corridors are blocked, and the underlying surface of the city is more rough, resulting in a decrease in urban wind speed and an increase in the frequency of weak wind and static wind; the large number of high-rise buildings also changes the wind field [8]; Develop industry and over-explore resources such as coal. Industry is an important source of air pollution. The pollutants emitted by industry into the atmosphere are of various types and complex in nature, including smoke and dust, sulfur oxides, nitrogen oxides, organic compounds, halides, and carbon compounds. Some of them are smoke and dust. Some are gases; over-exploitation of tourism and the development of transportation, automobiles, trains, airplanes, and ships are the main means of transportation in the contemporary era, and the exhaust gas produced by burning coal or oil is also important; living stoves and heating boilers. A large number of residential stoves and heating boilers in cities need to consume a large amount of coal. During the combustion process of coal, a large amount of dust, sulfur dioxide, carbon monoxide and other harmful substances will be released to pollute the atmosphere. Especially when heating in winter, the polluted area is often filled with smog, which is also a source of pollution that cannot be ignored.

5.1 Air pollution analysis

The change of pollutant concentration is related to the emission and diffusion of pollutants. As shown in Figure 1, the total emissions of various waste gas pollutants in 2019 have been reduced compared to 2014, but the emissions of industrial waste gas pollutants are still a large proportion of the total emissions. The main sources of air pollutants, SO2 and nitrogen oxides are the main emissions, and SO2 emissions are the highest.

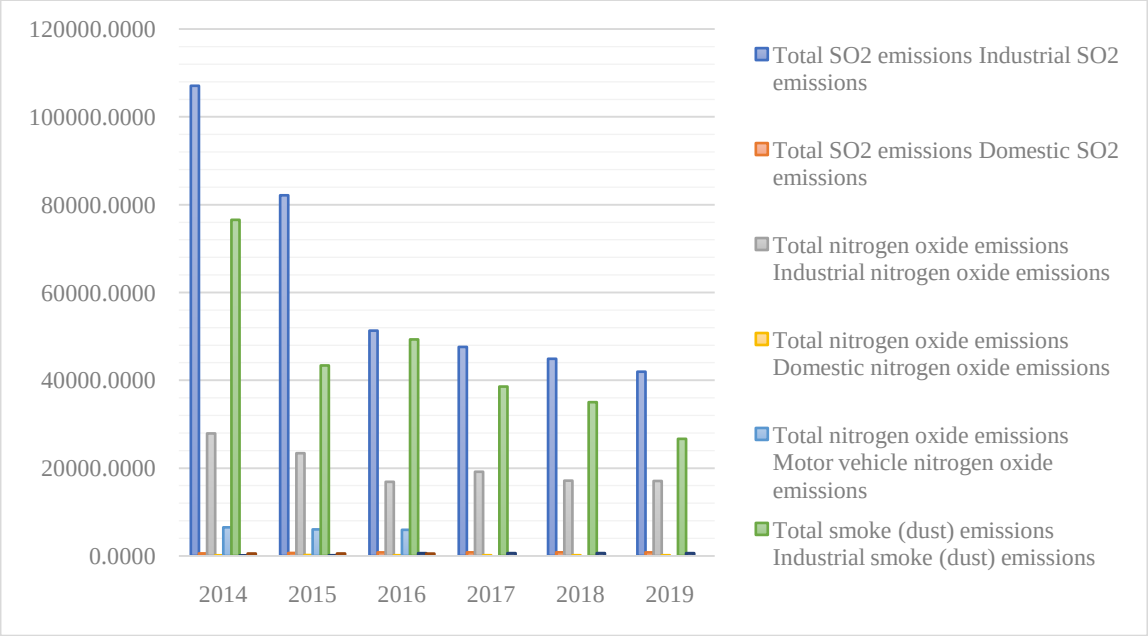

Figure 1 Emissions of various waste gases from 2014 to 2019

5.2 Air quality analysis

According to the relevant values (Figure 2), Panzhihua has good overall air. Since 2015, the air quality has been steady and good year by year, but at present, the air quality has declined. The temperature is suitable for living, but there is an urgent need to improve the air quality, and industrial air pollution is more serious. From the chart data, we can see that the air quality index was 66 in 2014. The index for the first half of 2020 was 57.5. Although the air quality index fluctuates slightly during the period, it generally declines. According to its definition of air quality, the data of PM2.5, PM10, CO, NO2, and SO2 have shown a downward trend in general, while O3 as a whole However, it is showing an upward trend and is doubling. It can be seen from this that the air quality in Panzhihua has improved in the past seven years, but for a city whose development is based on health care, the air quality needs to be further improved.

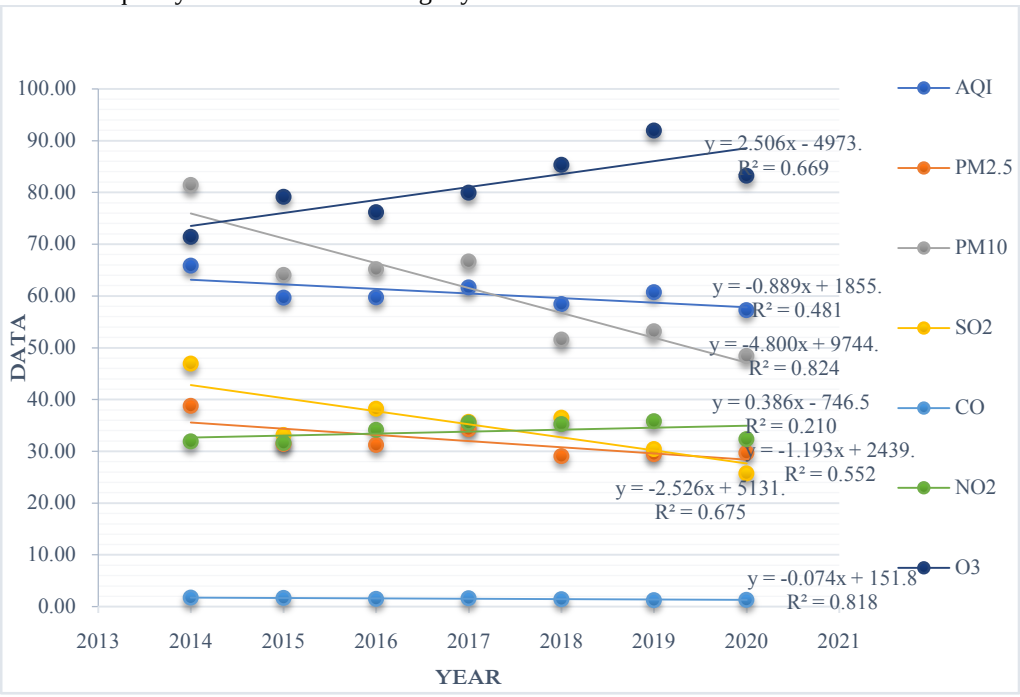

Figure 2 The annual change trend of Panzhihua's air quality indicators from 2014 to 2020

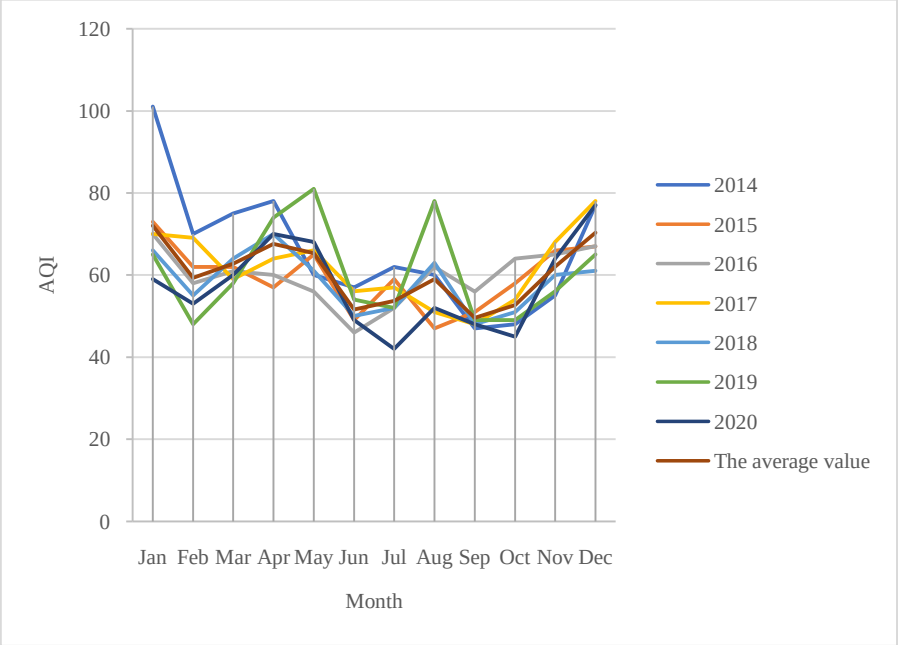

Figure 3 The trend of monthly average AQI from 2014 to 2020

According to the data published on the official website of Panzhihua Environmental Protection Bureau, the article counts the annual change trend of AQI (Figure 3), monthly change trend of AQI, and monthly change of AQI grade in Panzhihua City in the past 7 years (2014-2020). , The monthly average maximum value of AQI varies greatly and spans the two categories of light pollution and moderate pollution. The air quality in Panzhihua has obvious seasonal variability, which is mainly manifested in the characteristics of poor air quality in autumn and winter and relatively good air quality in summer. As shown in Figure 4, the air quality index range shows that when the air quality in Panzhihua is at its worst, the AQI is 180, reaching a moderate level of pollution.

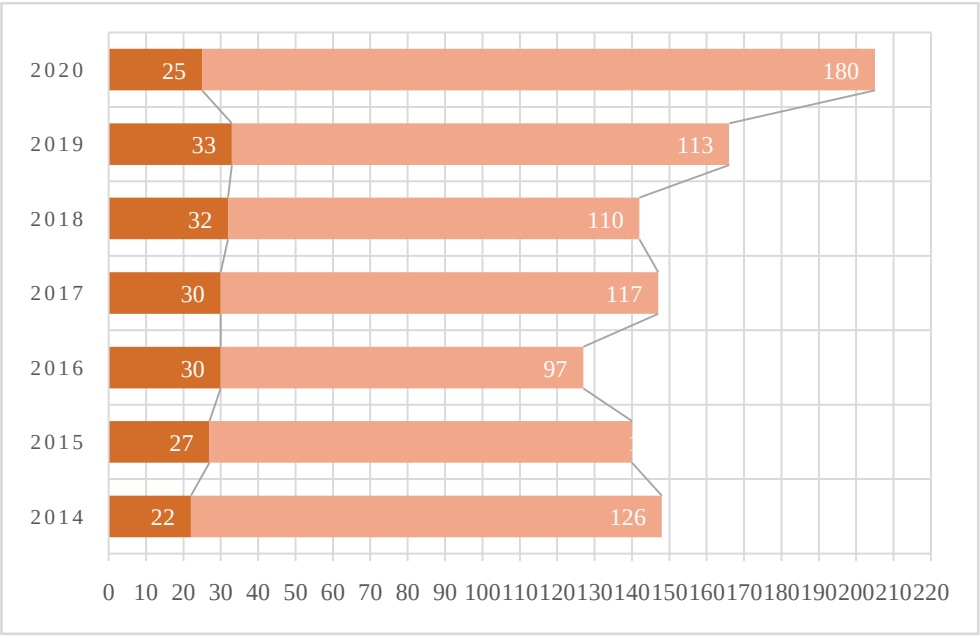

Figure 4 2014-2020 Panzhihua Air Quality Index Range

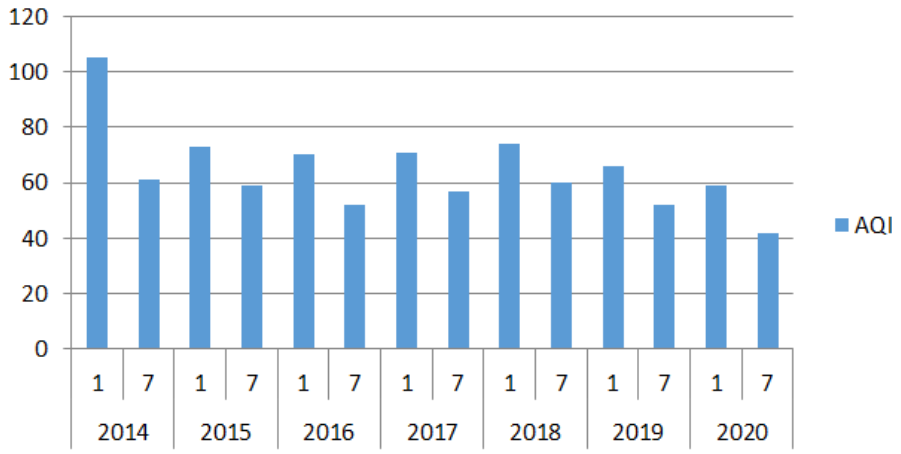

Figure 5 Comparison and analysis of AQI values between January and July 2014-2020

It can be seen in Figure 5 that although the air quality index is declining between 2014 and 2020, from the point of view of the month, whether it is January and July of 2014 or January and July of 2020, the air quality index of January The air quality index is greater than that in July, and this trend has been shown in the index for these seven years. Therefore, the AQI of Panzhihua has obvious seasonal changes, with winter being higher than summer.

5.3 Monthly average concentration of major pollutants

The annual average value of the six major pollutants monitored in the past 7 years in Panzhihua City from 2014 to 2020, which was crawled on the air quality online monitoring and analysis platform (https://www.aqistudy.cn), was sorted out and analyzed, and the following conclusions were reached. The main air pollutants in Panzhihua City are O3, PM2.5, and PM10, and the annual average values all exceed the national first-level indicators (Table 2). Through the analysis of the monthly average concentration change data of the four main pollutants, it can be seen that the concentration of particulate matter presents the characteristics of change in summer, autumn and winter. It exceeds the concentration limit of Class I in summer and seriously exceeds the concentration limit of Class II in winter; on the contrary, the concentration of O3 is in It increases in spring and summer, and decreases in autumn and winter.

Table 2 Statistical Table of Pollutant Concentrations in Panzhihua City from 2014 to 2020 (China Ambient Air Quality Standard (GB3095-2012))

Pollutants	Annual mean	Annual average concentration limit (level 1)	Super-level index rate (%)	Annual average concentration limit (level 2)	unit
Fine particulate matter PM2.5	31.98	15	1.132	35	μg/m³
Inhalable particulate matter PM10	61.50	40	0.5375	70	μg/m³
Sulfur dioxide SO2	35.24	20	0.762	60	μg/m³
Nitrogen Dioxide NO2	33.80	40	-0.155	40	μg/m³
Carbon monoxide CO	1.52	4	-0.62	4	mg/m³
	Daily average 90th percentile concentration		Maximum average daily limit of eight hours		μg/m³
		Leve 1		Lever 2	
Ozone O3	141.5	100	0.415	100	

Data source: http://www.pzhsxq.gov.cn/zwgk/bmgsgg/1613482.shtml,

In the past seven years, January has the highest concentration of PM2.5, and June has a lower average PM2.5, which is the month with the lowest monthly average of PM2.5 in the whole year (Figure 6). In general, although the monthly average concentration of PM2.5 in 2020 has a certain downward trend, the monthly average value is lower than the average value in spring and summer, but it is higher than the average value in autumn and winter. The monthly average change of PM10 and PM2.5 show similar seasonal changes, but the monthly average value of PM10 in 2020 is lower than the 7-year average, and the control of PM10 index is greatly improved compared with the extremely poor 2014 (Figure 7). The monthly average value of SO2 was at a high level in January, July, and December 2014, but by 2020, all months will be below the average level, and the SO2 content has a significant decreasing trend (Figure 8). The CO concentration was higher in January and December, and lowest in June, showing seasonal changes (Figure 9). The concentration of NO2 was higher in December than in January and lowest in June (Figure 10). On the contrary, the concentration of O3 is at a low level in summer and at a low level in autumn and winter (Figure 11).

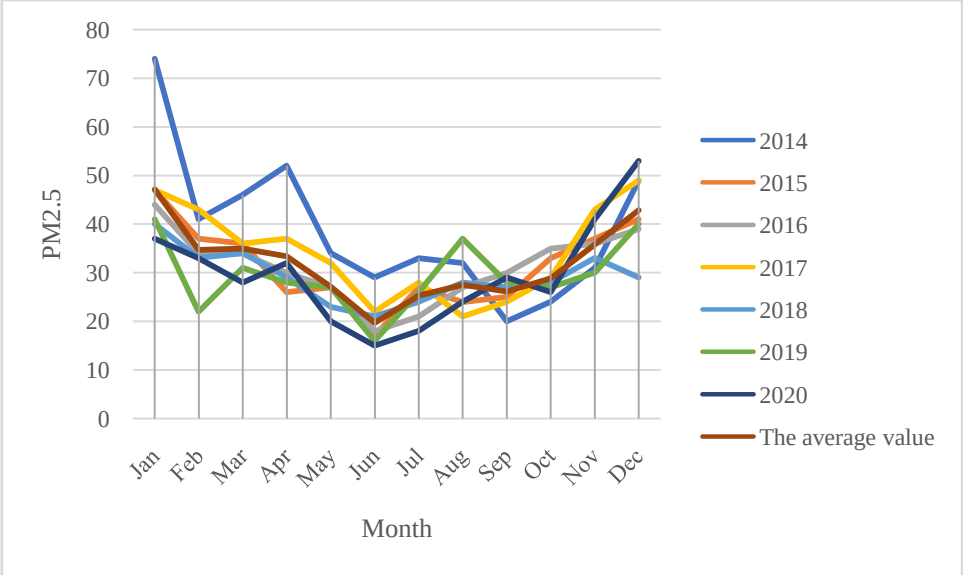

Figure 6 Monthly average change of PM2.5 concentration from 2014 to 2020

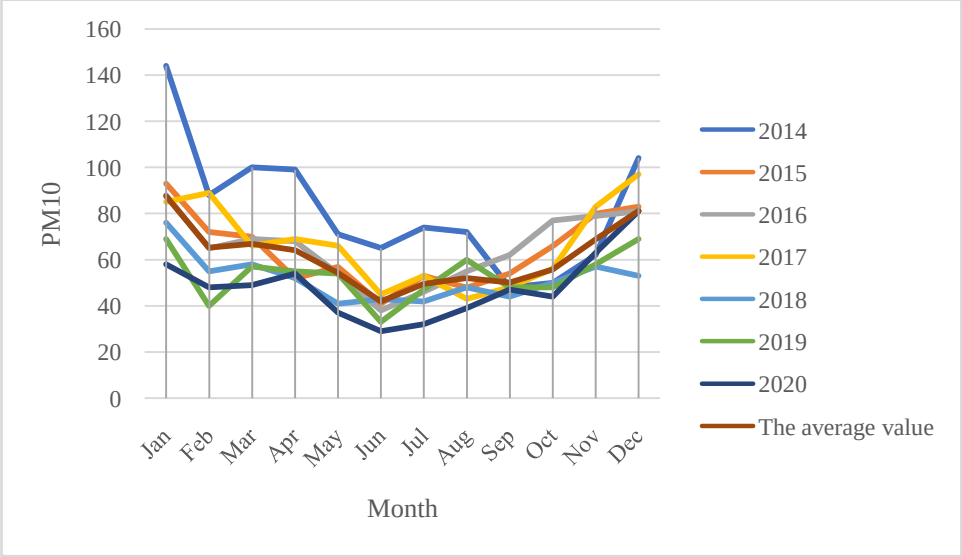

Figure 7 Monthly average change of PM10 concentration from 2014 to 2020

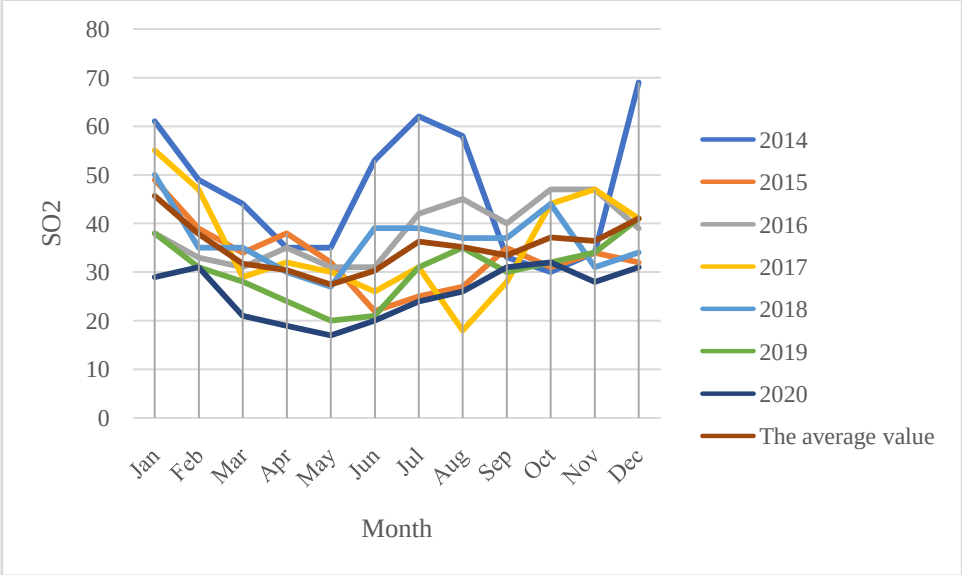

Figure 8 The monthly average change of SO2 concentration from 2014 to 2020

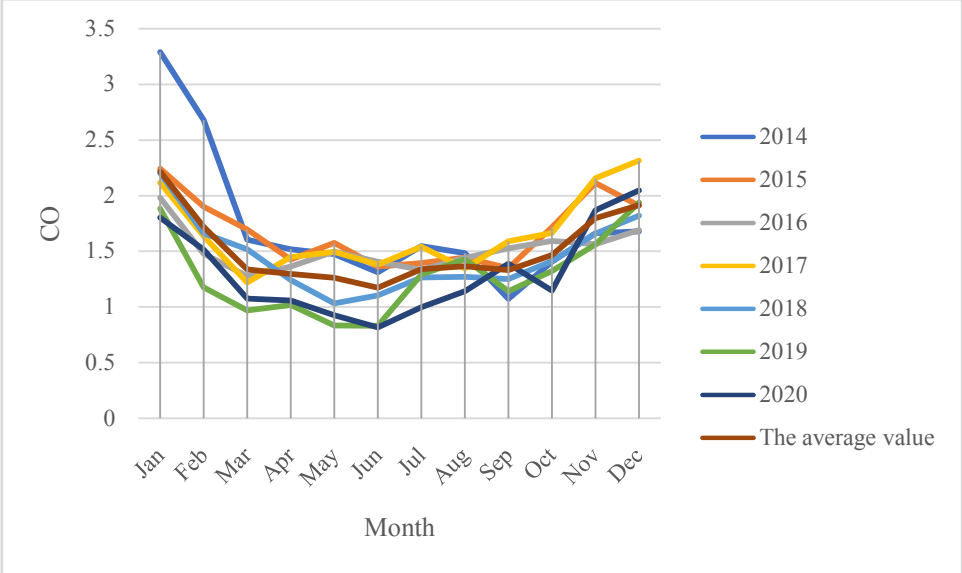

Figure 9 Monthly average change of PM10 concentration from 2014 to 2020

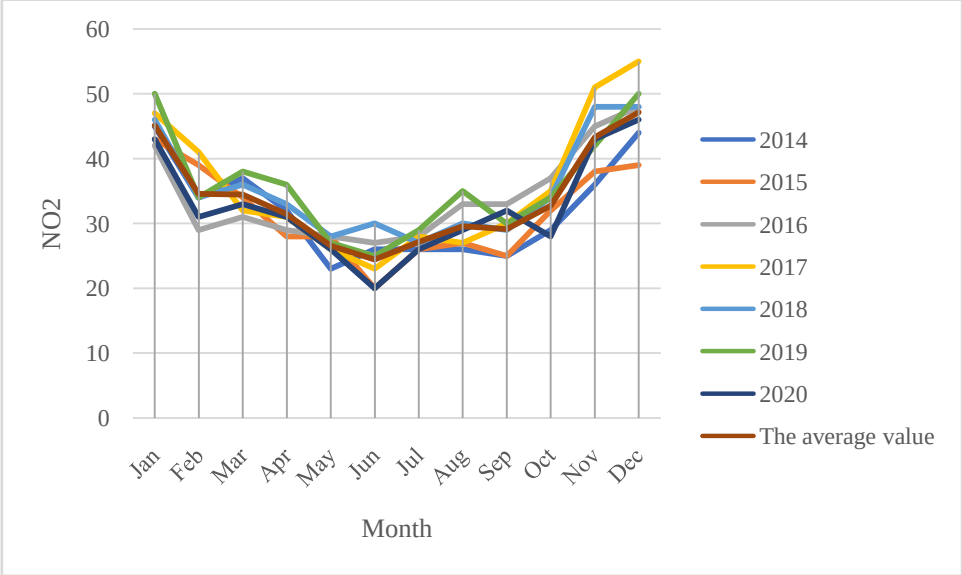

Figure 10The monthly average change of NO2 concentration from 2014 to 2020

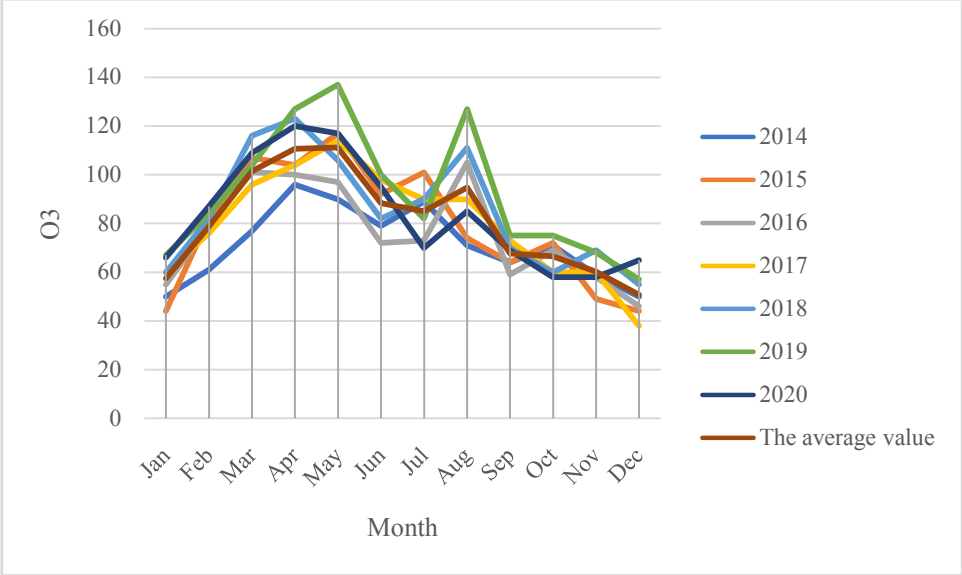

Figure 11 Monthly average change of O3 concentration from 2014 to 2020

VI. INFLUENCING FACTORS

6.1 Climate analysis

Panzhihua has a three-dimensional climate based on the southern subtropics, with significant vertical differences.

As shown in Figure 12, in terms of temperature, according to the map, Panzhihua has the highest temperature in a year from May to July; the temperature difference from May to June is quite significant. Studies have shown that the intensity of sunlight is related to the concentration of ozone. The stronger the sunlight, the higher the concentration of ozone. The second half of the year is more humid than the first half. The wind season of the year is from March to June, with the highest wind level in May. Among them, the PM2.5 value of Panzhihua is the highest in April and winter, and the pollution value is relatively high.

As shown in Figure 13, in terms of rainfall, the winter half of the year is controlled by tropical continental air masses, and the weather is sunny and dry; the summer half of the year is affected by the tropical monsoon and the rainfall is abundant. The rainy season is from June to October, and the dry season is from November to May of the following year. More than 90% of the precipitation is concentrated in summer. According to the comparative analysis with the change curve of particulate matter concentration, it is found that when the rainfall increases, the particulate matter concentration decreases. Rainfall can carry particulate matter in the air to the ground, and can

play a role in washing air particulate matter, so the concentration of particulate matter in the air will decrease during the rainy period.

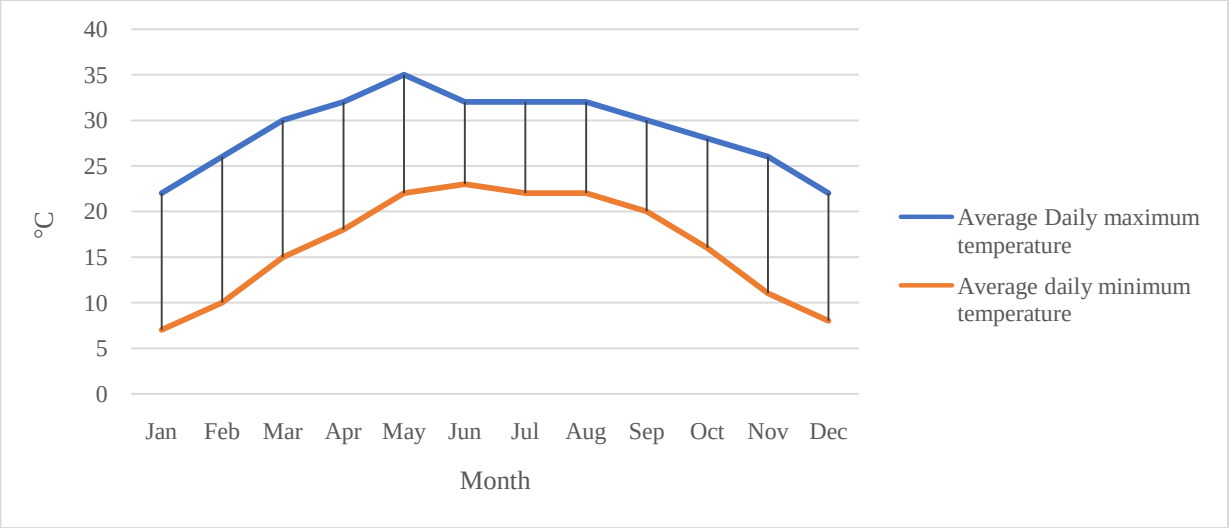

Figure 12 Monthly average temperature change trend in Panzhihua

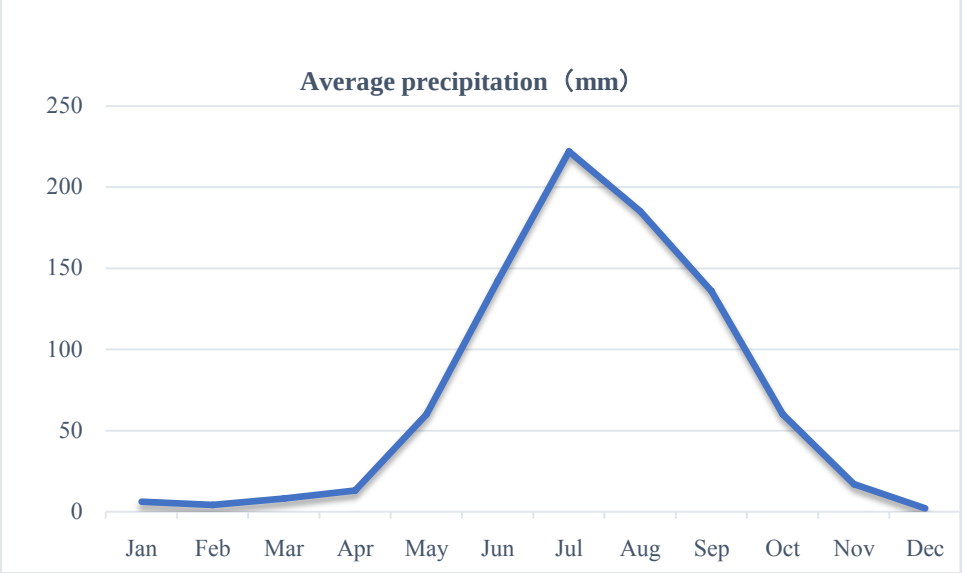

Figure 13 The daily change trend of humidity in Panzhihua

6.2 Topography

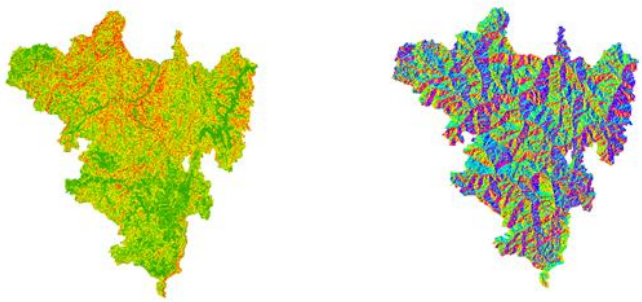

Figure 14 slope and aspect analysis in Panzhihua

As shown in Figure 14, Panzhihua is located in the central-southern section of the Panxi

Great Rift Valley. The terrain is undulating. The terrain slopes from northwest to southeast, high in the northwest and low in the southeast. The terrain is undulating, with large elevation differences and mountainous landforms. The climate is a small wind area, with many small winds in winter, and the horizontal transportation of pollutants is not good. The low-altitude wind in the region has a typical valley wind phenomenon, and the wind direction and wind speed have obvious shear phenomenon with height. Frequent temperature inversions limit the upward diffusion of pollutants. When there is a temperature inversion, the upward diffusion of pollutants is inhibited and the lateral diffusion is blocked by the ridges on both sides.

Combining the above analysis of Panzhihua's topography and topography, the inversion wind direction has a certain impact on the diffusion of pollutants, so the topography of Panzhihua has an impact on the air quality of Panzhihua.

6.3 Air quality and industrial structure

As an early industrial city developed by national policies, Panzhihua relies on its rich iron ore resources and has a large industrial share. In recent years, due to the limited resources and the country's current extreme emphasis on the ecological environment, Panzhihua actively responds to the country. Strategy, optimized and upgraded the industrial structure. The proportion of the secondary industry in Panzhihua City is much higher than the regional and national levels, and the development of the primary and tertiary industries is seriously lagging behind, and the economy is highly dependent on the secondary industry. As can be seen from the table below, the overall trend of Panzhihua's recent industrial structure evolution. (Figure 15)

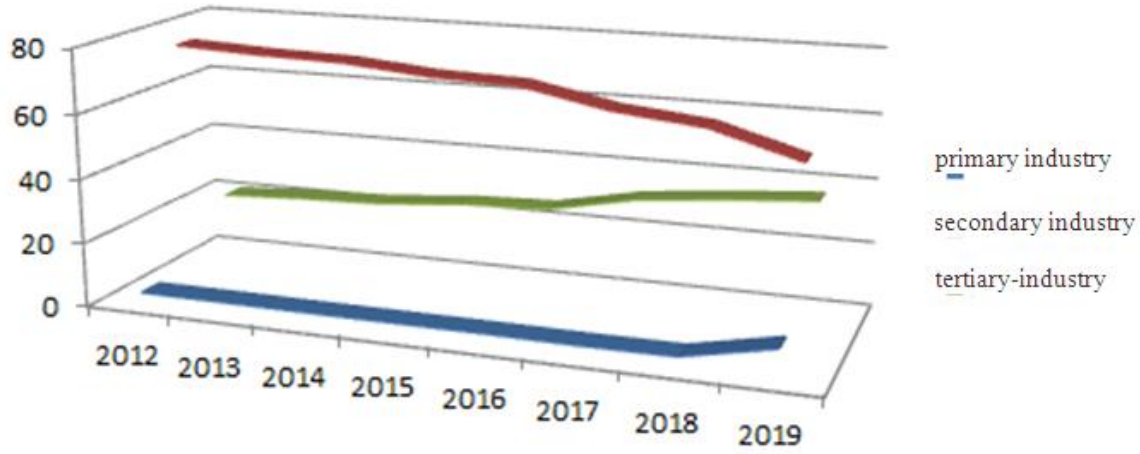

Figure 15Panzhihua's three industrial structure changes

As shown in the figure 15, we can see that the overall industry in Panzhihua accounts for a very large proportion of the secondary industry, close to two-thirds, while the primary and tertiary industries account for a relatively small proportion. However, in recent years, Panzhihua's industry has not remained unchanged, and the secondary industry, which has made a relatively large contribution to Panzhihua, has not continued to grow. In order to actively respond to national policies and promote industrial structure reform, it can be seen that the proportion of the secondary industry is declining, while the proportions of the primary and tertiary industries are gradually increasing, and the tertiary industry has shown good results. The growth trend, the level of development is better than that of the primary industry, and the proportion of the tertiary industry is gradually approaching the proportion of the secondary industry, indicating that Panzhihua has greatly optimized its industrial structure adjustment.

In combination with the adjustment of Panzhihua's industrial structure, the proportion of secondary industries has decreased. Relatively speaking, Panzhihua's pollutant emissions have also been reduced. This reflects that the adjustment of Panzhihua's industrial structure has promoted the improvement of Panzhihua's air quality index.

6.4 Urban Industrial Layout

Panzhihua's industries are distributed in a wide area and occupy a relatively large area. Panzhihua's industries are mainly concentrated in the East, West and Renhe Districts. As shown in Figure 16, which shows the industrial land in brown, it can be seen that the industrial distribution in

Panzhihua's city center and the West District account for more, and the waste gas generated by industrial production will affect the local area to a certain extent. Air quality. At the same time, Panzhihua has five air monitoring points, namely Bingcaogang, Nongnongping, Renhe, No. The poor air quality in the west area proves that the air quality has a greater relationship with the urban industrial layout.

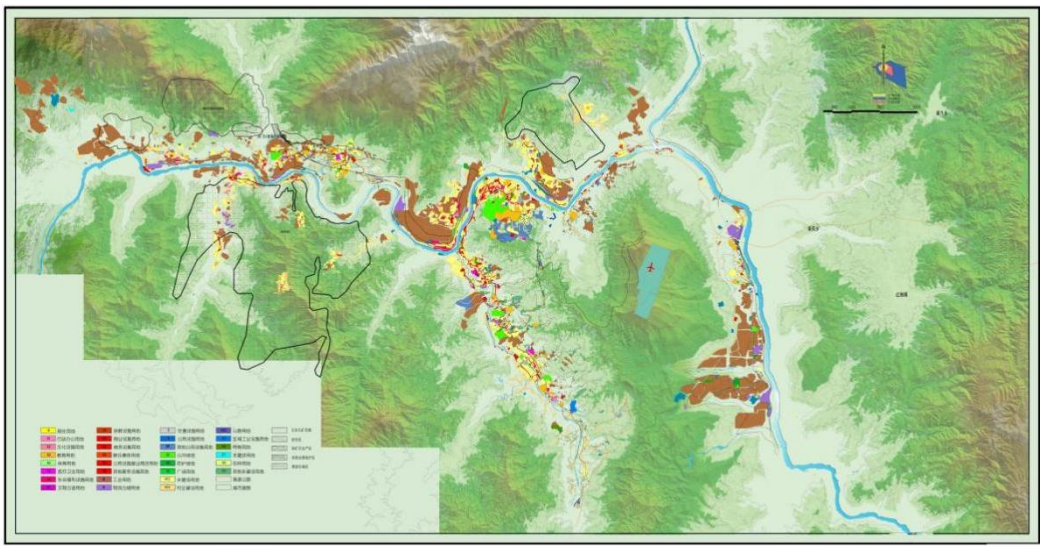

Figure 16 The current situation of land use in Panzhihua
(Picture source: Sichuan Panzhihua Planning and Architectural Design Co., Ltd.)

6.5 Summary

The air pollution situation in Panzhihua City is more serious. Among the six air pollutants monitored by the state, four of Panzhihua City exceed the national first-level concentration limit, which seriously endangers the urban air ecological balance.

In the time dimension, the pollution situation in Panzhihua City showed obvious seasonal changes. First of all, the air quality in Panzhihua City is generally better in summer and autumn, and worse in spring and winter. The concentrations of the four pollutants have obvious seasonal changes. When the temperature rises, the sunshine is strong and the city is dominated by quiet wind, which is conducive to the generation of O3, causing the concentration of O3 to increase, and vice versa. When the rainfall increases, the rainwater carries the particulate matter in the air to the ground, making the air The concentration of medium particulate matter drops a lot, and on the contrary, the concentration of particulate matter rises in hours of rainfall.

In the spatial dimension, the mountainous terrain of Panzhihua promotes the seasonal air pollution in Changsha. Mountain terrain causes frequent temperature inversions, which limits the upward diffusion of pollutants. When there is a temperature inversion, the upward diffusion of pollutants is inhibited and the lateral diffusion is blocked by the ridges on both sides. The development of Panzhihua's industrial structure has a greater impact on the seasonal air pollution in Panzhihua City. It can be seen from the current situation of Panzhihua that the more scattered industrial land is, the higher the intensity of urban construction and the worse the air quality.

VII. COUNTERMEASURES AND SUGGESTIONS

This article mainly analyzes and compares the air quality in Panzhihua from two aspects: time dimension and space dimension, and puts forward the following suggestions.

(1) Use the mountainous terrain of Panzhihua to strengthen the construction of urban ventilation corridors, and reduce the accumulation of air exhaust gas above the city at the overall level;

(2) In terms of urban microenvironment, reasonably control the density and height of buildings, form urban air ducts, and reduce air pollution in the urban area microenvironment;

(3) Pay attention to urban layout planning, rationally arrange industries, strengthen the management and control of exhaust emissions from related enterprises and construction sites, reduce pollutant emissions, and reduce the content of pollutants in the air from the source;

(4) Improve the urban air quality inspection system, grasp the air environment quality in time, strengthen the regional linkage mechanism, form an integrated

protection pattern with surrounding areas, and form a comprehensive air pollution control mechanism.

ACKNOWLEDGEMENTS

The study is supported by [035200153] the Ph.D Starting Research Fund from the PanzhihuaUniversity.

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Li-yun ZENG, et. al. "Research on Influencing Factors of Air Quality in Index Industrial Cities Based on Mountain Topography." *International Journal of Engineering Research and Applications (IJERA)*, vol.11 (5), 2021, pp 05-18.