

## Analysis of the Change Trendence of Ambient Air Quality in Zhangye

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**Abstract:** According to the air quality monitoring data of Zhangye city from 2015 to 2018, the current situation and change trend of environmental air quality in Zhangye city are systematically analyzed, and the causes of pollution are analyzed, and the corresponding countermeasures and suggestions are put forward in combination with the reality. The results show that the annual average concentration values of SO<sub>2</sub> and NO<sub>2</sub> are in line with the second-level standard of environmental air quality standard (GB3095-2012) from 2015 to 2018. The annual average concentration of PM<sub>10</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012) from 2015 to 2018. The annual average concentration of PM<sub>2.5</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012) except 2017. The major pollutants in the urban environmental air quality in Zhangye city from 2015 to 2018 are inhalable particulate matter, which has the highest pollution sharing rate. The concentration of pollutants in Zhangye city showed obvious seasonal characteristics from 2015 to 2018, which was the most polluted in the first quarter and the least polluted in the third quarter. The comprehensive air pollution index in heating period was significantly higher than that in non-heating period.

### 1. Introduction

Air pollution is a very prominent environmental problem facing cities today. It is not only a general concern of urban residents, but also an important indicator for measuring the sustainable development ability and livability of cities [1]. Based on the air quality monitoring data of Zhangye City in the past four years, this paper analyzes the trends of inter-annual changes, seasonal changes, and environmental changes during heating and non-heating periods of SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, and O<sub>3</sub>, and studies the air quality changes. Trends and influencing factors, the countermeasures and suggestions for improving ambient air quality are put forward. It can provide reference basis for the air pollution control and promote the healthy development of the ecological environment in Zhangye City.

### 2. Analysis of Environmental Air Quality in Zhangye City

**Basic information.** At present, Zhangye City has two automatic air monitoring points. Monitoring projects include SO<sub>2</sub>、NO<sub>2</sub>、PM<sub>10</sub>、PM<sub>2.5</sub>、CO、and O<sub>3</sub>. The monitoring frequency is 24h continuous automatic monitoring. From 2015 to 2018, the annual average concentration values of SO<sub>2</sub> and NO<sub>2</sub> are in line with the second-level standard of environmental air quality standard (GB3095-2012) from 2015 to 2018. The annual average concentration of PM<sub>10</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012) from 2015 to 2018. The annual average concentration of PM<sub>2.5</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012) except 2017. The ambient air quality remained stable. From 2015 to 2018, the ratio of environmental air quality grading days and excellent days in Zhangye City is shown in Table 1.

Table 1 The grading days of air environmental quality and excellent days proportion

Years	Monitoring the number of days	Level I excellent	Level II good	Level III light pollution	Level IV moderate pollution	Level V heavy pollution	Level VI Number of days	Percentage of excellent days (%)
2015	361	22	260	63	11	1	4	78.1
2016	363	31	284	34	7	4	3	86.7
2017	365	27	291	34	6	1	6	87.1
2018	365	22	285	37	2	5	14	84.1

From table 1, it can be seen that from 2015 to 2018, the number of days of excellent ambient air in Zhangye City was the lowest in 2015, with an excellent number of days being 78.1 %. After that, the proportion of excellent days reached more than 80 %, and the ambient air quality in zhangye city is up to the standard

**Air quality compliance.** As shown in Figure 1, from 2015 to 2018, Zhangye City has the highest number of Level I air quality days in 2016, Level II days have been maintained at a high level, and Level VI days have shown an upward trend. Overall, the rate of air quality excellence in Zhangye City has been stable in the past four years.

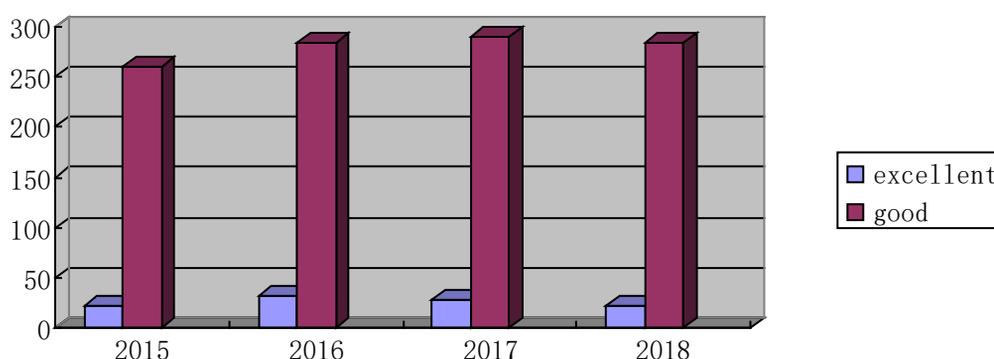


Figure. 1 From 2015 to 2018 air quality standards of zhangye

**Evaluation of ambient air quality.** The air quality in Zhangye City from 2015 to 2018 is generally good, with an average concentration range of 0.010-0.045 mg/m<sup>3</sup> for SO<sub>2</sub>, 0.018-0.023 mg/m<sup>3</sup> for NO<sub>2</sub>, and 0.081-0.104 mg/m<sup>3</sup> for PM<sub>10</sub>, The average annual concentration of PM<sub>2.5</sub> is 0.029-0.042 mg/m<sup>3</sup>, the average annual concentration of CO is 1.0-1.7 mg/m<sup>3</sup>, and the average annual concentration of O<sub>3</sub> is 0.138-0.150 mg/m<sup>3</sup>, the annual average concentration values of SO<sub>2</sub> and NO<sub>2</sub> are in line with the second-level standard of environmental air quality standard (GB3095-2012) from 2015 to 2018. The annual average concentration of PM<sub>10</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012). The annual average concentration of PM<sub>2.5</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012) except 2017, and the main pollutant pollution index is shown in table 2.

Table 2 The index of major pollutants

Year	Pollution index						Composite pollution index
	SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	CO	O <sub>3</sub>	
2015	0.75	0.58	1.39	1.20	0.42	0.89	5.23
2016	0.42	0.55	1.29	1.09	0.40	0.86	4.61
2017	0.22	0.52	1.16	0.83	0.28	0.94	3.95
2018	0.17	0.45	1.49	1.14	0.25	0.89	4.39

**Analysis of major pollutants.** From 2015 to 2018, the main pollutants of environmental air quality in Zhangye City are respirable particulate matter, and pollution contributes the most; The main pollutant pollution sharing rate in 2015 was  $PM_{10} > PM_{2.5} > O_3 > SO_2 > NO_2 > CO$ ; The main pollutant pollution sharing rate in 2016 was  $PM_{10} > PM_{2.5} > O_3 > NO_2 > SO_2 > CO$ ; In 2017, the main pollutant pollution sharing rate was  $PM_{10} > O_3 > PM_{2.5} > NO_2 > CO > SO_2$ ; In 2018, the main pollutant pollution sharing rate was  $PM_{10} > PM_{2.5} > O_3 > NO_2 > CO > SO_2$ . A statistical table showing the contribution rates of the main pollutants is shown in table 3.

Table 3 From 2015 to 2018 the share rate statistics of main pollutant pollution

Year	Pollution sharing rate (%)						Major pollutants
	SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	CO	O <sub>3</sub>	
2015	14.3	11.1	26.6	22.9	8.0	17.0	PM <sub>10</sub>
2016	9.1	11.9	28.0	23.6	8.7	18.7	PM10
2017	5.5	13.2	29.4	21.0	7.1	23.8	PM10
2018	3.9	10.2	33.9	26.0	5.7	20.3	PM10

### 3. Analysis of the Change of Air Quality in Urban Areas of Zhangye City

**Inter-annual variation of pollutant concentrations.** From 2015 to 2018, the monitoring results of ambient air quality in Zhangye City showed that the average annual mass concentration of SO<sub>2</sub>, NO<sub>2</sub>, CO reached a maximum in 2015, followed by a declining trend of the average annual mass concentration; The average annual mass concentration of PM<sub>10</sub> reached a maximum in 2018; The average annual mass concentration of PM<sub>2.5</sub> reached a maximum in 2015, followed by a downward trend, and an upward trend in 2018; The average annual mass concentration of O<sub>3</sub> reached a maximum in 2017, followed by a downward trend. Overall, the average annual mass concentration of CO and O<sub>3</sub> has the most obvious trend, and the average annual mass concentration of SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> has no significant trend.

Table 4 From 2015 to 2018 the monitoring results of ambient air quality in zhangye

Average per year	SO <sub>2</sub> (mg/m <sup>3</sup> )	NO <sub>2</sub> (mg/m <sup>3</sup> )	PM <sub>10</sub> (mg/m <sup>3</sup> )	PM <sub>2.5</sub> (mg/m <sup>3</sup> )	CO (mg/m <sup>3</sup> )	O <sub>3</sub> (mg/m <sup>3</sup> )
2015	0.045	0.023	0.097	0.042	1.7	0.142
2016	0.025	0.022	0.090	0.038	1.6	0.138
2017	0.013	0.021	0.081	0.029	1.1	0.150
2018	0.010	0.018	0.104	0.040	1.0	0.143

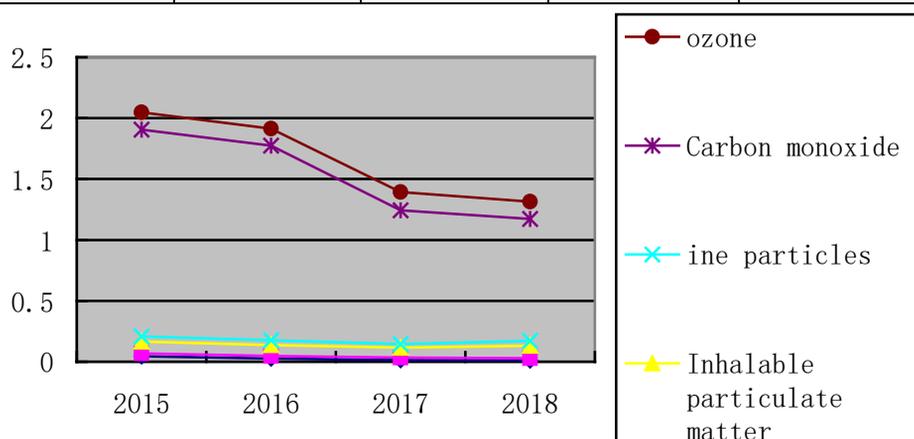


Figure. 2 From 2015 to 2018 the annual mass concentration of SO<sub>2</sub>、NO<sub>2</sub>、PM<sub>10</sub>、PM<sub>2.5</sub>、CO and O<sub>3</sub>

**Seasonal variation of ambient air quality.** The change of pollution index of main pollutants in different quarters from 2015 to 2018 in Zhangye City is shown in Table 5, and the change of

comprehensive pollution index of ambient air quality in different quarters is shown in Figure 3.

Table 5 main pollutant pollution index changes in different quarters

Years	quarters	Pollution index						Composite pollution index
		SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	CO	O <sub>3</sub>	
2015	First quarter	1.53	0.70	2.47	2.14	0.45	0.72	8.01
	Second quarter	0.28	0.40	1.64	1.26	0.22	0.96	4.76
	Third quarter	0.22	0.42	0.63	0.60	0.15	0.89	2.91
	Fourth quarter	0.95	0.82	0.80	0.86	0.45	0.76	4.64
2016	First quarter	1.08	0.72	1.74	1.34	0.50	0.66	6.04
	Second quarter	0.20	0.42	1.26	0.97	0.20	0.92	3.97
	Third quarter	0.10	0.42	0.74	0.69	0.20	0.90	3.05
	Fourth quarter	0.30	0.65	1.41	1.31	0.3	0.74	4.71
2017	First quarter	0.35	0.62	1.54	1.23	0.35	0.78	4.87
	Second quarter	0.13	0.48	1.23	0.74	0.15	1.03	3.76
	Third quarter	0.13	0.40	0.53	0.34	0.12	0.94	2.46
	Fourth quarter	0.27	0.60	1.33	1.00	0.22	0.66	4.08
2018	First quarter	0.22	0.45	2.06	1.37	0.25	0.68	5.03
	Second quarter	0.12	0.38	1.23	0.86	0.15	0.91	3.65
	Third quarter	0.08	0.32	0.69	0.66	0.12	0.98	2.85
	Fourth quarter	0.27	0.68	1.97	1.66	0.28	0.69	5.55

Table 5 shows that the environmental air quality of Zhangye City has changed significantly with the seasons. The pollution in the first quarter was relatively heavy, and the pollution in the third quarter was relatively light. Among the six pollutants, particulate matter, fine particulate matter, sulfur dioxide and carbon monoxide were relatively heavy in the first quarter and relatively light in the third quarter. Ozone pollution was relatively heavy in the second quarter and relatively light in the fourth quarter.

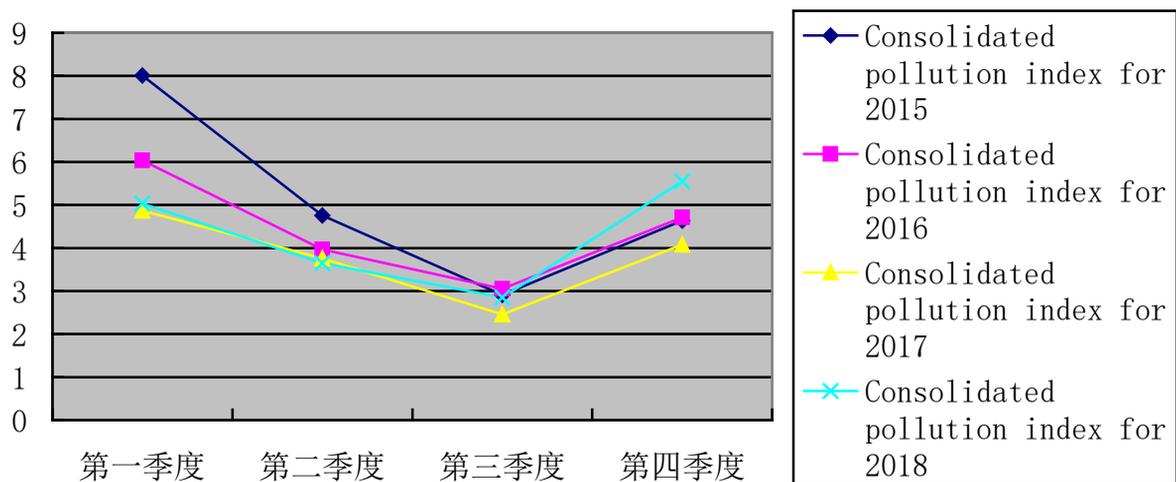


Figure. 3 synthetic pollution index of air environmental quality changes of Different quarters

It can be seen from Figure 4 that the ambient air quality of Zhangye City is greatly changed with the seasons, showing obvious seasonal changes. Pollution was highest in the first quarter and lowest in the third quarter.

**Analysis of change of ambient air quality during heating and non-heating period.** From 2015 to 2018, the comprehensive air pollution index of the urban heating period in Zhangye City was significantly higher than that of the non-heating period. Affected by the winter heating coal combustion, the pollution during the heating period was heavy, and the heating period of the SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, and CO pollution index was significantly higher than that of the non-heating period. O<sub>3</sub> is exactly the opposite to other parameters. The non-heating period is higher than the heating period. See table 6 for details.

Table 6 main pollutant pollution index change of the heating period and the non-heating period

Years	period	Pollution index						Composite pollution index
		SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	CO	O <sub>3</sub>	
2015	Heating period	1.43	0.78	1.84	1.71	0.45	0.71	6.92
	Non-heating period	0.27	0.45	1.04	0.86	0.28	0.91	3.81
2016	Heating period	0.80	0.72	1.68	1.40	0.28	0.52	5.40
	Non-heating period	0.15	0.45	1.01	0.86	0.13	0.71	3.31
2017	Heating period	0.32	0.62	1.54	1.2	0.3	0.75	4.73
	Non-heating period	0.15	0.45	0.87	0.57	0.15	0.98	3.17
2018	Heating period	0.25	0.55	2.11	1.51	0.25	0.51	5.18
	Non-heating period	0.12	0.40	1.04	0.86	0.18	0.93	3.53

#### 4. Analysis of Pollution Causes

**Coal is consumed for heating in the urban area in winter, causing soot pollution.** According to the seasonal change trend of pollution, SO<sub>2</sub> peak appeared in the winter heating period, indicating that coal combustion pollution is the main form of pollution in winter. Although the city is centrally heated, some urban residents still use small stoves and small coal furnaces to heat and heat in winter. They are mainly distributed in trade markets, commercial stores, and urban

bungalows. Contaminants are directly discharged into the atmosphere, causing soot pollution.

**Dust pollution on roads and construction.** The road dust and the sludge could not be cleared in time, and the commercial concrete vehicles and slag transport vehicles were seriously scattered, causing road dust pollution. In addition, various construction sites in urban areas sand and stone piles dust, dust measures are not implemented, resulting in dust pollution.

**Weather impact of sand and dust.** Zhangye City is located in the northwestern Hexi Corridor. In the spring, it is vulnerable to cold air carrying dust storms and high-altitude dust weather, causing serious dust pollution.

**Motor vehicle exhaust pollution.** Due to the increase in the number of motor vehicles in the old city of Zhangye and Binhe New Area, motor vehicle exhaust pollution has increased. The traffic volume of various roads in the urban areas is too large. Most of the main roads have more than 1,000 hourly traffic, and the vehicle idle speed has caused a sharp increase in exhaust emissions. In addition, the yellow standard vehicle elimination rate is low, the lack of motor vehicle pollution control and other factors caused the motor vehicle exhaust increased trend.

## 5. Countermeasures and Suggestions

**Change the fuel composition and optimize the combustion method.** We will continue to step up efforts to reduce emissions of pollutants, formulate and adopt effective measures to control the discharge of pollutants from coal-fired pots(kilns), thermal power plants, iron alloys and chemical industries, and increase the construction of central heating projects in urban areas. Promote the use of low-sulfur, low-ash, high-quality coal, deep processing of fuel, improving fuel efficiency and reducing pollutant emissions<sup>[2]</sup>.

**Improving the energy mix and making rational use of clean energy.** We will actively guide the transformation of the coal based energy structure and vigorously develop new and renewable sources of energy. Natural gas is a kind of clean energy, and it is an effective way to adjust the energy structure in Zhangye City. We will actively promote the eco-agriculture cycle with biogas as the link, and develop clean energy sources such as solar energy and biomass energy.

**Control dust pollution.** Further strengthen the management of construction sites, persist in blocking operations, and harden the roads entering and leaving the site. In case of strong winds at or above level 4, the earthworks and demolition projects will be stopped. Dust nets must be used to cover the piles and sand. When demolition sites are demolished, water must be sprinkled at the same time. After the demolition of houses and facilities, the slag must be cleared and shipped. Units and individuals engaged in bulk construction materials and construction waste transportation must use closed trucks to prevent leakage in vehicle transportation<sup>[3]</sup>.

**Strengthen motor vehicle environmental supervision and control of motor vehicle exhaust pollution.** We will increase the supervision and inspection of motor vehicle exhaust gas, and focus on spot checking the use of privately operated passenger cars, trucks、 farmers motor vehicles and special vehicles such as environmental vehicles and earth pullers, We will introduce a mechanism for social oversight of vehicles that emit black smoke, and force old vehicles that exceed the standards to be phased out<sup>[4]</sup>. We will continue to step up our efforts to further strengthen environmental supervision over the entire production and use of motor vehicles. We will speed up the promotion of clean fuel for taxi and bus use, and install tail gas purification devices. We will strengthen the annual inspection and sampling of motor vehicle emissions, step up the administration of motor vehicles on the road, and in accordance with the National 《Standards for automobile scrapping》, the system for automobile scrapping shall be strictly enforced.

**Afforestation and strengthening ecological environment construction.** Green plants are natural air conditioners. To do a good job in urban greening is an important measure to prevent and control urban atmospheric pollution<sup>[5]</sup>. We will strengthen afforestation, regulate the small climate of cities, reduce dust on the ground, absorb harmful gases, and focus on greening roads, urban areas, and surrounding cities.

## 6. Conclusion

From 2015 to 2018, the air quality in Zhangye City was generally good. Since 2016, the proportion of excellent days has reached more than 80 %. with an average concentration range of 0.010-0.045 mg/m<sup>3</sup> for SO<sub>2</sub>, 0.018-0.023 mg/m<sup>3</sup> for NO<sub>2</sub>, and 0.081-0.104 mg/m<sup>3</sup> for PM<sub>10</sub>, The average annual concentration of PM<sub>2.5</sub> is 0.029-0.042 mg/m<sup>3</sup>, the average annual concentration of CO is 1.0-1.7 mg/m<sup>3</sup>, and the average annual concentration of O<sub>3</sub> is 0.138-0.150 mg/m<sup>3</sup>,the annual average concentration values of SO<sub>2</sub> and NO<sub>2</sub> are in line with the second-level standard of environmental air quality standard (GB3095-2012)from 2015 to 2018. The annual average concentration of PM<sub>10</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012). The annual average concentration of PM<sub>2.5</sub> exceed the second-level standard of environmental air quality standard (GB3095-2012) except 2017.

From 2015 to 2018, the main pollutants of environmental air quality in Zhangye City were inhalable particulate matter, and the pollution sharing rate was the largest.the concentration of pollutants in the urban areas of Zhangye City showed obvious seasonal characteristics, with the heaviest pollution in the first quarter and the lightest pollution in the third quarter; The comprehensive pollution index of ambient air was higher than that of non-heating period.

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