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Evaluation and Analysis of Ambient Air Quality in Jiaozuo City

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ABSTRACT: Taking Jiaozuo agglomeration area as the research area, the environmental quality evaluation was carried out. The monthly and annual variation characteristics of 6 basic pollutants and 3 supplementary monitoring pollutants were analyzed by single factor index and ambient air quality index (AQI). The results showed that the AQI value of the average concentration in 2019-2021 reached the secondary standard. Compared with the air quality in 2019 and 2020, the single factor pollution index decreased year by year in 2021. The annual air quality index of 2020 and 2021 shows that the average value of AQI increases from October to the highest value in January of the second year, decreases from January to the lowest value in July and August, and the three supplementary monitoring pollutants all meet the evaluation criteria. The ambient air quality pollutants in the study area are mainly PM10 and PM2.5. It is necessary to take corresponding measures to prevent air pollution and provide scientific basis for atmospheric environmental governance.

KEYWORDS: Jiaozuo Atmospheric pollution Particulate matter

I. INTRODUCTION

In the era of rapid economic and social development in China, urban industry[1-2] continues to develop, industrial production, coal, dust[3]. and locomotive exhaust are increasing, and air pollution is increasing[4-5]. Many scholars at home and abroad have done a lot of research on ambient air quality. Wang Xiaoyan et al[6].analyzed the primary pollutants of air quality in Beijing-Tianjin-Hebei mountainous cities from 2014 to 2016. The results showed that the primary pollutants in the city were $PM_{2.5}$, O_3, NO_3 and PM_{10}. Deng Aiping et al. [7]. analyzed the main pollutants in Jiangsu Province, and the results showed that the primary pollutants of air quality were PM10, $PM_{2.5}$, O_3 and NO_2. Gao Qingxian[8] et al.compared the air quality index (AQI) between China and the United States. The results show that the pollution indicators contained in China's environmental quality standards are more comprehensive. The calculation method of using the 24-hour average concentration limit instead of the 1-hour average concentration limit will aggravate the pollution level. Based on the monitoring data of SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3, CO and three supplementary monitoring pollutants in Jiaozuo City from 2019 to 2021, this paper will systematically evaluate the air quality and air pollution status of Jiaozuo agglomeration area in three years. In recent years, China has successively put forward a series of environmental pollution monitoring methods and environmental standards, such as 《Integrated emission standard of air pollutants》 《Hygienic Standards for the Design of Industrial Enterprises 》《 Technical guidelines for environmental impact assessment—Atmospheric environment》. These standards are formulated from the aspects of toxicity, the degree of harm to human health, the degree of impact on biological survival, and the impact on environmental quality. In this paper, these standards will be used to evaluate and analyze the three supplementary monitoring pollutants by single factor, in order to make a reasonable evaluation of the air quality in Jiaozuo City, and for the atmosphere.

II. DATA AND METHODS

A. Research data

The evaluation of basic pollutants is combined with the statistical data of Jiaozuo City in 2021 and the ecological environment quality data of Jiaozuo City issued by Jiaozuo Ecological Environment Bureau. Other supplementary monitoring pollutants are combined with the evaluation of regional topographic conditions, wind frequency distribution

characteristics and environmental functional area evaluation. A total of 7 monitoring points were set up.

B. Evaluation method

The study area is mainly residential area, mixed area of commercial traffic residents, cultural area, industrial area and rural area, and the environmental air function area is the second class area. Therefore, the annual quality pollutant concentration in the area implements the secondary standard of 《Ambient air quality standards》(GB-3095-2012).

The pollutants involved in the evaluation of the study area are SO2, NO2, PM10, PM2.5, O3, CO, etc., while the API classification calculation refers to the 《Ambient air quality standards》(GB3095-1996). The pollutants evaluated are only SO2, NO2 and PM10, etc. There is a big difference between AQI and air pollution index (API)[9]. The AQI adopts a stricter classification limit standard, more pollutant indicators than API monitoring, and its evaluation results are more objective. Therefore, the air quality index in the study area implements the 《Technical Regulation on Ambient AirQuality Index (on trial)》(HJ633-2012)[10], and the air pollution index is divided into six grades, corresponding to the six levels of air quality index.

The three evaluation standards for supplementary monitoring pollutants implement the《Integrated emission standard of air pollutants》《Hygienic Standards for the Design of Industrial Enterprises 》《 Technical guidelines for environmental impact assessment—Atmospheric environment》 standard. According to the monitoring results of ambient air quality status, the standard method was used to evaluate the ambient air quality status. The single factor pollution index formula is :$P_i = \frac{C_i}{C_{o_i}}$, Pi——Pollution index of substance i;Ci——Monitoring concentration of substance i,mg/m^3;Coi——Evaluation criteria of substance i,mg/m^3

III. EVALUATION RESULTS AND ANALYSIS

A. Trend analysis of basic pollutant quality status

The annual average concentration and evaluation results of six basic pollutants in the ambient air of Jiaozuo demonstration area from 2019 to 2021 are shown in Table 1.

Table 1. Concentration and evaluation level of environmental air monitoring factors in Jiaozuo agglomeration area from 2019 to 2021

project	$PM_{2.5}$	PM_{10}	SO_2	NO_2	O_3	CO	AQI evaluation level
evaluation standard	35	70	60	40	160	4000	
Average for 2019（μg/L）	63	109	13	37	199	2200	secondary standard
Average for 2019（μg /L）	56	100	12	33	188	1700	secondary standard
Average for 2019（μg /L）	48	102	10	28	105	740	secondary standard

It can be seen from Table 1 that compared with 2019, the concentrations of six pollution factors in the ambient air quality of the agglomeration area in 2021 all decreased, and the annual average concentrations of $PM_{2.5}$,PM_{10},SO_2, NO_2,O_3 and CO decreased by 23.8%, 6.4%, 23.1%, 24.3%, 47.2% and 66.4%, respectively. The annual average concentration of CO decreased from 2200μg / m^3 to 740μg / m^3, a decrease of 66.4 %. PM10 had the smallest decrease, which was 102 μg / m^3 in 2021, only 6.4 % lower than 109 μg / m^3 in 2019. Among the six factors in 2021, the annual average concentration of SO_2, NO_2, O_3 and CO reached the secondary standard ; the annual average concentration of $PM_{2.5}$ and PM_{10} exceeded the secondary standard, and the exceeding multiples were 0.37 times and 0.46 times respectively. From 2019 to 2021, the comprehensive index of ambient air in the demonstration area (the sum of the six factor pollution indexes) was 6.29,5.56 and 4.54, respectively, showing a downward trend year by year, with a decrease of 27.9 % in 2021 compared with 2019.

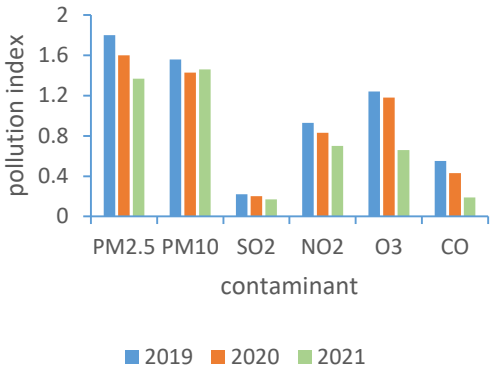

Figure 1. Annual changes of ambient air single index in Jiaozuo demonstration area from 2019 to 2021

From Figure 1, it can be seen that from 2019 to 2021, the single index of $PM_{2.5}$ is between 1.37 and 1.80, the single index of PM_{10} is between 1.43 and 1.56, the single index of SO_2 is between 0.17 and 0.22, the single index of NO_2 is between 0.70 and 0.93, the single index of O_3 is between 0.19 and 0.55, and the single index of CO is between 0.17 and 0.22. The five factor indexes of SO_2, NO_2, $PM_{2.5}$ and CO show a downward trend year by year, and the SO_2 index has no significant change. The PM_{10} index increased from 1.43 to 1.46 in 2021 compared with 2020.From the perspective of individual index, $PM_{2.5}$ and PM_{10} were the main pollutants. The average concentration of air quality in Jiaozuo City for 24 hours was calculated monthly and the air quality index was calculated, and Fig.2. It can be seen from Fig.2 that the average value of AQI in the study area increased from October to the highest value in January of the second year, decreased from January to July, and the lowest value in August.

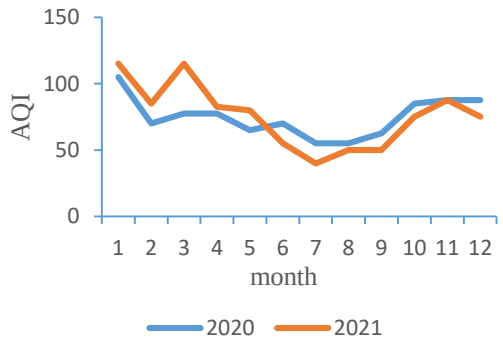

Figure 2. Monthly average statistical chart of air quality index (AQI) in Jiaozuo agglomeration area

The ambient air category in Jiaozuo agglomeration area is still not up to standard, and the days with $PM_{2.5}$ and PM_{10} as the primary pollutants are the majority. From Figure 3, it can be seen that the concentration of $PM_{2.5}$ and PM_{10} has obvious U -shaped monthly variation characteristics. The reason is that the monthly change of temperature in Jiaozuo area shows a ∩ -shaped change trend. In addition, the wind speed in Jiaozuo area in spring and summer is relatively large, which creates relatively good diffusion conditions. Therefore, in general, the exceeding standard of $PM_{2.5}$ and PM10 is concentrated in January-February and November-December, and the concentration of $PM_{2.5}$ and PM_{10} is higher in winter heating period. In 2020 and 2021, the change trend of monthly concentration value is the same, which shows a downward trend and then an upward trend. On the whole, the over-standard rate of PM10 and $PM_{2.5}$ in 2021 is lower than that in 2020, but the downward trend is not obvious. The prevention and control of particulate matter on air pollution is still an important work of air pollution control.

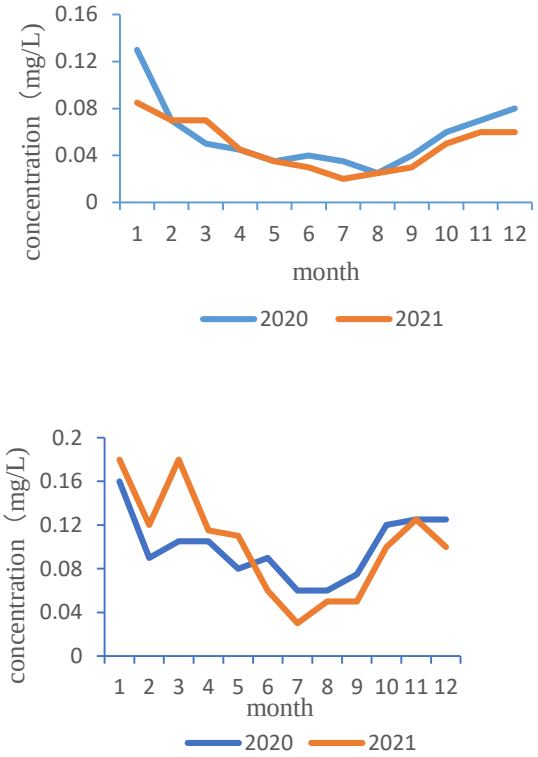

Figure 3. Monthly variation of PM2.5 (upper) PM10 (lower) concentration in 2020-2021

Through the analysis of the above data and the actual situation of Jiaozuo agglomeration area, the main reasons for the annual and monthly changes of pollutants are as follows:

(1) From 2019 to 2021, the relevant departments of Jiaozuo City reformed the waste gas of enterprises, strictly controlled the dust on the construction site, and improved the relevant mechanism to control the pollution according to law.

The comprehensive index of environmental air in Jiaozuo City decreased year by year. According to the '《Henan Social Governance Development Report 》, Jiaozuo City 's livable index ranked the top three in Henan Province for two consecutive years in 2019 and 2020.

(2) In winter, it is relatively dry compared with summer, and there is less precipitation in winter. The effect of scouring pollutants in the air is poor, and it is easy to produce dust. In addition, the photosynthesis in summer is strong, and the plants are helpful to the purification of the air. Therefore, the concentration of particulate matter in winter is higher, and the air quality index is higher than that in summer. It corresponds to the highest monthly average AQI in the study area in January and the lowest in July and August.

B. Supplementary monitoring of other pollutants

Monitoring points and monitoring factors : combined with the terrain conditions of the evaluation area, the shape of the park planning, and the distribution characteristics of wind frequency, a total of 7 monitoring points were set up. The monitoring factors were non-methane hydrocarbons, xylene and fluoride. The statistical results of this monitoring data are shown in Table 2.

Table 2. Statistical results of monitoring hourly concentration of ambient air

point positions	contaminant	Monitoring concentration range (μg/m^3)	Occupancy rate%
Dazhangbei	non-methane hydrocarbon	380-1370	19-68.5
	Xylenes	no detection	/
	Fluoride	0.9-3.5	4.5-17.5
Hanpingling	non-methane hydrocarbon	610-1730	30.5-86.5
	Xylenes	no detection	/
	Fluoride	0.7-1.8	3.5-9
Qintun	non-methane hydrocarbon	260-610	13-30.5
	Xylenes	no detection	/
	Fluoride	0.7-3	3.5-15
Yongzhitun	non-methane hydrocarbon	290-1690	14.5-84.5
	Xylenes	no detection	/
	Fluoride	1-3.4	5-17
Yaoguozhuang	non-methane hydrocarbon	260-530	13-26.5
	Xylenes	no detection	/
	Fluoride	0.8-2.4	4-12
Zhangjiantun	non-methane hydrocarbon	330-1360	16.5-68
	Xylenes	no detection	/
	Fluoride	0.9-3	4.5-15
Zhouzhuangzhen	non-methane hydrocarbon	340-1670	17-83.5
	Xylenes	no detection	/
	Fluoride	0.6-1.2	0.03-6

It can be seen from Table 2 that all the three supplementary monitoring pollutants at each monitoring point during the monitoring period reached the standard. Compared with the previous data, the concentration of non-methane total hydrocarbons monitored in 2017 ranged from 490 to 710μg/m^3, and the concentration of xylene was 4-20mg/m^3.Although with the construction of the agglomeration area, the regional non-methane total hydrocarbons have increased, the overall contribution value still meets the ambient air quality standards. When the total non-methane hydrocarbons in the atmosphere exceed a certain concentration, it can not only cause direct harm to the human body, but also produce photochemical smog under appropriate light conditions, which will cause certain harm to the human body and the environment. The total non-methane hydrocarbons are mainly derived from coal combustion, automobile exhaust emissions, waste incineration, etc. Xylene is an important chemical raw material, mainly from the waste water and waste gas of the production plant, as well as the ventilation in the production process. Xylene has a strong stimulating effect, and direct skin contact will make the skin dry and inflammatory. Fluoride in the atmosphere mainly comes from a series of industrial activities such as aluminum smelting, steel smelting and coal combustion. When the

fluoride content in the atmosphere exceeds 1mg/m^3, it will cause harm to human organs. When the fluoride content in the atmosphere reaches 45-90mg/m^3, it will cause damage to plant tissues. Therefore, the monitoring of non-methane hydrocarbons, xylene and fluoride is of great significance to the improvement of air quality.

IV. CONCLUSION

In this paper, the monthly and annual variation characteristics of six basic pollutants and three supplementary monitoring pollutants were analyzed by using single factor pollution index and ambient air quality index (AQI). The following conclusions were obtained:(1)According to the secondary standard in the 《Ambient air quality standards》 (GB-3095-2012), the annual average concentrations of SO_2,NO_2,O_3 and CO in the six factors in 2021 reached the secondary standard, and the annual average concentrations of $PM_{2.5}$ and PM_{10} exceeded the secondary standard. The comprehensive index of ambient air in the demonstration area (the sum of the six factor pollution indexes) showed a downward trend year by year from 2019 to 2021, and the annual average concentration AQI level reached the second-level standard from 2019 to 2021.

(2) The 24-hour average concentration AQI value in the study area from 2020 to 2021 increased from October to the highest value in January of the second year, decreased from January to July, and the lowest value in August. It is greatly affected by the season, so it is necessary to further strengthen the monitoring and control of particulate pollutants from October to January of the second year.

(3) During the monitoring period, all the three supplementary monitoring pollutants at each monitoring point reached the standard. Although the total non-methane hydrocarbons in the region increased with the construction of the agglomeration area, the overall contribution value still met the ambient air quality standards.

(4) Through the analysis of the air quality in the study area for three years, it can be seen that the primary pollutant in the agglomeration area of Jiaozuo City is particulate matter ($PM_{2.5}$,PM_{10}).Although the over-standard rate of particulate matter has decreased in 2021, the downward trend is not obvious. Particulate matter is still the main pollutant causing air pollution, so it is still necessary to strengthen the treatment of particulate matter in the atmosphere in the future.

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