Air Quality Monitoring Scheme Considering the Influences of Endemic Disease in Tongliao City

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Keywords: Air quality monitoring, Endemic disease, Monitoring point, Testing analysis.

Abstract. Forecast of air pollution through air quality monitoring will provide basic data for the environmental protection department to carry out environmental protection laws and regulations. In this paper, the air quality monitoring program is analyzed considering the influences of endemic disease in Tongliao city. Pollutant monitoring projects are determined in environmental air quality monitoring, and monitoring points are optimized. The methods of sampling and pollutants analysis are determined. According to the monitoring data of main pollutants in environmental air, it is decided whether air quality conforms to related standards. Also, the results will be used to evaluate the air quality and analyze the pollutants information of migration and transformation.

Introduction

Tongliao city locates in the eastern part of the Nei Monggol Autonomous Region, China. Tongliao city has more than 30 primary key pollution sources, such as Nei Monggol Mengniu Dairy Ke’erqin Co., LTD., Nei Monggol Jinlian Aluminum Co., LTD., Tongliao Thermoelectric Co., LTD., etc. There are 14 key pollution sources enterprises, with the main discharge of pollutants including particulate matter, sulfur dioxide, carbon monoxide, nitrogen oxides, lead and its compounds [1].

The pollution sources in Tongliao city are mainly concentrated in Huolinguole city, also the pollution sources are also produced in Ke’erqin District, Zuoyi Hou County and Kulun County. The key pollution sources in Tongliao city are shown in Figure 1. It should be given more attention that the distribution of the pollution monitoring points will be concentrated in these areas.

Tongliao city locates in the arid and semi-arid climate zone; its climate is influenced by airflow of Mongolia plateau, being temperate continental monsoon climate. It’s dry windy in spring and hot with rainfall concentrated in summer, cool and short in autumn, cold and long with less snow in winter. The climate characteristic shows that raining and high temperature is over the same period. It has annual average temperature 1.7°C to 8.1°C in Tongliao city, with the average highest temperature of 7.6°C-14.3°C and the average lowest temperature of -3.7°C-3.1°C, with the rainfall of 325.1 mm-652.8 mm, 70% rainfall is concentrated in June, July and August. Annual average frost-free period is about 119days-257 days.

The topography of Tongliao city appears higher in the south and north, and lower in the middle, the saddle shape on the whole [2].

There are several common endemic diseases in Tongliao city, such as the plague, iodine deficiency disorders, brucellosis, endemic fluorosis, kaschin-beck disease [3]. The population health level of the different regions of Tongliao city has no significant differences. While air quality monitoring is carried out, we will not consider the influence of the population health differences. However, endemic disease should be considered when the project of environmental air quality monitoring program are chosen to test, and more monitoring points should be scheduled on the distribution of the population concentration areas.
Figure 1. Key pollution sources in Tongliao city.

Air Quality Monitoring Projects Considering the Influence of the Endemic Disease

In 2017, there were 316 days that air quality was good in Tongliao city, about 86.6% all the year round. Pollution weather 49 days, mainly concentrated in the early spring and winter. The pollutants are mainly fine particulate matter (PM2.5). In Tongliao city, the fine particulate matter (PM2.5), particulate matter (PM10) and sulfur dioxide (SO$_2$), nitrogen dioxide (NO$_2$) have the annual average concentration of 35, 69, 14, 22 μg/m$^3$, respectively. Carbon monoxide (CO) has 24-hour average concentration of 1.2 mg/m$^3$, ozone (O$_3$) has maximum 8 hours average concentration of 114μg/m$^3$ [5]. Dust-fall of Tongliao city is 19.12 tons/(month · square kilometers). The acid rain in the city hasn’t been detected out in single sample [6].

According to the above information, the projects of environmental air quality monitoring and pollution monitoring considering the influence of endemic diseases should be selected as below:

- Basic Projects: SO$_2$, NO$_2$, CO, O$_3$, PM10, PM2.5;
- Selected Projects: TSP, Pb, NOx, Benzopyrene, Fluoride (F) [3].

Air Quality Monitoring Points Distribution

It is necessary to carry out detailed investigation of monitoring area for obtaining distribution monitoring points optimally, such as climate, topography, history monitoring data, population distribution and the main pollution sources and other related information. Thus monitoring of pollutant sampling will be ensured with representativeness and universality. At the same time it should be ensured that monitoring data of the sample point can represent the average pollution level, avoiding the effect of local factors, so that the monitoring space representation and comparability will be reflected.

The Number of Monitoring Points

Tongliao city has a total area of 59835 square kilometers; the constructed area is only 164.42 square kilometers [7]. According to the requirements of national environmental air quality assessment points, it is necessary that at least six points should be arranged [8].

Optimizing Distribution Monitoring Points

It is a better method to distribute monitoring points by using function zone analysis. The method will provide a great convenience for administrative management, and the function zone points are set up with the priority in accordance with the administrative division. Tongliao city function zones are shown in Figure 2.
Tongliao city environmental protection monitoring station has three monitoring points now, as shown in Figure 3, which located in Ke’erqin Art Vocational College, Tongliao City Hotel and Tongliao Jiaojian Aluminum Co., LTD. [9], and they are automatic monitoring points. The business zone of Tongliao city is located near the Mingren Street and the Heping Road in Ke’erqin District, the residential zone and administrative zone are also located in same district. The industrial zone is located at Huolinguole city and Ke’erqin District, the farming and animal husbandry zone distributing in each of the administrative districts are very fragmented as well as comprehensive tourist zone. In the same time, the population density of Ke’erqin District is the largest. Therefore, based on the analysis of functional partition and population density, the more monitoring points should be distributed appropriately in the Ke’erqin District.

![Figure 2. Tongliao city function zones.](image)

![Figure 3. Monitoring points in Tongliao city.](image)

The plan of optimizing distribution monitoring points is determined through detailed analysis according to the above situations. Relating to the original three monitoring stations, the monitoring point of Ke’erqin Art Vocational College is located in the Administrative zone, the monitoring point of Tongliao City Hotel is located in the Commercial zone and which of Tongliao Jiaojian Aluminum Co., LTD. is located in the Industrial zone, they are all located in Ke’erqin district and
should be kept in the original sites because it is reasonable for satisfying the rule of analysis results. Based on environmental requirements of the sampling points and management problems, the monitoring point also need to be located in the Residential zone and it is suitable to put into school area. The monitoring point in the Residential zone can be located in the No. 11 Middle School of Ke’erqin district.

The pollution resources of Huolinguole city is relatively concentrated, it ought to have a monitoring point in the area. It is reasonable to be located in the Industrial Park Management Committee based on comprehensive consideration. In addition, the traffic of Tongliao city is developed so that it needs to be monitored for road traffic. Though the traffic of Ke’erqin district maybe marked as the most developed and at least 4 monitoring points has already arranged, the monitoring point for road traffic is better to be located Ke’erqin Zuoyi Hou County rather than central city. The position of the monitoring point is located in the intersection of Bowang Street and Bayan Road. Due to the consideration of covering all the monitoring area, the monitoring points should be distributed in some locations, such as Kailu County People's Government, Ke’erqin Zuoyi Zhong County People's Government, Naiman County People's Government, Kulun County People's Government, Zhalaute County People's Government. The optimizing distribution monitoring points in Tongliao city are shown in Figure 4.

In conclusion, eleven monitoring points will be arranged according to the location optimization scheme in Tongliao city.

**Sampling Time and Sampling Frequency**

The air quality monitoring and pollution monitoring will be continuous monitoring in 24 hours a day all the year round with automatic detecting instruments [10]. At the same time, manual monitoring should give any assistance on the basis of the automatic monitoring. TSP, Pb, Benzopyrene and Fluoride (F) need for artificial sampling analysis.

Manual sampling time will be on the date of 1st, 6st, 12st, 18st, and 24st for every month. It should get started at 1:00 with 2 hours interval. The sampling will have duration of 1hour every time.

**Testing Method and Analysis**

**Testing Method**

The automatic monitoring equipments are used to determine the data of SO$_2$, NO$_2$, CO, O$_3$, PM10, PM2.5 and NOx, matching sampling pump and sampling tube. To determine TSP, Pb, Benzopyrene
and Fluoride (F), the membrane sampling is used. The determination of Fluoride (F) need to use filter paper samples with calcium hydroxide solution impregnated.

**Testing Analysis**

Testing analysis will be conducted using different method relating to different pollution project. The methods of testing analysis are listed as Table I.

| No. | pollution project | manual analysis | automatic analysis                  |
|-----|------------------|----------------|-------------------------------------|
| 1   | SO\(_2\)         | —              | Ultraviolet fluorescence spectrometry |
| 2   | NO\(_2\)         | —              | Chemiluminescence analysis          |
| 3   | CO               | —              | Non-dispersive infrared absorption method |
| 4   | O\(_3\)          | —              | Ultraviolet absorption method       |
| 5   | PM10             | —              | \(\beta\) ray absorption method     |
| 6   | PM2.5            | —              | \(\beta\) ray absorption method     |
| 7   | NO\(_x\)         | —              | Differential absorption spectrometry |
| 8   | TSP              | Weight method  | —                                   |
| 9   | Pb               | Flame atomic absorption spectrophotometry | — |
| 10  | BaP              | High performance liquid chromatography | — |
| 11  | Fluoride (F)     | Lime filter paper samples - Fluorine ion selective electrode method | — |

**Conclusions**

The air quality monitoring scheme considering the influences of endemic diseases is researched in this paper. Taking Tongliao city as an example, pollutant monitoring projects are determined in environmental air quality monitoring, and monitoring points are optimized. The methods of sampling and pollutants analysis are determined. According the monitoring data of main pollutants in environmental air, it is decided whether air quality conforms to related standards. Also, the results will be used to evaluate the air quality and analyze the pollutants information of migration and transformation.

The comprehensive quality management should be conducted to ensure the monitoring quality in the whole process of environmental monitoring. The accurate and reliable environmental monitoring results will be obtained during the whole process, such as distributing monitoring points, sampling, sample storage, pre-processing, measurement, data processing, data auditing and application. The monitoring results will be proved to be representative, accuracy and validity.

The report of monitoring results ought to be complete, clear and reasonable. The change trend of air pollutants and space-time distribution can be obviously displayed, so that the basic data can be obtained to forecast air quality and work out reasonable and effective prevention measures.

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