Analysis of Main Factors of PM 2.5

Zhuo Chen

School of North China Electric Power University, Baoding 071003, China;

953167915@qq.com

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Abstract. Anti-haze masks sell pretty well in recently years in north China. But it isn't a good thing. It means many cities in the northern China are under great pollution of PM2.5. Reducing the PM2.5 concentration and controlling haze weather effectively are imminent.

This paper tries to find out the main source of PM2.5. However, the factor affecting the density of PM2.5 vary with regions and time. To maximize the significance of the model we used, we choose the capital of China, BeiJing, where the haze is serious, as our research object. Through access to information, we obtain the most formation mechanism of PM2.5, and analyze the PM2.5 pollution source. Then we use Analytic Hierarchy Process (AHP)^[1] to rank the main factors and find the most important source.

1. Introduction

1.1 Background

Since 2013, thick haze has been shrouding the northern China increasingly^[2], causing a lot of serious consequences, e.g. fatal road accidents, closure of highways and delay or cancel of flights, larger economic losses in industry field and respiratory ailments. Severe fog and haze has brought great inconvenience to people's lives.

It has been found that, excessive level of PM2.5 in the atmosphere is a main factor causing the haze weather. Elements affecting the pm2.5 concentration are diverse and different at different time and in different regions. In order to effectively reduce air pollution, and create a good living environment, appropriate measures are needed in accordance with the characteristics of the region. A key procedure is to execute source analysis. That is to say, we are supposed to establish qualitative or quantitative relationship between pm2.5 source and ambient air quality, the density of pm2.5 specifically. Based on the results, we can then determine a suitable governance program, including the main aspects that needed to be controlled and governance order.

1.2 Our Work

As mentioned above, factors affecting PM2.5 denseness vary with regions. To maximize the model significance, we choose the capital of China, BeiJing where the haze is serious, as our research object. Through access to information, we obtain the general formation mechanism of PM2.5, and analyze the PM2.5 pollution source^[3]. Then we use Analytic Hierarchy Process (AHP) to rank the main factors and find the most important source .

2. Assumptions

- **Ignore the effect of adjacent areas.** Actually PM2.5 can spread through the air, however, this account for a small proportion of total content in a region. To simply the question, we don't consider this part.

- **The data is accurate.** We find the data in different websites and it is roughly the same. So we have reasons to assume the data is true.

3. Model

3.1 AHP---for researching the main factors affecting BeiJing PM2.5 reading

3.1.1 establishing the model

In the same region, the factors affecting the PM2.5 density may also be diversity in different time .Considering the fact, we focus mainly on winter. We investigate the PM2.5 reading in BeiJing Environmental Bulletin and get some elements contributed to the quantity of PM2.5 ^[4]. The survey shows that in winter the reading of PM2.5 is higher than other seasons, this is due to the coal-fired heating. Besides BeiJing is a developed city ,so there are many private cars, as shown in Fig 1

Fig 1 the general formation mechanism of PM2.5 in BeiJing

According to Fig 1, we combine the source with the formation mechanism of PM2.5 and establish the following AHP model. As shown in Fig2 , see PM2.5 concentration as the target layer, the main component of PM2.5 as the criterion layer and the major source of PM2.5 as the program layer.

Fig 2 Hierarchical model

Next we execute pairwise comparison between the various levels. Using 1-9 scale method, we construct the comparative judgment matrix, the results are listed in Table 1.

Table1 Judgment matrix about different layers

A	B1	B2	B3	B4
B1	1	3	3	7
B2	1/3	1	1	2
B3	1/3	1	1	2
B4	1/7	1/2	1/2	1

B1	C1	C2	C3	C4
C1	1	1/2	1/4	2
C2	2	1	1/2	4
C3	4	2	1	8
C4	1/2	1/4	1/8	1

B2	C1	C2	C3	C4
C1	1	2	5	8
C2	1/2	1	2	4
C3	1/5	1/2	1	2
C4	1/8	1/4	1/2	1

B3	C1	C2	C3	C4
C1	1	2	5	8
C2	1/2	1	2	4
C3	1/5	1/2	1	2
C4	1/8	1/4	1/2	1

B4	C1	C2	C3	C4
C1	1	1	5	7
C2	1	1	5	7
C3	1/5	1/5	1	2
C4	1/7	1/7	1/2	1

where A is PM2.5, B1, B2, B3, B4 is suspension, sulfate, nitrate, organic respectively, C1, C2, C3, C4 is coal combustion, vehicles, dust weather, other things respectively.

3.1.2 Result of the model

We solve the model with MATLAB and get the maximum eigenvalues and corresponding eigenvectors of each comparison matrix, then we normalize the eigenvectors to get the single sorting weight vectors. Further we obtain the total weight of the program layer on the target layer. The following table shows the calculation results.

Table 2 single and total sorting weight

A	Single sorting weight
B1	0.5570
B2	0.1785
B3	0.1785
B4	0.0859
CR	0.0011

B1	Single sorting weight
C1	0.1571
C2	0.5714
C3	0.1286
C4	0.1429
CR	0

B2	Single sorting weight
C1	0.5514
C2	0.2603
C3	0.1233
C4	0.0651
CR	0.0023

B3	Single sorting weight
C1	0.5514
C2	0.2603
C3	0.1233
C4	0.0651
CR	0.0023

B4	Single sorting weight
C1	0.4254
C2	0.4254
C3	0.0934
C4	0.0558
CR	0.0059

A	Total sorting weight
C1	0.3440
C2	0.3478
C3	0.2086
C4	0.0996
CR	0.0024

It can be easily seen from table 2 that the weight of C1, C2 account for a large proportion, which means coal combustion and vehicles are the main source of PM2.5 production in winter of BeiJing. This is consistent with the facts.

4 Conclusion

Therefore, in order to reduce local density of PM2.5, BeiJing takes measures to restrict the number of cars according to license plate and date and achieves good results. Since January, the PM2.5 reading has declined apparently. This, to a certain extent, shows the correctness of our model. As for another main factor, coal combustion, central heating is recommended in villages located in the city.

References

- [1] <http://www.madio.net/thread-29173-1-1.html>
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- [4] <http://www.doc88.com/p-3387349958872.html>