Research on Haze and Pm 2.5 Based on AHP

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Abstract. In a variety of environmental pollution problems, excessive air quality decline caused by PM2.5 has become a hot topic of social concern at home and abroad, PM2.5 concentration over the adverse effects on human health has been generally recognized, but on PM2.5's influence on the population, social and economic factors hidden after the population health risks are not seen in china.[1] Since 2013, haze has becoming more and more thick in the north area of china. Haze affects our daily life. So it's urgent to find the relationship between the haze and pm 2.5.This paper aims at finding the relationship based on AHP**.** Pm 2.5 includes different kinds of elements such as Pb, Mn, Sb, As, Cd, Co, Cr.....and materials like PAHs. We take some typical elements and materials to approach. The whole order of importance of pm2.5's components is:(PAHs,Pb)>(As,Cr) >(Cd,Co)>(Mn,Sb,$SO4^{2-}$).After establishing health evaluation coefficient and related layers, we can get the typical cities order: Beijing>Zhengzhou>Urumqi>Qinhuangdao>Xian>Anshan>Tianjin>Lanzhou>Yinchuan.

Introduction

Comprehensive characterization of chemical composition of atmospheric aerosols is necessary for the understanding of their impact on the global climate, air quality and human health (Seinfeld and Pandis, 1998; Finlayson-Pitts and Pitts, 2000 ; Brunekreef and Holgate, 2002). Organic compounds constitute a substantial fraction of atmospheric aerosols (Andreae and Crutzen, 1997 ; Zhang et al., 2011), however, hundreds of individual organic compounds in different concentrations make a detailed chemical characterization of aerosols difficult (Kubátová et al., 2002 ; Pietrogrande and Bacco, 2011).[2]

There are things floating around in the air. Most of them, you cannot even see. They are a kind of air pollution called particles or particulate matter. In fact, particulate matter may be the air pollutant that most commonly affects people's health.[3] Obviously, the unhealthy degree increases with the rise of concentration of pm2.5.

We describe the unhealthy degree of the pm 2.5 by different levels, such as: high, normal. In this task, we focus on the negative influences on different organs caused by pm 2.5.

1)Pm 2.5 includes different kinds of elements such as Pb, Mn, Sb, As, Cd, Co, Cr.....and materials like PAHs. We take some typical elements and materials to approach.

2)We also consider that different organs have different important degree to the whole health situation .So we choose several ordinary organs as our samples.

3)The concentration of pm2.5 of four seasons are also different.so we analyze the different influences to health. We use the average as our data.

The process of AHP analyzing

The introduction of AHP.

We choose AHP to analyze the relationship between the cities and components of pm 2.5 and harmful degree. AHP can provide a layered model which can divided by target, principle and solution. The target layer is the final result of our model. The principle included the components of pm 2.5.They are the elements which affect the injury coefficient.

The steps to use AHP:

(1) The factors involved in the complex problems are divided into several levels, the establishment of multi-level hierarchical structure model (the target layer, the judgment, the program layer).

(2) Scale and description. When comparing the importance of any two factors at the same level, it is more important to judge the importance of them.

(3) Compared to the elements of the same level of the above elements for the two comparison, according to the evaluation scale to determine their relative importance, according to the construction of the judgment matrix A.

(4) Calculate the matrix of the characteristic vector, in order to determine the relative importance of each layer of elements (weight).

(5) In the end, according to the principle of maximum weight, the optimal scheme is determined according to the calculation of the overall importance (weight).

The easy will comparative judgment quantitative, introducing 1 ~ 9 ratio mark degree method, provisions 1, 3, 5, 7, 9, respectively, which indicated that judgment based on experience, compared to the elements of I and elements of J: equally important, slightly important, strong, strong important, absolutely important, and 2, 4, 6, 8 said the compromise between the two judgment level value.

Table 1. The scales and their meaning

Scale	**Meaning （Comparing factors i and j）**
1	Factors I and j are equally important
3	Factors I and j are slightly important
5	Factors J and I is of great importance
7	Factors I and j are strongly important
9	Factors I and j is absolutely important
2、4、6、8	The intermediate values of two adjacent judgement factors
Reciprocal	Factors I and j are compared to determine the matrix ij a, then the factors J and I compared to the judgment of aji=1/aij

Evaluation of some typical cities.

Firstly, In this model, we also establish three layers. Before this, we must definite the scale at first. We use the scale to describe the importance of different elements. In this model, we use the scale to describe the relationship between pm 2.5 and its components.

Fig 1. Three layers of AHP

After establishing the three layers, we can establish the evaluation matrix.We get the concentration of pm 2.5's components in different cities from other papers.

Table 2. Model matrix

	Mn	Sb	As	Cd	Pb
Beijing	0.354	0.00285	0.023	0.012	0.481
Tianjin	0.013	0.00206	0.003	0.001	0.101
Qinhuangdao	0.134	0.000985	0.007	0.001	0.237
Xi'an	0.325	0.0031	0.01225	0.01825	0.2675
Lanzhou	0.144333333	0.00163	0.011	0.0925875	0.104
Yinchuan	0.183	0.00183	0.009	0.004	0.114
Urumqi	0.014825	0.000675	0.0085	0.00125	0.373775
Anshan	0.1059	0.00206	0.012	0.0106	0.1303
Zhengzhou	0.03898625	0.002965	0.032185	0.00548875	0.308355

	Co	Cr	SO_4^{2-}	PAHs
Beijing	0.00358	0.073	2.15	0.015
Tianjin	0.00259	0.023	1.91	0.1492
Qinhuangdao	0.00268	0.074	1.99	0.176
Xi'an	0.00412	0.076	2.32	0.0128
Lanzhou	0.000003	0.013	1.017	0.00085
Yinchuan	0.00166	0.019	1.06	0.0073
Urumqi	0.001175	0.039	1.34	0.042
Anshan	0.001	0.065	2.06	0.113
Zhengzhou	0.00099125	0.0351475	2.12	0.165

We can calculate the final weight and the weight of principles by the matrix.We use the final weight as the standard to evaluate the injury coefficient of different cities.

According to other papers,we get a whole order of importance of pm2.5's components:

(PAHs,Pb)>(As,Cr) >(Cd,Co)>(Mn,Sb,SO_4^{2-})

Health eveluation.

Then we do some evaluations of the harmful influences of Pm2.5. We focus on the relationship between those system's importance to our body.Then we decide the differebt layers as shown in Fig 2.

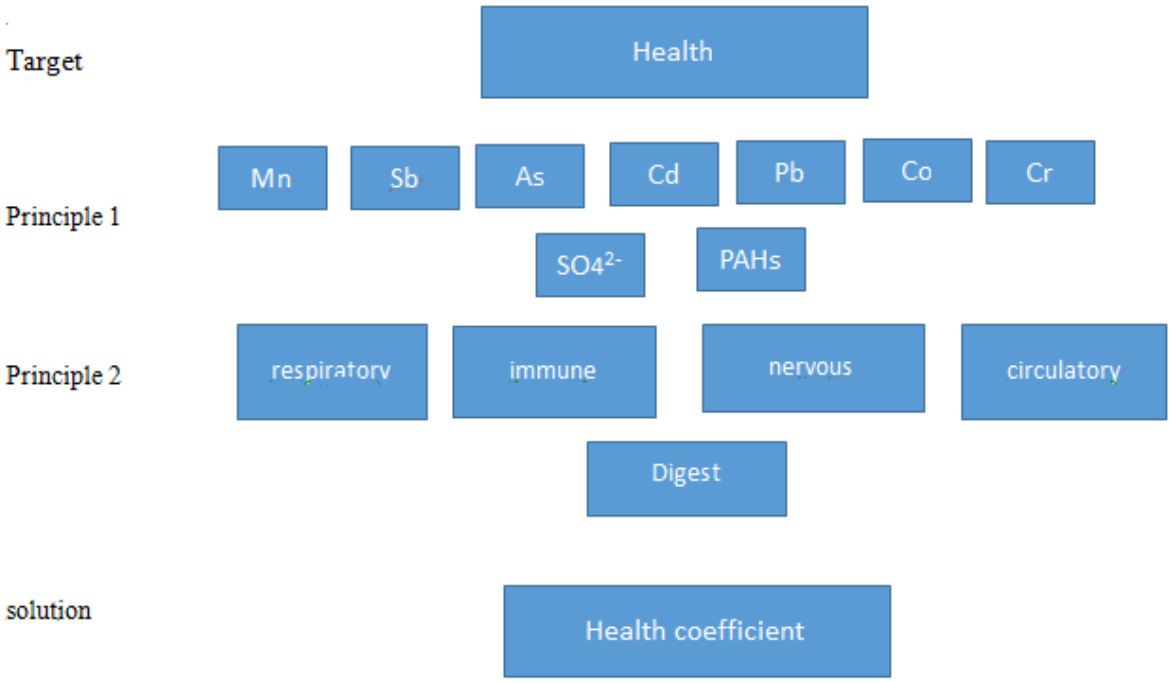

Fig2. Different layers of health eveluation

The scale matrix is:

Table 3 Health eveluation scale matrix

health	respiratory	immune	nervous	circulatory	digest
respiratory	1	2	3	3	2
immune	1/2	1	2	2	1
nervous	1/3	1/2	1	1	1/2
circulatory	1/3	1/2	1	1	1/2
digest	1/2	1	2	2	1

After checking, CR 0.002958523<0.1, corresponding to the consistent.
Considering the result in 2.2 , we can get the final result:

Table 4 Final result

Cities	Health coefficient
Beijing	0.1901
Tianjin	0.1271
Qinhuangdao	0.1003
Xian	0.1604
Lanzhou	0.0730
Yinchuan	0.0738
Urumqi	0.1101
Anshan	0.1219
Zhengzhou	0.1486

Accuracy of the models

In order to check the accuracy of the model, we use the rate of illness of the city as the standard. We use the standard to evaluate the negative influence.

According to data we get,The real situation:

Beijing>Zhengzhou>Urumqi>Qinhuangdao>Xian>Anshan>Tianjin>Lanzhou>Yinchuan
The result of model:
Beijing>Zhengzhou>Qinhuangdao>Urumuqi>Xian>Anshan>Tianjin>Lanzhou>Yinchuan
The rate of illness may have some error,so the result of model is acceptable.

Reference

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