How to use the atmospheric environmental self-cleaning capability effectively in China

Yating Li 1, Jingkun Zhou 2*

1 School of Law and Public Administration, Wuzhou University, Guangxi, 543002, China
2 School of Public Administration, Hebei University of Economics and Business, Hebei, 050061, China

*Corresponding author’s e-mail: zhoujingkun@heuet.edu.cn

Abstract. Based on the analysis of the effectiveness and disadvantages of artificial intervention in the treatment of air pollution, this paper briefly describes the importance of the application of atmospheric environmental self-cleaning capability for the comprehensive prevention and control of environmental pollution. According to the concept and connotation of atmospheric environmental self-cleaning capability, and referring to the main methods of foreign atmospheric environmental self-cleaning capability, this paper puts forward some suggestions on how to effectively use atmospheric environmental self-cleaning capability in China, such as strengthening the research of atmospheric environmental self-cleaning capability in China, making full use of the dilution and purification effect of wind, using the purification effect of dry and wet deposition effectively, playing the purification effect of human-oriented design reasonably, speeding up the adjustment of industrial and energy structure in combination with the characteristics of regional self-cleaning ability level, and establishing a comprehensive and key self-purification ability system index. It hopes to provide a reference for China to achieve the goal of air pollution control.

1. Introduction
For a long time, influenced by the concept of Nature rights and the belief that man can conquer nature, western countries have formed the practice of human intervention over nature in social governance. On the one hand, western society and people hope that the government can delegate power to maximize the role of market economy; on the other hand, they hope that the government can focus more on public issues such as air pollution control with a strong posture. However, the profit-oriented market economy drives economic subjects to blindly pursue the maximization of economic benefits, which leads to a large number of environmental pollution problems in the process of economic operation, and seriously damages public health and social development. Air pollution has increasingly become a public issue of close concern to the public all over the world. On the other hand, although Western governments have achieved a lot by adopting active artificial intervention methods to control air pollution, at the same time, countries have to face difficulties such as high cost of treatment and treating the symptoms rather than the root causes. As these governance dilemmas become more prominent, western countries increasingly realize that human society and nature are interdependent systems. It is wrong and one-sided to separate air pollution governance from natural laws. Nature has the function of purification, such as atmospheric circulation, plant absorption, which can purify air
pollution to a certain extent. Bringing the self-cleaning capability of the atmosphere into the air pollution prevention and control system is not only the respect and effective use of natural laws, but also the beneficial supplement to the traditional air pollution intervention control measures, so as to reduce the pollution control cost and seek both temporary and permanent solutions.

2. Main practices of atmospheric environmental self-cleaning capability in foreign countries
The atmospheric environmental self-cleaning capability mainly refers to the ability of atmospheric environmental elements to reduce the concentration, toxicity or disappearance of pollutants entering the atmosphere through complex physical, chemical and biochemical processes. At present, the application of atmospheric environmental self-cleaning capability in foreign countries is usually based on the whole region, and its goal is to ensure that the total amount of atmospheric pollutants in a specific region within a certain period of time does not exceed the maximum capacity of natural purification capacity of atmospheric environment. Foreign related research and practice show that the concentration of air pollutants can be reduced to a harmless level through the self-cleaning capability of atmospheric environment, so as to achieve the solution of air pollution. Therefore, in practice and exploration, countries have gradually concluded that the fundamental core idea of air pollution prevention and control should be to re-balance the atmospheric environment system, that is, air pollutants match the self-cleaning capability of atmospheric environment, and then atmospheric environmental self-cleaning capability gradually draws the attention of all countries. In terms of the dilution effect of wind on air pollutants, the air pollution control policies stipulated by arbitration courts of the Canadian and American governments take the measured values of atmospheric turbulence, wind speed and direction as the basis [1] and incorporate them into the influencing factors of government policy making. Biofiltration is widely used in European countries to achieve biodegradation of air pollutants through biological processes such as vegetation growth absorption and electrostatic properties [2]. In the aspect of the application of atmospheric dry deposition, the governments of some countries, with the support of the development of Internet information technology, have taken the lead to set up specialized departments and institutions for monitoring applied atmospheric dry deposition. The National Dry Deposition Network (NDDN) was established in 1986 to document the magnitude, spatial variability, and trends of dry subsidence across the United States. Currently, the network operates as an integral part of the Clean Air Status and Trends Network (CASTNET). In addition to actively using the existing atmospheric environmental conditions, foreign countries have also carried out a wealth of practices to promote the development of atmospheric environmental self-cleaning capability such as building industry symbiotic system, bringing atmospheric environmental self-cleaning capability into closed industrial production cycle, realizing circular industrial production procedure (Sterr&Ott, 2004) [3], and integrating ecological and urban design into air pollution prevention and control, the representative eco city index systems [4] are formed, including Hamabi eco city index system, Masdar eco city index system, European green city index system, Asian green city index system, environmental sustainable development index system of Yale University and Columbia University, and sustainable development index system of Scotland. Generally speaking, the main methods of the application of atmospheric environmental self-cleaning capability abroad include the dilution of wind, the wet deposition of rain and snow, the dry deposition of plants and buildings, the purification of temperature and humidity, the purification of natural geomorphic environmental factors, the regulation of artificial wet land on the atmospheric water cycle, the boost of eco-city design, scientific planning or regulation of pollution intensive industries.

3. How to use the atmospheric environmental self-cleaning capability effectively in China
The application of atmospheric environmental self-cleaning capability has been mature relatively in foreign countries, and has played an important role in total environmental pollution control and urban planning and development. To solve the air pollution problem in China, we should explore a road with Chinese characteristics on the basis of learning from the successful experience of foreign countries.
Specifically, the application of atmospheric environmental self-cleaning capability in China can be carried out from the following aspects:

3.1. Strengthen atmospheric environmental self-cleaning capability research
In the last century, the western industrial countries experienced the development of "treatment after pollution", which brought serious air pollution consequences. Serious public incidents of air pollution have aroused public anger. In Britain, the government has been accused of failing to control air pollution in court. In order to deal with public crisis, western governments advocate active human intervention. Furthermore, these artificial intervention means are consistent with the value concept of "man can conquer nature" in western society, so it is highly praised by western society. Facts have proved that a series of human intervention means have indeed played a very important role in dealing with sudden air pollution disasters and reducing social losses. However, at the same time, the traditional human intervention means also produces the side effects such as high management cost and difficult to radical cure. The problem of air pollution in all countries is no longer limited to control, but a combination of long-term prevention and control. Effective use of atmospheric environmental self-cleaning capability is the fundamental method to prevent and control air pollution. At present, China is faced with air pollution problems similar to or even more complex than those experienced by western countries. China has also made many achievements in actively absorbing and learning from foreign beneficial experience. However, in order to fundamentally solve and prevent the occurrence of air pollution, it is necessary to strengthen the comprehensive research and application of atmospheric environmental self-cleaning capability, and further incorporate it into the comprehensive system of air pollution control, and promote each other with the development of atmospheric environmental self-cleaning capability and the traditional artificial means.

3.2. Make full use of the dilution and purification effect of wind
At present, the application of wind in China is more focused on the prevention of typhoon and other meteorological disasters, but there are relatively few studies and practices on how to apply the regular function of wind to air pollution purification. The reason is that our country is influenced by the experience of western industrial countries which emphasized pure human intervention in the early stage of air pollution control half a century ago. In addition, the situation of air pollution in our country is more severe in recent years, and the society and the people urgently expect the government to effectively fight against air pollution. Therefore, "wait for the wind" was once irony as a satirical name for the government's inability to effectively control air pollution. Words. At present, on the basis of increasing the publicity and popularization of the role of wind in purifying air pollution, we should speed up the related research in the field of meteorology, especially in the field of surface wind. Because meteorological factors can make the original concentration of pollutants discharged from pollution sources change greatly after entering the atmospheric environment, and its change effect is direct and obvious. So, on the one hand, wind related meteorological factors such as wind and turbulence motion, atmospheric stability, mixing layer height, etc. are the focus of research on the development and utilization of wind to purify air pollution in China. We should pay more attention to the research on dilution or accumulation of air pollutants caused by windy conditions can be further subdivided according to wind speed, wind direction and wind frequency. For example, the surface layer wind can pay attention to the surface layer height of seasonal change of wind speed, near formation and formation the height direction change regularity study such as each month high wind speed. We should also strengthen the cross-over studies and application of meteorology, environmental science, architecture, etc., to provide a scientific basis for regional air pollution control and environmental planning. On the other hand, it is pointed out in the report of the 19th National Congress of the Communist Party of China that "the urban pattern of coordinated development of large, medium and small cities and small towns should be built with urban agglomeration as the main body to promote coordinated regional development". This indicates that China's strategic planning unit has moved from a single city and province to a world-class urban agglomeration. In the layout design
of large urban agglomerations, the development and utilization of atmospheric environmental self-
cleaning capability should be further closely combined, such as strengthening the design layout of air
ducts within cities, between cities and between large areas. At the same time, the construction of
Shelterbelts in desert areas should be strengthened, so as to effectively use the dilution and purification
effect of wind.

3.3. Effective utilization of dry and wet sedimentation purification

For a long time, more attention has been paid to soil pollution caused by atmospheric deposition, but
the cleaning effect of atmospheric dry and wet deposition on dust in the environment has not been paid
much attention. However, compared with heavy metals in the soil and other pollutants, the human
body is more likely to ingest and adsorbed pollutants in the atmosphere by hand, mouth and direct
inhalation, so it is more harmful to the human body and the environment. The dry and wet atmospheric
subsidence can be brought into the comprehensive air pollution control system, which can achieve the
purpose of treating both symptoms and root causes. The purification of atmospheric dust by dry and
wet deposition includes two types: dry deposition and wet deposition. However, there are some
problems in China, such as insufficient understanding of dry deposition of atmospheric dust, and the
research of dry deposition process is obviously weaker than that of wet deposition. China is a vast
country with great differences in climatic conditions and landforms, so it is necessary to actively
explore the dry and wet subsidence models suitable for different regions. On the one hand, we should
increase the research and application of atmospheric dry dust, including natural dust and dust storm. In
terms of dry dust, it is necessary to highlight the retention and dilution of atmospheric dust by plants
and buildings, increase the number and area of vegetation such as urban forest park, street green space
and affiliated green space, and intensify efforts to return farmland to forest and grassland. On the other
hand, we should also increase atmospheric research and application of wet dust, including rain, hail
and other forms. In terms of wet dust, the cleaning effect of precipitation in the form of rainfall and
snow is highlighted. For example, the calculation of pollutant cleaning effect caused by different
rainfall conditions such as topographic rain, frontal rain, convective rain and typhoon rain is calculated.
According to the situation of water sources, such as river wet season, rainwater collection, sewage
treatment and South to North Water Diversion, it is planned to increase urban reservoirs, lakes,
swamps, rivers and other constructed wetlands in areas with lower atmospheric environmental self-
cleaning capability, and then increase rainfall by changing the regional climate. At the same time, we
can learn from the experience of the federal government of the United States to establish the national
dry and wet settlement monitoring center. Based on the characteristics of strong regional mobility of
air pollutants, a four-level linkage dry and wet settlement monitoring system of "central - provincial -
municipal - county" should be explored to apply the effect of dry and wet settlement on air purification
on the basis of real-time data monitoring.

3.4. Reasonable play of human design of purification

Human design factor refers to the maximization of self-cleaning effect of atmosphere by means of
eco-city construction, water conservancy measures layout, industrial planning and allocation on the
basis of full respect for atmospheric environmental self-cleaning capability. The purification of nature
is not only independent of human society, but also influenced by human factors. On the one hand, the
purification ability of nature has its inherent law, which will not be changed by human will. On the
other hand, we can give full play to this purification ability through reasonable human design, so as to
provide greater benefits for the development of human society. First of all, we should improve the
research and application of pollution source distribution and emission measurement. The statistical
evaluation of the source distribution of air pollutants should be strengthen, and according to the
emission mode of pollutants, monitor and summarize the emissions of each pollution source in a
specific period of time from the three directions of point source, line source and non-point source,
among which the point source is the industry evaluation monitoring focusing on high pollution
industries; the line source is the coal-fired motor vehicles and ships; non-point sources include man-
made non-point sources such as waste incineration, civil fuel combustion, dust, industrial production and agricultural ammonia emissions, etc., and natural sources including volcanic eruption, forest fire, natural dust, forest plant release, sea spray and so on. At the same time, the cross-accumulation effect between different pollution sources should be evaluated. At present, China is facing a similar but more serious air pollution problem with the western developed countries in the last century, which is manifested in the cross accumulation of traditional pollution sources and emerging pollution sources. Therefore, we need to consider more factors when applying atmospheric environmental self-cleaning capability. It is necessary not only to strengthen the research on the different effects of various pollution sources, but also to perfect the research on the cumulative effects of pollution sources and countermeasures. Secondly, we should actively promote eco-city design. At present, some explorations have been made in some cities in China, but the overall effect is still not obvious, and the problem of formalization is still prominent. In view of similar problems, we can actively construct the evaluation system of eco-city design, and strengthen the guiding role of evaluation indicators such as forest city, low-carbon city, green space and green building for urban construction planning. At the same time, we should speed up the research and application of urban air duct, and actively develop from the overall urban climate model to the small-scale architectural climate model, so as to closely integrate urban air duct with urban planning and the topography of various regions. For example, according to the different seasonal rules of pollutant formation, the total atmospheric capacity of different months in a year can be predicted, so as to develop more accurate policies for pollutant emission permits. Another example is to simulate the transport and diffusion of pollutants in the region according to the law of wind direction and speed in the region, so as to formulate industrial layout planning and related management policies. Through the organic combination and application of atmospheric environmental self-cleaning capability and traditional governance means to better achieve the combination of prevention and control, both symptoms and root causes of the goal.

3.5. Speed up the adjustment of industrial and energy structure according to the characteristics of regional self-cleaning capability

Regional self-cleaning capability has certain capacity limitation in specific space and time, so we should not only fully develop and utilize atmospheric environmental self-cleaning capability, but also ensure that it does not exceed the regional purification capacity, so as to ensure the sustainability of atmospheric environmental self-cleaning capability.

Therefore, in the future, on the one hand, we should speed up the study on the overall capacity of atmospheric environmental self-cleaning capability, especially the combination of atmospheric environmental self-cleaning capability with regional industrial distribution and energy structure. On the other hand, under the guidance of the concept of industrial symbiosis, we should accelerate the adjustment of China's industrial structure and energy structure. Firstly, the gradient transfer of pollution intensive industries should be carried out to ensure that the industrial waste gas does not exceed atmospheric environmental self-cleaning capability in a specific region. Secondly, emerging environmental protection industries should be cultivated in the region to build a symbiotic industrial system to support the sustainable development of atmospheric environmental self-cleaning capability. At present, a considerable part of industrial ecological parks has been built in China, and some applicable industrial ecological development experiences have been explored. On the basis of summarizing relevant experience, we should further deepen the research and application of symbiotic industrial system in combination with regional air purification capacity, industrial circulation and rational development and utilization of capacity. For example, at present, China's eco-industrial parks are mainly government led. In the future, we can actively explore and build government service-oriented eco-industrial parks, which not only conforms to the concept of building a service-oriented government in China, but also can promote the optimal allocation of industrial resources under the guidance of market mechanism.
3.6. Constructing a comprehensive and key index system of atmospheric environmental self-cleaning capability

Throughout the evaluation and research on atmospheric environmental self-cleaning capability in various countries, it involves a wide range of disciplines, including meteorology, geography, architecture, ecology and so on. In order to accurately evaluate the ability of natural purification of air pollution in a certain region, in addition to estimating the total capacity of air in the region, meteorological factors, geographical factors, pollution source distribution and emission factors, as well as the interaction among the three factors should be included in the evaluation system. So, the atmospheric environmental self-cleaning capability evaluation index should be considered comprehensively. At the same time, in the atmospheric environmental self-cleaning capability evaluation system, the role of various factors is different, and the important influencing factors should be highlighted. The weight distribution of the system should be inclined, such as the dilution of air pollutants by wind, the wet deposition of pollutants by rainfall, the retention and absorption of pollutants by plant cover, and the urban planning for atmospheric pollutants reasonable guiding. So, these factors should be set as key evaluation index.

4. Conclusion

At present, China has entered a new stage of development, and its reform has entered a deep-water zone and a critical area. Improving the atmosphere environment is not only an important driving force to promote the sustainable development of economy, but also a prerequisite to ensure the normal operation of economy. High-quality economic development must be based on the carrying capacity of resources and the environment. Due to the diversity of the causes, complexity of the process and spill over-impact of air pollution, the comprehensive prevention and control means, which is composed of the effective use of atmospheric environmental self-cleaning capability and manual intervention, can achieve the treatment of both symptoms and root causes of air pollution to a greater extent. China should speed up the research and application of atmospheric environmental self-cleaning capability, so as to better realize the air pollution control and promote the high-quality development of economy and society.

Acknowledgments

The authors thank the Humanities and Social Sciences Research Foundation Committee of the Ministry of Education. This work was supported by Humanities and Social Sciences Research of the Ministry of education in 2018, grant number 18YJC790071. The authors also thank the Key projects of haze control in Hebei Province(18273715D).

References

[1] Hewson, E. W. (2010). The meteorological control of atmospheric pollution by heavy industry. Quarterly Journal of the Royal Meteorological Society, 71(3090), 266-282.
[2] Devinny, J.S., Deshusses, M. A., Webster, T.S. (2017) Biofiltration for Air Pollution Control. CRC Press, Boca Raton.
[3] Sterr, T., Ott, T. (2004). The industrial region as a promising unit for eco-industrial development—reflections, practical experience and establishment of innovative instruments to support industrial ecology. Journal of Cleaner Production, 12(8/10), 947-965.
[4] Lars Fränne. (2007) Hammarby Sjöstad: a unique environmental project in Stockholm.http://www.hammarbysjostad.se.