Air Pollution Control in Ha-Chang City Cluster - Empirical analysis of social networks based on inter-city and inter-governmental perspectives

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ABSTRACT: Atmospheric pollution has always been an intractable regional problem that requires the cooperation of various cities and departments within a city cluster to achieve good results. As one of the key urban agglomerations in China, the Ha-Chang urban agglomeration is also plagued by the problem of air pollution. With the help of institutional collective action theory and social network analysis, we analyze the current situation of air pollution cooperation in the Ha-Chang urban agglomeration from two perspectives: inter-city cooperation network and inter-governmental cooperation network, and put forward suggestions for improving the strategic height and precision of treatment by calculating indicators such as network density and network centrality.

1. Introduction

The problem of air pollution is an important part of good environmental protection, and the northeast region of China has also been plagued by the problem of air pollution in recent years. The central government has invested a lot of resources in the treatment of air pollution in the northeast region, requiring localities to actively promise to defend the blue sky. However, due to the high mobility and diverse sources of air pollution, the traditional local management can no longer meet its management needs [2]. Therefore, the regional coordination governance mechanism linking the central, provincial, municipal and departmental governments was conceived. Few studies have been conducted on the northeast region represented by the Ha-Chang urban agglomeration. The reality is that in recent years, a collaborative mechanism for atmospheric management in the Ha-Chang urban agglomeration has been gradually established; in 2014, a joint meeting system for air pollution prevention and control in Heilongjiang Province was formally established, and in 2016, the State Council adopted the "Ha-Chang Urban Agglomeration Development Plan". The main role of a regional organization is to coordinate [1].

There is a need to clarify the structural characteristics of the cooperative air pollution management in the Ha-Chang urban agglomeration, and inter-governmental and inter-city relationships are important entry points for understanding the cooperation of governments at all levels in the urban agglomeration. [5]. Based on the perspective of institutional collective action theory, the social network analysis method is applied to quantitatively analyze the characteristics of the cooperative network at group level and individual level by calculating the interaction between actors, reveal the mechanism of cooperation, visualize the inter-governmental cooperative network and inter-city cooperative network, clarify the roles of governments at all levels in the network, and make reasonable suggestions for optimizing the path of air pollution control in the Ha-Chang urban agglomeration under realistic circumstances.

2. Institutional Collective Action (ICA) Theory and Air Pollution Control Cooperation Network in Ha-Chang City Cluster

Institutional Collective Action (ICA) theory, a theoretical and analytical framework that reveals the behavior of different interactions between organizations [6-7], is based on the assumption of rational choice of actors and explains various forms of cooperation by introducing transaction costs and cooperation risks as influencing factors. forms of formation. Studies have been made on the Chineseization of ICA theory, and the choices of Chinese local governments for environmental governance cooperation mechanisms can be classified into three kinds [9]. For the problem of collaboration among local governments within a city cluster, the essence of its micro-action is how different local governments make rational and autonomous choices in terms of collaboration partners, types of collaboration, and ways of connection. The direct cause of the institutional collective action dilemma is the fragmentation of power, where government departments make decisions in their functional areas that affect the work of other government departments. The fragmentation of political responsibility in the environmental sphere can cause problems such as

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governance that does not meet expectations. When a participant plans a strategy based on his or her own short-term interests, the lack of integrated decision-making mechanisms across policies in collective action makes action inefficient, both for the individual and for making the whole.

The Ha-Chang urban agglomeration is an urban agglomeration plan proposed by the state in the northeast region, with the goal of building the Ha-Chang urban agglomeration into a green urban agglomeration with significant influence and competitiveness, livable and workable. [10] believe that although the construction of the Ha-Chang urban agglomeration has achieved certain results, the development in the economic field has encountered bottlenecks such as weak radiation power of the central city and imperfect cross-regional management system. [4] et al. studied the evolution of the spatially linked network structure of economic growth in the urban agglomerations in Northeast China. Harbin is one of the centers of regional economic growth, and the composition of urban blocks has not changed much and has become increasingly tight after 2010. [3] et al. studied the Hachang urban agglomeration from the perspective of urban resilience and found that the overall level of urban resilience in the Hachang urban agglomeration is low; the core areas are more resilient than the peripheral areas and have a "point-like fragmented" distribution. For the Ha-Chang urban agglomeration, the existing studies are mainly focused on the economic field, and the discussion on air pollution control is still in the pioneering period, and the Ha-Chang urban agglomeration should be a synergistic development of economy, culture and environment.

The core cities of urban agglomerations are generally at the core of an urban agglomeration and have a strong radiation and driving effect on the surrounding areas. Harbin and Changchun are also the only two core cities in the Harbin-Changzhou city cluster. During the three years from 2017-2019, the annual average concentrations of pollutants such as nitrogen dioxide, PM10 and PM2.5 in Changchun were lower than those in Harbin. In order to better manage the air pollution problem in the city cluster, the Harbin-Changzhou city cluster has also launched various forms of cooperation, and this paper will take a more comprehensive understanding of the cooperation in air pollution management in the Harbin-Changzhou city cluster from two perspectives: inter-city relationship and inter-governmental relationship.

3. Empirical Analysis

The cooperative network is constructed by the social network analysis method, and the network density, degree centrality, betweenness centrality and closeness centrality are calculated with the help of Equation 1.

$$DENSITY = \frac{2L}{n(n-1)} \quad (1)$$

Where L = the actual number of existing links, n = the actual number of existing nodes.Equation 2 calculates the degree centrality.

$$C_{Adi} = \sum_{j=1}^{n} Xij, j \neq i \quad (2)$$

X_{ij} indicates whether point i is related to point j.Equation 3 calculates the betweenness centrality.

$$C_{ABi} = \sum_{j}^{n} \sum_{k}^{n} b_{jk}(i), j \neq k \neq i, \text{and } j < k \quad (3)$$

The ability of point i to control the interaction between point j and point k is expressed by $b_{jk}(i)$. Equation 4 calculates the closeness centrality.

$$C_{ACi}^{-1} = \sum_{j=1}^{n} dij, j \neq i \quad (4)$$

dij denotes the number of lines contained in the shortcut between points i and j.

3.1. Intercity cooperation analysis

Under the perspective of inter-city relationship, a total of 92 cooperation events involving each city in the Ha-Chang city cluster from 2016 to 2021 were collected, including special cooperation with the main purpose of air pollution and non-special cooperation under pan-thematic cooperation. The number of special cooperation events reached 52, accounting for 56.5%, with an overall rising trend, reaching 17 in 2020. Non-specific cooperation as a whole also shows an upward trend, reaching 14 cases in 2019.

The cooperation network of Ha-Chang city cluster of atmospheric governance is shown in Figure 1, and the core index values and centrality of the cooperation network can be obtained at the same time.

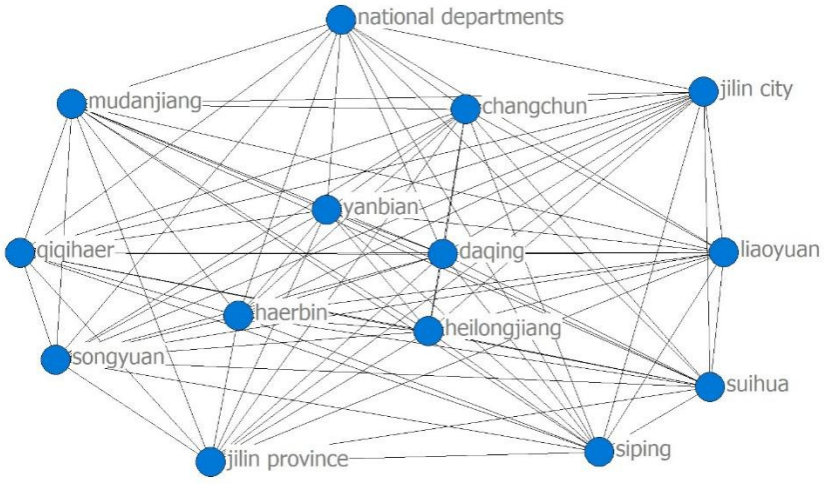

Figure 1 2016-2021 Inter-city cooperation structure of Ha-Chang city cluster

In the inter-city cooperation network of Ha-Chang city cluster, the cooperation network density is 4.91, and Harbin, Heilongjiang Province and Changchun City are in the top three of point degree centrality and are at the core of this network. Harbin City, Daqing City and Qiqihar City are the top three in intermediary centrality and assume an important intermediary role. Harbin, Daqing, and Qiqihar are the top three cities in proximity centrality, indicating that cooperative resources are mainly concentrated in these three actors. Heilongjiang Province, especially Harbin City, occupies the central position in the cooperation network, and Jilin Province and Changchun City need to strengthen their position in the network and integrate more into the cooperation.

3.2. Analysis of inter-governmental cooperation

Under the perspective of inter-governmental relationship, the cooperation events of government departments in Harbin and Changchun were collected separately at the point of time of the "Three-Year Action Plan to Win the Blue Sky Defense War" released by the State Council in 2018, with the effective number of 69 events in Harbin and 58 events in Changchun. After the statistics, the number of cooperation departments in Changchun is 33 and 26 in Harbin, the number of cooperation events in Changchun reaches 295 and 162 in Harbin, and the density of cooperation network in Changchun is 3.52 and 1.58 in Harbin. The cooperation network between various departments of air pollution governance in Harbin in 2018 network is shown in Figure 2.

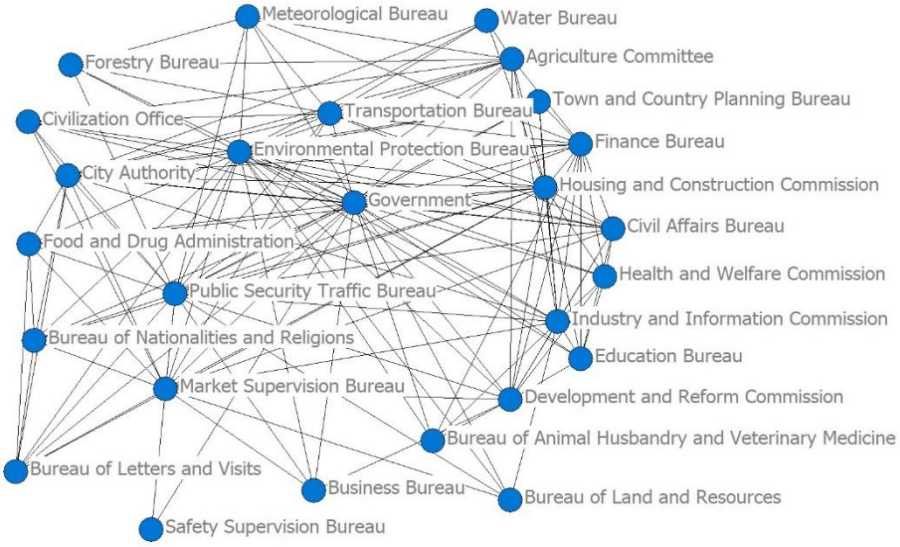

Figure 2 Cooperation network of government departments for air pollution control in Harbin in 2018

From the analysis results, it can be seen that EPA and district and county governments are in the center of the whole network. EPA and district and county governments are in the top two positions in degree centrality, betweenness centrality and closeness centrality, undertaking a large number of cooperative tasks and being two important cores of the cooperative network. The Public Security and Traffic Bureau is in the third position in both closeness centrality and betweenness centrality, indicating that Harbin City pays more attention to the control of public transportation emissions and has close cooperation in the control activities of high emission motor vehicles, elimination of yellow-label vehicles, and control of non-road mobile machinery.

The cooperation network of air pollution control government departments in Changchun in 2018 is shown in Figure 3.

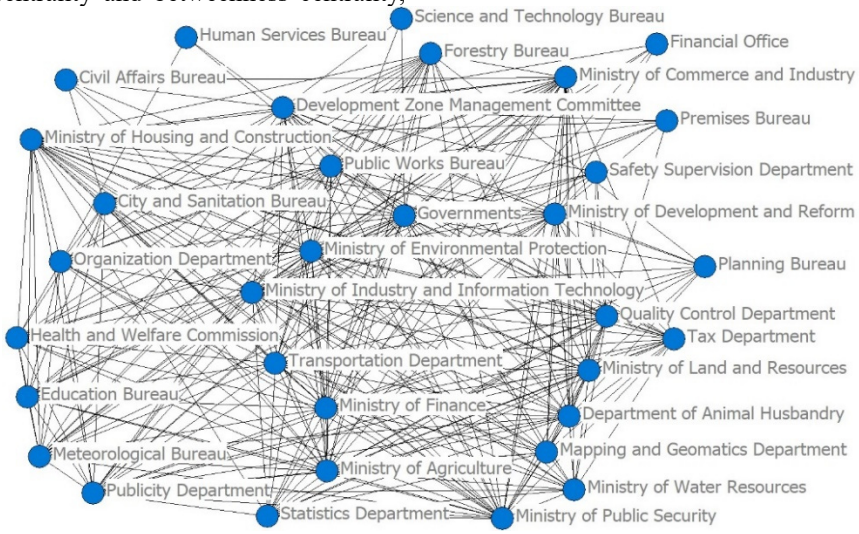

Figure 3 Cooperation network of government departments for air pollution control in Changchun, 2018

As can be seen from Changchun's cooperative network, the district and county governments are at the center of the network, ranking first in degree centrality, betweenness centrality, and closeness centrality, with the government playing a central role in cooperative governance. The Ministry of Environmental Protection and the management committees of the development zones are also actively involved in the cooperation for air pollution treatment, and mainly assume the responsibility for the implementation of the final treatment tasks.

The level of cooperation against air pollution control in 2018 is generally better in Changchun than in Harbin, which has a more dense cooperation network and more participating sectors. The effectiveness of air pollution management in Changchun is also better than in Harbin as reflected in the main pollutant indicators for 2017-2019. Changchun government departments, the Ministry of Environmental Protection and the Development Zone Management Committee are the three core points, while Harbin City is driven by a dual core of the Ministry of Protection and government departments. Harbin City focuses more on the treatment of tailpipe emission pollution, while Changchun City has a more obvious bias towards industrial pollution.

4. Conclusions

Under the perspective of inter-city cooperation, the resources for air pollution cooperation within the city cluster are clearly biased toward Harbin and Changchun, and the cooperation is closer within Heilongjiang Province than in Jilin Province. However, combining the pollutant indicators of the two provinces in recent years, Jilin Province performs better than Heilongjiang Province in general. On the one hand, Heilongjiang Province has invested more cooperation resources without getting good cooperation results, and should consider optimizing the form of cooperation; on the other hand, Heilongjiang Province should increase the cooperation linkage with Jilin Province and learn from each other's experience in air pollution control. In the perspective of inter-governmental cooperation, various departments within Changchun are more closely linked, the number of participating departments is higher, and the willingness to break functional boundaries to take cooperative actions is stronger. In general, the results of internal cooperation in Jilin Province, especially Changchun, should benefit more cities, and Heilongjiang Province needs to take the initiative to strengthen cooperation and communication with Jilin Province and change from a "principled participant" to an "active participant" [8]. The two regions need to work together to not only break down the barriers to cooperation within each province, but also to break down the barriers to cooperation between the two provinces, and to adopt more diverse and localized forms of cooperation to combat air pollution.

5. Suggestions and Prospects

From the analysis of the air pollution governance policy cooperation between Harbin and Changchun in Harbin and Changchun city clusters in 2018, it can be seen that the air pollution governance cooperation between the two cities is in the government-led, compulsory power under command type of agreement cooperation, which can take more loosely embedded forms under the theoretical framework of ICA. The looser the governance network is, the more diverse the applicable forms are bound to be, and the number of sectors that can participate will increase at the same time. Comprehensive relevant research, the following recommendations are made: First, the regional air pollution management should be incorporated into the new mechanism of regional coordinated development and elevated to a strategic level. Since the establishment of the Ha-Chang city cluster for the environmental problems within the city cluster, especially the air pollution problem does not introduce a general strategic policy, the two cities to reflect the core city to the surrounding areas of the radiation-driven role, to achieve the Ha-Chang city cluster livable and workable green city cluster goals. Second, the establishment of a richer network form of air pollution management system to enhance the degree of accuracy of governance. Nowadays, Changchun City and Harbin City have the prototype of network cooperation within the Harbin-Changzhou City Cluster, and the remaining regions should each establish an effective linkage network for air pollution management. Establish a large-scale air pollution information sharing, analysis and research system, enhance the early warning of serious pollutants, and build a regular institutionalized information linkage network and collaborative emergency network. Third, the policy tools for air pollution management are expanded to enhance the effectiveness of governance. The policy form of the Ha-Chang urban agglomeration is relatively single, basically in the form of compulsory power orders led by government departments and environmental protection bureaus. The experience of the more economically developed provinces in China shows that a mature and sustainable cooperation mechanism should include formal and informal contracts and dialogue mechanisms, combining binding agreement policies and adaptive agreement policies to guarantee the effectiveness of the agreement from both strategic and legalistic perspectives.

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