

Research on Eco-environment Collaborative Governance of Wanjiang Urban Belt under the Perspective of Yangtze River Delta Regional Integration

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Abstract: The Wanjiang City Belt is a key area for Anhui Province to integrate into the Yangtze River Delta and undertake industrial transfer. It also serves as the ecological hinterland and barrier for the economically developed regions of the Yangtze River Delta. While experiencing rapid economic growth, the Wanjiang City Belt is facing increasing pressure on its ecological environment. This paper uses the SWOT model to analyze the strengths, weaknesses, opportunities, and threats of collaborative ecological governance in the Wanjiang City Belt under the background of regional integration in the Yangtze River Delta. It proposes the adoption of a WO strategy (a turnaround strategy), where the economically developed regions of the Yangtze River Delta, as beneficiaries of ecological preservation, utilize their economic, technological, and human resources to carry out targeted collaborative ecological compensation. Based on this, the paper suggests industrial collaboration, technological collaboration, financial collaboration, and collaborative safeguard measures to promote the protection of the ecological environment in the Wanjiang City Belt.

Keywords: Wanjiang Urban belt, Ecological environment, Collaborative governance, Yangtze River Delta regional integration, SWOT model.

1. Introduction

The Wanjiang Urban Belt is a key driver for Anhui Province to integrate into the Yangtze River Delta and achieve high-quality development. Through industrial transfer, innovation-driven development and regional coordination, it not only boosts the economic growth of the entire province but also provides hinterland support for the integration of the Yangtze River Delta. During the rapid economic development, the Wanjiang Urban Belt has encountered ecological and environmental issues such as intensified industrial pollution, imbalance in the ecological security pattern and imperfect cross-border governance mechanisms, which have harmed the physical and mental health of the people and affected the realization of the high-quality development goals of the region. These have become the social focus issues that need to be urgently addressed at the present stage.

Environmental pollution control has always been a research field that scholars at home and abroad focus on. Maddison (2007) found that there are externalities in pollution and governance between neighboring countries [1]. Hosseini & Kaneko (2013) also pointed out that there is a spatial spillover of air pollution between neighboring countries. [2] Deng Yuping et al. (2016) also found that there is a significant positive correlation between urban pollution emission intensity and space in China [3]. Therefore, as early as the 1960s, the countries related to the Rhine River Basin, such as France, Germany and Switzerland, signed the "Berne Agreement on the International Commission for the Prevention of Pollution in the Rhine River" and established the International Commission for the Protection of the Rhine River from Pollution (ICPR) to jointly control pollution in the Rhine River field, and achieved remarkable results. [4] In view of the governance of cross-regional pollution problems, Dong Xiao et al. (2015), taking the Yangtze River Delta urban

agglomeration in China as an example, believed that a regional integrated environmental collaborative governance mechanism should be established [5]. Wei et al. (2022) also believe that the cross-regional joint prevention and control mechanism is a key means to solve the problem of cross-regional pollution. [6]. Regarding the ecological environmental issues of pollution in the Wanjiang City Belt, Ren Xueping et al. (2015) pointed out that the transfer of industries both domestically and internationally has, to some extent, damaged the ecological environment of the receiving areas. As a pioneer region in Anhui Province for undertaking industrial transfer, the Wanjiang City Belt should proactively engage in ecological environmental protection efforts [7]. Zhang Liwei et al. (2018) used four ecological factors—greenness, wetness, dryness, and heat—as assessment indicators to construct a Remote Sensing Ecological Index (RSEI). They found that the ecological environmental quality of the Wanjiang City Belt showed an overall upward trend from 1995 to 2015 [8]. Zhou Zhenhong et al. (2024) also discovered that the ecological environmental quality of the Wanjiang City Belt exhibited a declining trend from 2000 to 2020, with a spatial characteristic of "higher in the south and lower in the north" [9]. Based on economic development and ecological environmental data from 2016 in the Wanjiang City Belt, Zhu Yanna et al. (2021) found that the comprehensive ecological environmental levels of Hefei, Wuhu, and Ma'anshan were relatively high, while the other six cities were lower, showing a spatial trend of "lower in the southwest and higher in the central-east" [10]. Fang Li et al. (2022) observed that the ecological security pattern of the Wanjiang City Belt exhibited significant spatial differentiation, with higher ecological security levels in the southern region, gradual improvement in the northern region, and poorer levels in the central region [11]. In response to these ecological environmental issues, Sun Lei (2020)

proposed adhering to the construction of an ecological civilization, strengthening resource management, enhancing institutional development, and promoting the coordinated development of the economy, society, and environment in the Wanjiang City Belt [12]. Zhang Lina et al. (2020) suggested that the Wanjiang City Belt should establish a regional talent-sharing mechanism to reduce the cost of talent acquisition, improve the efficiency of talent utilization, and achieve the goal of undertaking industrial transfer from the Yangtze River Delta [13]. Bai Jiawen et al. (2023) also emphasized the need to accelerate the division of labor and cooperation between the Wanjiang City Belt and the economically developed regions of the Yangtze River Delta [14]. Therefore, based on the background of the integration of the Yangtze River Delta region and drawing on previous research, this article uses the SWOT model to analyze the internal and external environmental conditions of the coordinated governance of the ecological environment in the Wanjiang urban belt. It proposes to adopt the OW strategy, carry out a coordinated ecological compensation model, fully utilize the resource advantages of the economically developed areas in the Yangtze River Delta, promote ecological protection work in the Wanjiang urban belt, and promote ecological green integration in the Yangtze River Delta region.

2. Overview of the Study Area, Data Sources and Research Methods

2.1. Overview of the Study Area

The Wanjiang Urban Agglomeration originated from the "Planning for the Wanjiang Urban Agglomeration to Undertake Industrial Transfers" issued by the State Council in January 2010. Its specific scope includes the entire territory of eight cities: Hefei, Wuhu, Ma'anshan, Tongling, Anqing, Chizhou, Chuzhou and Xuancheng, as well as Jin'an District and Shucheng County of Lu'an City. It covers an area of approximately 76,000 square kilometers and had a GDP of about 2.4966 trillion yuan in 2020, accounting for 65% of the province's GDP. The Wanjiang Urban Agglomeration plays a significant role in receiving industrial transfers from the Yangtze River Delta and serves as a leading force for economic development in Anhui Province. It is also a key development area in the strategy for the rise of the central region. In 2016, the eight prefecture-level cities of the Wanjiang Urban Agglomeration were officially included in

the Yangtze River Delta Urban Agglomeration, fully integrating into the integrated development of the Yangtze River Delta region.

2.2. Data Sources

The economic development-related data in this study are sourced from the "China Regional Economic Statistical Yearbook" and the "Anhui Statistical Yearbook". The land use type data are derived from the 30-meter resolution land cover dataset of China from 1990 to 2022 released by the team of Professors Yang Jie and Huang Xin from Wuhan University.

2.3. Research Methods

The SWOT model is a management tool for the company's strategy formulation, which mainly includes the analysis of four aspects: strengths, weaknesses, opportunities and threats. The purpose is to determine the business strategy and analysis by analyzing the internal and external environmental conditions of the enterprise. With the application and promotion of SWOT model, its application field has also extended to the formulation of macro policies [15].

3. Current Status of Economic Development and Ecological Environment in the Wanjiang City Belt

From 2011 to 2016, the GDP of the Wanjiang City Belt increased from 1.09 trillion yuan to 1.71 trillion yuan, marking a growth of 56.48%. During the same period, the discharge of industrial wastewater decreased from 384 million tons to 313 million tons, a reduction of 18.49%, and the emission of industrial SO₂ dropped from 278,100 tons to 110,000 tons, a significant decrease of 60.71%. From 2016 to 2022, the GDP of the Wanjiang City Belt reached 3.16 trillion yuan, an increase of 84.55%. However, the discharge of industrial wastewater remained largely unchanged at 304 million tons, and the reduction in industrial SO₂ emissions slowed down, with emissions decreasing to 45,900 tons. This indicates that after joining the Yangtze River Delta urban agglomeration in 2016, the Wanjiang City Belt has undertaken industrial transfer, leading to continuous industrialization and rapid economic growth. However, this has also resulted in increased environmental damage and greater pressure on ecological governance.

Table 1. Economic Development Status of Wanjiang Urban Belt in 2011-2022

Index	2011	2016	Tolerance (%)	2022	Tolerance (%)
GDP (Trillion yuan)	1.09	1.71	56.48	3.16	84.55
Industrial wastewater discharge (10000000 tons)	3.84	3.13	-18.49	3.04	-2.25
Industrial SO ₂ emissions (10000 tons)	27.81	11.00	-60.71	4.59	-58.28

4. SWOT Analysis of Collaborative Ecological Environmental Governance in the Wanjiang City Belt under the Background of Yangtze River Delta Integration

4.1. Strengths

4.1.1. Policy Support and Regional Cooperation

As a significant economic development region, the

Wanjiang City Belt has garnered high attention from both national and local governments. The construction of the Wanjiang City Belt Industrial Transfer Demonstration Zone has been incorporated into the national development strategy, with clear planning and policy support, such as the "Plan for the Wanjiang City Belt Industrial Transfer Demonstration Zone." Cooperative mechanisms exist among municipal governments, such as the Joint Conference of Eight Cities in the Wanjiang Region. Additionally, the procuratorates of five cities in the Wanjiang Region signed the "Opinions on Establishing a Judicial Collaboration Mechanism for

Ecological Environmental Protection among the Procuratorates of Five Cities in the Wanjiang Region," aimed at coordinating and resolving prominent issues in handling ecological environmental protection cases. These initiatives provide direction and a foundation for collaborative ecological environmental governance.

4.1.2. Geographical and Resource Advantages

The Wanjiang City Belt boasts a superior geographical location, being part of the Yangtze River Basin and serving as the core urban cluster in the central region of the Yangtze River Economic Belt. Its well-developed water systems facilitate the implementation of regional joint prevention and control mechanisms. The region is endowed with abundant natural resources, with forests and arable land holding significant ecological value and maintaining relatively stable conditions. This provides a solid foundation for ecological environmental protection.

4.2. Weaknesses

4.2.1. Low level of economic development and uneven regional development

The economic development level of the Wanjiang urban belt is relatively low, with a per capita GDP of only 73600 yuan in 2022, lower than the national average. At the same time, the internal regional development is unbalanced, and the economic development of cities along the Yangtze River is rapid, but the ecological environment pressure is relatively high; The economic development of the southwestern Dabie Mountains and the southern Wannan Mountains is relatively lagging, but the ecological environment is relatively good. This imbalance may increase the difficulty of ecological environment protection and require coordination between regional development and ecological environment protection.

4.2.2. Unreasonable industrial structure and energy structure

In the Wanjiang urban belt, industrial enterprises in Wuhu, Ma'anshan, Tongling, and Hefei have a relatively large proportion and consume a large amount of energy, mainly relying on traditional energy sources such as coal, which puts certain pressure on the ecological environment.

4.2.3. The contradiction between land use and ecological environment is prominent

With the advancement of urbanization and industrial transfer, the number of industrial parks in the Wanjiang urban belt has increased, the economic strength has strengthened, and the contradiction between land use and ecological environment protection has become increasingly prominent. The phenomenon of construction land encroaching on forest land, water bodies, and cultivated land has led to an increase in ecological environment pressure.

4.3. Opportunities

4.3.1. Integration into the Yangtze River Delta Integrated Development

The Yangtze River Delta region, including Shanghai, Jiangsu Province, and Zhejiang Province, boasts a developed economy, high technological standards, and abundant human resources. The Wanjiang Urban Belt, bridging the east and west as well as the south and north, shares geographical proximity, close social ties, and cultural similarities with the Yangtze River Delta region. Leveraging the opportunity of the Yangtze River Delta's integrated development, the Wanjiang Urban Belt can strengthen cooperation with developed areas

in the Yangtze River Delta in terms of economy, technology, and ecological environment, jointly promoting the regional economic development level and enhancing ecological environment quality.

4.3.2. Establishment of Cross-Regional Ecological Compensation Mechanisms

As the country places increasing emphasis on ecological environmental protection, ecological compensation mechanisms have been continuously improved. The Wanjiang Urban Belt can strive for more ecological compensation funds for ecological environmental protection and restoration efforts. In particular, the Xin'anjiang Ecological Compensation Pilot Program is a model of cross-regional cooperation led by the central government, co-constructed by local governments of Anhui and Zhejiang, and participated in by social capital. It serves as a valuable reference for the three provinces and one municipality in the Yangtze River Delta to jointly participate in the ecological environmental governance of the Wanjiang Urban Belt [16]. Recently, the governments of Anhui and Jiangsu provinces signed the "Cooperation Agreement on Establishing a Horizontal Ecological Protection Compensation Mechanism in the Yangtze River Basin," marking the first cross-provincial horizontal ecological protection project established between the two provinces.

4.3.3. Government Support and Technological Progress

Under the background of the country vigorously promoting ecological civilization construction and the concept of green development, the Wanjiang Urban Belt can seize this opportunity to accelerate industrial restructuring, promote industries to develop in a green, low-carbon, and circular direction, and achieve a benign interaction between economic development and ecological environment protection. With technological advancements, the research and application of environmental protection technologies have developed rapidly. The application of these technologies has not only improved production efficiency but also significantly reduced environmental pollution.

4.4. Threats

4.4.1. Cross regional pollution transfer and industrial undertaking pressure

In the process of industrial upgrading in the developed areas of the Yangtze River Delta, traditional industries with high pollution and energy consumption may be transferred to the Wanjiang region, forcing the Wanjiang region to relax environmental protection standards and exacerbating the contradiction between ecological protection and economic development.

4.4.2. The 'free rider' effect of regional environmental governance

The cross regional ecological compensation mechanism is not yet perfect and has not been popularized, resulting in the Wanjiang urban belt bearing the cost of ecological protection alone, while the surrounding areas enjoy ecological benefits.

5. Measures to Improve the Ecological Environment Coordinated Governance of the Wanjiang City Belt under the Background of Yangtze River Delta Integration

Against the backdrop of Yangtze River Delta integration,

the SWOT model is employed to analyze the internal and external environmental conditions of coordinated governance of the ecological environment in the Wanjiang City Belt. It is found that the economic development level of the Wanjiang City Belt is relatively low, and there is an insufficiency in resources such as science and technology and manpower. It is difficult to solve ecological environment problems solely with its own strength. As early as 2018, the Central Committee of the Communist Party of China and the State Council proposed that eco-benefit regions should establish horizontal compensation relationships with ecological protection regions, downstream and upstream areas of river basins through methods such as financial compensation, counterpart collaboration, industrial transfer, talent training, and joint park construction [17]. As the ecological hinterland and shield of the economically developed Yangtze River Delta region, the benefited areas of Jiangsu Province, Zhejiang Province, and Shanghai should provide corresponding compensation to the Wanjiang City Belt. Therefore, this paper suggests adopting a WO strategy, that is, drawing on the ecological compensation and counterpart collaboration model of the middle route of the South-to-North Water Diversion Project, and carrying out counterpart collaborative ecological compensation in relevant areas of the Wanjiang City Belt by the economically developed Yangtze River Delta region, to address the low level of economic development and high pressure of ecological environment governance in the Wanjiang City Belt, and promote the smooth progress of coordinated governance of the ecological environment in the Wanjiang City Belt.

5.1. Industrial Collaboration Measures

Assist ecological protection areas in making good use of natural resources and cultural landscapes, developing ecological agriculture, ecological tourism, and clean energy industries, reducing pollution, and lowering carbon emissions. Conduct technological transformations of traditional industries, develop circular economy, promote clean production, and lead the ecological, intelligent, and digital development of industries with science and technology. While improving production efficiency, reduce the consumption of natural resources, decrease the impact on the ecological environment, and actively transform towards green and low-carbon directions. Promote the vigorous development of emerging industries in ecological protection areas to optimize and upgrade the industrial structure. Industrial parks can be established to attract local related industries to settle in, form an industrial agglomeration effect, establish and improve benefit distribution mechanisms, and protect the legitimate rights and interests of ecological protection areas.

5.2. Technological Collaboration Measures

Establish a platform for technological cooperation, share scientific research resources, data, and achievements, and promote the coordinated development of technological innovation and application. For key technologies and difficulties in ecological protection, counterpart collaborative regions can jointly carry out scientific and technological breakthroughs, jointly research and develop new technologies and methods, which can enhance the technical level and effect of ecological protection and provide scientific and technological support for ecological compensation. Jointly carry out talent training work, such as holding training classes and seminars, to improve the professional quality and skill

level of scientific and technological personnel in ecological protection areas. This can provide more high-quality scientific and technological talent support for ecological compensation work and promote the application of green technology in traditional industries in ecological protection areas. Establish a scientific and technological incentive mechanism to commend and reward units and individuals who have made outstanding contributions in scientific and technological cooperation for ecological protection, which can stimulate the enthusiasm and creativity of scientific and technological personnel and promote the in-depth development of ecological compensation work.

5.3. Financial Collaboration Measures

Counterpart collaborative parties can jointly establish a green development fund, and raise funds for supporting ecological protection projects through government guidance and social capital participation. Financial institutions can innovate financial products and services according to the actual needs of counterpart collaborative regions to meet the financing needs of ecological protection projects. For example, they can develop green credit, green bonds, and other financial products to provide long-term and stable financial support for ecological protection projects. In addition, they can also explore risk protection mechanisms such as green insurance to provide risk protection for the implementation of ecological protection projects. It is necessary to strengthen financial cooperation and exchanges, establish a regular financial cooperation mechanism, jointly research and formulate financial policies and measures to support ecological protection, and promote the optimal allocation and efficient utilization of financial resources.

5.4. Collaboration Guarantee Measures

It is necessary to establish a strong coordination and management institution within the region. At the national level, it is suggested to grant greater powers to the Yangtze River Delta regional ecological environment protection collaboration group to coordinate and carry out corresponding collaborative governance work. Break down administrative barriers, improve inter-governmental cooperation mechanisms, and promote the establishment of closer inter-governmental cooperation mechanisms between the Wanjiang City Belt and other provinces and cities (such as Jiangsu and Zhejiang) in the Yangtze River Delta, especially in terms of transboundary water body governance and joint prevention and control of air pollution. Improve policy and legal guarantees, unify environmental standards and law enforcement, promote the integration of ecological environment standards in the Yangtze River Delta region, unify law enforcement discretion, and increase the investigation and punishment of cross-regional environmental violations. Strengthen supervision and assessment mechanisms, incorporate the effectiveness of ecological environment governance into the assessment system of local governments, and hold accountable regions that are lax in governance.

6. Conclusion

The Wanjiang urban belt has achieved significant results in undertaking industrial transfer, and the level of economic development continues to improve. At the same time, the pressure on the ecological environment is also increasing day by day. This article uses the SWOT model to analyze the

internal and external environmental conditions of ecological environment governance in the context of the integration of the Yangtze River Delta. It is found that relying solely on one's own conditions is difficult to cope with ecological environment pressure. External resources should be utilized, such as adopting the WO strategy, introducing economic, technological, and human resources from economically developed areas in the Yangtze River Delta, and carrying out coordinated ecological compensation for the Anhui River urban belt. On this basis, propose industrial cooperation, technological cooperation, financial cooperation, and corresponding safeguard measures.

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