

## **Coupling Coordination between Ecological Resilience and Regional Economy in the Yangtze River Economic Belt**

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### **ABSTRACT**

*In recent years, the Yangtze River Economic Belt has faced significant challenges in balancing ecological environmental protection with economic development. The Central Committee of the Communist Party of China and the State Council have clearly emphasized the need to prioritize ecological protection and green development, with the goal of promoting high-quality development in the Yangtze River Economic Belt. Based on a city-level analysis perspective, this paper measures the ecological resilience and regional economy of 24 prefecture-level cities in the Yangtze River Basin from 2018 to 2022. A coupling coordination model is constructed to analyze the coupling coordination between ecological resilience and regional economy. The results show that: (1) In terms of coupling coordination, there are notable regional differences. Most cities are in a state of mild or moderate imbalance, and some cities in moderate imbalance are showing a trend toward mild imbalance; (2) Regarding the scores of ecological resilience and regional economic levels based on the entropy weight method, regional differences in ecological resilience are significant, with cities in the middle and upper reaches performing much better than those in the lower reaches. The regional economic level is generally stable, with some cities showing slight upward fluctuations. Overall, cities in the lower reaches have a higher level of economic development than those in the middle and upper reaches. Based on the findings, it is recommended that all regions accelerate the comprehensive green transformation and upgrading of economic and social development, strengthen regional connections, and promote coordinated development driven by large urban agglomerations.*

**Keywords:** Coupling Coordination; Yangtze River Economic Belt; Ecological Resilience; Regional Economy

### **0. Introduction**

Scholars both domestically and internationally have conducted extensive research on ecological

resilience and ecological economics. Huang Jie and Li Yongle applied the global entropy method to assess the urban ecological resilience of the Huaihe River Ecological Economic Belt while considering multiple indicators. They further analyzed regional differences using the Dagum Gini coefficient, Kernel estimation, and Markov chain methods<sup>[1]</sup>. Liu Xiaoman et al. introduced a coupling coordination model to construct evaluation index systems for ecological civilization construction and socio-economic development<sup>[2]</sup>. Tao Jieyi, Dong Ping, and Lu Yuqi developed an ecological resilience evaluation model based on three dimensions—resistance, adaptability, and recovery—to study the spatiotemporal evolution characteristics of urban ecological resilience in the Yangtze River Delta from 2011 to 2019<sup>[3]</sup>. While existing research has achieved certain results regarding the coordinated development of ecology and economy in the Yangtze River Economic Belt, there remain notable shortcomings.

Under the context of the "Yangtze River Protection" initiative, studying the coordination between ecological conservation and regional economic development holds significant importance. Therefore, it is necessary to propose objective and accurate methods for measuring ecological resilience, establish a coupling coordination model between ecological resilience and regional economy, and provide reliable recommendations for the sustainable development of ecology and economy in the Yangtze River Economic Belt.

## **1. Mechanism Analysis**

The Yangtze River Economic Belt spans multiple provinces and municipalities, and its ecological environment is crucial for sustainable economic development. The coupling coordination degree model can analyze the interconnections, synergies, and coordination between subsystems within a regional economic system, as well as their impacts on regional development. By evaluating the development level of ecological resilience in the Yangtze River Economic Belt, determining indicator weights via the entropy weight method, and calculating comprehensive scores for both economic development and ecological environment subsystems, a coupling coordination degree model is constructed to quantify the degree of interaction between the two subsystems.

## **2. Research Design**

### **2.1 Study Area**

This study divides the Yangtze River Economic Belt into upper, middle, and lower reaches. It selects 24 major prefecture-level cities along the Yangtze River's main stream, including Upper reaches Kunming, Chengdu, Panzhihua, Yibin, Chongqing, Guiyang, Zunyi; Middle reaches Wuhan, Yichang, Jingzhou, Ezhou, Huanggang, Huangshi, Yueyang, Jiujiang; Lower reaches Anqing, Chizhou, Tongling, Wuhu, Maanshan, Nanjing, Zhenjiang, Nantong, Shanghai.

The study evaluates urban ecological resilience and regional economic development levels in these cities and analyzes their coupling coordination status and potential driving factors.

## **2.2 Evaluation Indicators and Data Sources**

The DPSIR model (Driving Force, Pressure, State, Impact, Response) is adopted. Following principles of regionality, hierarchy, and relative independence<sup>[4]</sup>, 19 indicators across five dimensions (Driving Force, Pressure, State, Impact, Response) are selected to construct the ecological resilience evaluation system. Data sources include city statistical yearbooks, water and soil conservation bulletins, and the China Air Quality Online Monitoring and Analysis Platform.

For regional economic development, an evaluation system is established based on three dimensions—economic structure, economic scale, and economic vitality—to reflect the principles of "innovation, coordination, green development, openness, and sharing" in high-quality economic development<sup>[5]</sup>.

## **2.3 Research Methods**

### **2.3.1 Entropy Weight Method**

To avoid subjective bias in assigning weights to multi-dimensional ecological resilience indicators, the entropy weight method is employed. This method calculates weights based on the variability of indicators, ensuring objectivity<sup>[6]</sup>.

### **2.3.2 Coupling Coordination Degree Model**

After calculating the comprehensive scores of ecological resilience and economic development subsystems, the coupling coordination degree is derived to measure their interaction. Drawing from physics, coupling coordination degree is categorized into eight levels: 0-0.2: Severe imbalance, 0.2-0.3: Moderate imbalance, 0.3-0.4: Mild imbalance, 0.4-0.5: Near imbalance, 0.5-0.6: Barely coordinated, 0.6-0.7: Primary coordination, 0.7-0.8: Intermediate coordination, 0.8-1.0: High coordination.

## **3. Results Analysis**

### **3.1 Evaluation of Ecological Resilience and Regional Economic Development in the Yangtze River Basin**

From 2018 to 2022, ecological resilience in the Yangtze River Basin exhibited fluctuations, with some cities showing improvement while others declined. Regional economic levels remained

relatively stable. Spatially, significant disparities exist: upper-reach cities like Chongqing have higher ecological resilience but lower economic development; middle-reach cities are transitional; lower-reach cities, such as Shanghai and Nanjing, demonstrate strong ecological resilience and high economic performance.

### **3.2 Coupling Coordination Analysis**

From 2018 to 2022, coupling coordination degrees varied across cities. Shanghai consistently achieved primary or intermediate coordination, while Ezhou remained in severe imbalance. Upper-reach cities generally had low coordination, except Chengdu. Middle-reach cities like Wuhan improved gradually, while lower-reach cities remained stable. Spatial distribution maps (generated via ArcGIS) reveal that most cities are in mild or moderate imbalance, with coordinated cities scattered in upper and lower reaches.

By 2022, only two cities reached coordination (e.g., Shanghai). The COVID-19 pandemic slightly impacted regional economies in 2020–2021, with recovery observed in 2022. Lower-reach cities maintained stable ecological resilience, whereas upper and middle-reach cities experienced fluctuations due to complex influencing factors.

## **4. Conclusions and Recommendations**

Key findings include:

- (1) Ecological resilience fluctuated significantly (2018–2022), with downstream cities outperforming others in both ecology and economy.
- (2) Coupling coordination levels improved slowly, but most cities remained imbalanced. Only Shanghai achieved primary coordination.
- (3) Economic stability post-pandemic and spatial disparities in ecological resilience highlight the need for region-specific policies.

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