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Research on the Practical Dilemmas and Realization Mechanisms of Collaborative Governance for *Carbon Reduction, Pollution Reduction, Green Expansion, and Growth* in Northwest Sichuan

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Abstract: As a core ecological barrier in the upper reaches of the Yangtze and Yellow Rivers, Northwest Sichuan holds a prominent and irreplaceable ecological status. Nevertheless, its inherently fragile plateau ecosystem restricts the synergistic advancement of carbon reduction, pollution reduction, green expansion and high-quality economic growth. Based on regional realities, this paper identifies multiple dilemmas of collaborative governance. Specifically, it includes sluggish industrial transformation, insufficient conversion efficiency of ecological value, fragmented cross-regional governance mechanisms, and inadequate supply of essential production factors. Thia paper further analyzes the underlying driving causes of these bottlenecks, constructs systematic realization mechanisms covering multi-dimensional coordination, industrial empowerment and ecological value transformation. Targeted implementation paths are proposed from the perspectives of industrial layout optimization, pollution control, ecological restoration, cross-regional collaboration and factor guarantees. This paper aims to provide solid theoretical references and practical insights for plateau ecological function zones to coordinate ecological protection and sustainable economic development.

Keywords: Northwest Sichuan; Carbon Reduction; Pollution Reduction; Green Expansion and Growth; Collaborative Governance; Value of Ecological Products; Plateau Ecological Barrier

1. Introduction

Northwest Sichuan serves as a crucial ecological security barrier in the upper reaches of the Yangtze and Yellow Rivers, bearing the dual mission of ecological protection and green development. With the in-depth advancement of the "Dual Carbon" strategy, coordinating carbon reduction, pollution reduction, green expansion, and growth has become a core proposition for the transformation and development of plateau regions. Constrained by factors such as plateau natural conditions, industrial foundations, and administrative divisions, conflicts between regional ecological governance and economic development persist. Relying on collaborative governance theory [1], this paper analyzes the practical dilemmas of the "Four Synergies" governance in Northwest Sichuan, constructs realization mechanisms adapted to plateau scenarios, and proposes implementation paths, aiming to provide practical references for similar ecological function zones to promote the coordinated development of ecological protection and the economy.

2. Current Status of Ecological Economic Development and "Four Synergies" Governance in Northwest Sichuan

Northwest Sichuan, an ecological barrier in the upper reaches of major rivers, is dominated by plateau mountains with a fragile ecological base and significant strategic status. Currently, the region is steadily advancing carbon reduction efforts, strictly controlling the increment of high-energy-consuming industries based on its clean energy resource advantages, and continuously promoting energy consumption control for traditional industries. In terms of pollution control, the region focuses on normalized remediation of urban and rural domestic pollution, agricultural and pastoral non-point source pollution, and industrial and mining residual pollution, with the overall regional environmental quality showing steady improvement. Green expansion relies on ecological projects such as natural forest protection, grassland restoration, and soil and water conservation, leading to a continuous expansion of the regional ecological space and a steady increase in ecological carrying capacity

[2]. Regarding economic growth, the region is developing green industries such as eco-tourism and modern ecological agriculture and animal husbandry based on ecological resources, gradually moving away from traditional extensive development models. However, at the current stage, regional carbon reduction, pollution reduction, green expansion, and growth are mostly advanced individually. The connection between various governance dimensions is insufficient, and a systematic collaborative governance pattern has not yet been formed.

3. Practical Dilemmas of Collaborative Governance for "Carbon Reduction, Pollution Reduction, Green Expansion, and Growth" in Northwest Sichuan

3.1 Insufficient Adaptability between Carbon Reduction Transformation and Regional Economic Growth

The industries in Northwest Sichuan are extensive, with the economy relying on primary agriculture/animal husbandry and small-scale mining. The space for low-carbon transformation is limited, and the cycle is long. Although the region has abundant clean energy reserves, the local conversion and industrial supporting systems are imperfect, making it difficult to effectively transform green resource advantages into low-carbon economic momentum. Local fiscal foundations are weak, and enterprises lack sufficient funds for autonomous energy-saving and carbon-reduction renovations. The introduction of low-carbon technologies and equipment updates lag behind. Meanwhile, most market entities in the region have weak awareness of low-carbon development and a heavy dependence on traditional production paths. As carbon reduction constraints tighten, it is easy to suppress the cultivation of local tax sources and the improvement of livelihood economies, creating a developmental contradiction where low-carbon constraints and economic income growth constrain each other.

3.2 Prominent Contradictions between Pollution Control and Industrial Development Coordination

Pollution in Northwest Sichuan presents composite and dispersed characteristics, with frequent occurrences of agricultural, pastoral, soil, and tourism pollution, making region-wide control highly difficult. Current regional pollution control mostly adopts end-of-pipe remediation models, lacking source prevention and process control systems. This results in high governance costs and weak sustainability of governance effectiveness. As ecological environmental control standards tighten annually, the compliance operational pressure on some small and medium-sized agriculture-related and tourism-related industries continues to increase. The pace of industrial upgrading and renovation struggles to match the rhythm of environmental supervision, making it difficult to synchronize regional ecological governance with industrial quality improvement and efficiency enhancement, posing significant challenges to achieving a bidirectional balance [3].

3.3 Low Efficiency in Ecological Green Expansion Quality Improvement and Value Conversion

Northwest Sichuan is promoting the restoration of mountains, waters, forests, and grasslands, with ecological space continuously expanding. While green expansion focuses more on basic maintenance and management, lacking refined quality improvement of ecosystems [4]. The mechanisms for assetization and market-oriented operation of regional ecological resources are not yet sound. While ecological resources have prominent public welfare attributes, the channels for realizing their economic value are narrow. Large-scale investments in ecological protection and restoration have long relied on one-way fiscal transfusions, lacking the participation of market-oriented investment and financing entities. Consequently, ecological dividends are difficult to effectively feed back into the local economy and increase masses' income, leading to a structural imbalance where significant ecological expansion results lag behind in generating green growth benefits.

3.4 Fragmentation of Multi-Dimensional Governance Subject Collaborative Linkage Systems

Northwest Sichuan spans multiple cities and prefectures, with unclear rights and responsibilities in ecological governance and a lack of unified coordination mechanisms. Carbon reduction and pollution control fall under multiple departments with different target assessments, creating departmental governance

barriers. The operational mechanisms for horizontal departmental linkage, vertical hierarchical connection, and cross-regional collaborative co-governance are imperfect. The phenomena of dispersed allocation of governance resources and redundant investment are prominent, making it difficult to form a unified "four-in-one" governance pattern, which severely restricts the release of the overall effectiveness of collaborative governance.

3.5 Imperfect Support from Institutional Policies and Assessment Incentive Systems

There is a lack of special collaborative governance policies adapted to the Northwest Sichuan plateau. Existing policies mostly apply provincial general standards, lacking differentiated regulatory content. Supporting detailed rules for policy implementation are imperfect, leaving grassroots execution without precise basis. Some beneficial policies suffer from vague implementation and weak execution. Meanwhile, regional ecological governance assessments emphasize hard indicators such as emission reduction and greening, with insufficient weighting for collaborative benefits like economic growth and livelihood security. The imbalance in incentive and constraint mechanisms makes it difficult to guide the grassroots level to coordinate the promotion of four-dimensional goals.

3.6 Shortcomings in the Core Development Factor Supply Guarantee System

Restricted by the plateau location of Northwest Sichuan, it is difficult to attract and gather green technologies and professional talents. The existing workforce is ill-suited to the needs of collaborative governance. Regional green finance development lags behind, with insufficient innovation in financial products and limited special credit support for ecological restoration, low-carbon transformation, and pollution control [5]. Furthermore, grassroots governance infrastructure construction is weak, with low penetration of intelligent and digital governance equipment. The superposition of technological and factor shortcomings hinders the quality improvement and efficiency enhancement of various governance tasks, restricting the long-term promotion of collaborative governance.

4. Realization Mechanisms for Collaborative Governance of "Carbon Reduction, Pollution Reduction, Green Expansion, and Growth" in Northwest Sichuan

4.1 Multi-Dimensional Linkage Collaborative Coordination Mechanism to Construct an Integrated Governance Pattern

Based on the cross-administrative ecological units of Northwest Sichuan, establish vertical and horizontal linkage coordination platforms to break down departmental segmentation, delineate ecological control units, and compile collaborative governance plans. Clarify the boundaries of rights and responsibilities among departments such as ecology and environment, development and reform, forestry and grassland, and agriculture and rural affairs. Establish normalized systems for information sharing, joint inspections, and problem transfer to avoid overlapping governance tasks or regulatory blind spots. Relying on special deliberation carriers for ecological protection in the upper reaches of the Yangtze and Yellow Rivers, coordinate and handle matters such as the implementation of cross-regional ecological projects, joint prevention and control of pollution, and joint accounting of carbon sink resources. Integrate dispersed governance tasks into systematic actions to promote the simultaneous planning, deployment, and assessment of the four goals of carbon reduction, pollution reduction, green expansion, and growth, eliminating efficiency losses caused by fragmented governance [6].

4.2 Industrial Green Transformation Empowerment Mechanism to Balance Carbon/Pollution Reduction with Economic Growth

Relying on Northwest Sichuan's clean energy endowments, promote the local development of hydropower and photovoltaic resources, and support the layout of low-energy-consuming green processing industries. Guide traditional agriculture/animal husbandry and small-scale mining entities to carry out low-carbon renovations. Establish a dynamic adjustment system for the negative list of industrial access, strictly controlling the landing of high-energy-consuming and high-polluting projects. Provide low-cost process upgrade guidance to market entities through green technology service platforms. Cultivate industries such as ecological agriculture/animal husbandry and low-carbon tourism based on plateau characteristic resources,

extending green industrial chains and increasing product added value. Use means such as tax incentives and technical transformation subsidies to reduce the transformation costs for market entities, guiding production methods towards low-emission and low-loss directions. This stabilizes local economic tax sources while reducing pollutant and carbon emissions, achieving sustainable industrial development under ecological constraints.

4.3 Ecological Expansion Efficiency Enhancement and Conversion Mechanism to Achieve Green Quality Improvement and Value Addition

Relying on natural forest, grassland, and soil and water conservation projects, shift the mindset of green expansion towards precise restoration, optimize forest and grass structures, and enhance ecosystem stability and carbon sink capacity. Improve the accounting process for the value of ecological products, promote the confirmation and registration of grassland and forest carbon sinks, and build docking channels for ecological product trading to open up market-oriented realization paths for ecological dividends [7]. Explore diversified models of ecological compensation, promote the implementation of horizontal ecological compensation funds, and attract social capital to participate in ecological management projects. Organically combine ecological restoration tasks with the employment transition of farmers and herdsmen. Broaden income channels for the masses through ecological management positions and under-forest product operations, continuously converting the ecological assets formed by green expansion into local economic benefits [8].

4.4 Policy Guarantee and Assessment Incentive Mechanism to Standardize Governance Implementation Processes

Combining the regional characteristics of Northwest Sichuan's plateau—ecological fragility and weak industrial foundation—issue differentiated supporting policies for collaborative governance, avoiding the direct application of environmental control standards from plain areas. Refine detailed rules for policy implementation, clarify grassroots execution standards and operational processes, and reduce policy implementation deviations. Reconstruct the local comprehensive assessment system, adjust the weighting of assessment indicators, and no longer rely solely on emission reductions or greening areas as the only judgment basis. Incorporate collaborative benefit indicators such as industrial quality improvement and mass income increase to build a comprehensive evaluation system that balances ecological protection and economic development. Support this with linked reward and punishment rules, linking assessment results with fiscal transfer payments and project approvals. Combine positive incentives with rigid constraints to guide localities to coordinate the promotion of multi-dimensional governance goals.

4.5 Multi-Subject Collaborative Participation Mechanism to Condense Social Governance Synergy

Construct a co-governance system led by the government, supported by the market, and jointly participated in by farmers, herdsmen, and social organizations, clarifying the role positioning of different subjects in collaborative governance. Conduct normalized ecological publicity and education for pastoral area masses and tourism business entities, popularizing knowledge on low-carbon production and pollution prevention to enhance the ecological protection consciousness of grassroots groups. Encourage industry associations to build exchange platforms to promote market entities to spontaneously implement emission reduction and pollution control responsibilities [9]. Introduce third-party institutions to undertake tasks such as ecological monitoring and value assessment to compensate for the insufficiency of grassroots regulatory forces. Unsmooth public feedback channels, establish environmental petition response mechanisms, guarantee the supervision rights of social subjects, and form a synergy of multi-party forces working in the same direction to jointly maintain the coordinated development pattern of regional ecology and economy.

4.6 Technology and Factor Support Guarantee Mechanism to Consolidate the Foundation of Collaborative Governance

Targeting the Northwest Sichuan plateau environment, introduce adaptive ecological technologies, build green technology conversion stations, and promote the application of scientific research achievements. Improve talent introduction and cultivation mechanisms, issue special plateau support policies, attract

professional talents in fields such as ecological environment, carbon accounting, and ecological economy, and simultaneously conduct skill training for local grassroots management personnel. Innovate green financial products, develop carbon sink pledges and special loans for ecological restoration, and broaden financing channels for ecological projects. Upgrade the environmental monitoring network, deploy plateau intelligent monitoring stations, and collect real-time data on carbon emissions, pollutants, and vegetation changes. Rely on factor supply to make up for shortcomings and ensure the long-term operation of collaborative governance.

5. Implementation Paths for the "Four Synergies" Collaborative Governance in Northwest Sichuan

5.1 Optimize Regional Industrial Layout and Cultivate a Green Low-Carbon Industrial System

Based on the ecological function positioning of Northwest Sichuan, delineate industrial development boundaries relying on main functional area planning. Implement industrial control in key ecological protection areas and orderly phase out high-energy-consuming and high-disturbance production projects. Relying on regional hydropower and photovoltaic resource advantages, promote the local consumption of clean energy and support the development of deep processing of plateau agricultural and livestock products to extend the industrial chain of characteristic agriculture and animal husbandry. Develop low-impact eco-tourism relying on plateau landscape resources, strictly control the intensity of scenic area development, and reduce pollution emissions and ecological disturbances caused by tourism activities. Construct a review mechanism for green industrial project storage, incorporating carbon emissions, pollutant output, and ecological impact into access thresholds. Guide various market entities to change production modes, consolidate the foundation of the local green economy under the premise of protecting the ecological base, and achieve the simultaneous promotion of industrial development and carbon reduction goals.

5.2 Deepen Comprehensive Pollution Control and Promote the Quality Upgrade of the Ecological Environment

Targeting the diverse and composite pollution in Northwest Sichuan, abandon single end-of-pipe governance and construct an integrated pollution prevention, control, and restoration system covering source, process, and end. Promote planting-breeding cycle models in pastoral areas, optimize the layout of livestock and poultry manure resource utilization facilities, and reduce the entry of fertilizers and breeding waste into rivers and grasslands. Improve township domestic sewage and garbage collection and disposal facilities, deploying small-scale, low-cost treatment equipment adapted to the dispersed population characteristics of the plateau. Carry out soil restoration for mine trace lands and establish a normalized mechanism for tracing and investigating pollution sources. Link pollution control effectiveness with carbon emission control, simultaneously reducing pollutants and greenhouse gases, so that the pollution reduction process synergistically drives the realization of carbon reduction goals.

5.3 Continuously Promote National Land Greening and Improve the Realization Path of Ecological Product Value

Conduct integrated restoration of mountains, waters, forests, and grasslands oriented towards improving ecological service functions, taking species adaptability into account, optimizing community structures, and enhancing carbon sequestration and anti-interference capabilities [10]. Continuously promote natural forest management, decertified land governance, and degraded grassland restoration projects to consolidate the regional ecological barrier function. Systematically conduct baseline surveys and asset accounting for forest and grassland carbon sinks, improve confirmation and registration processes, and dock with provincial ecological product trading platforms. Deepen cross-regional horizontal ecological compensation, encourage the development of carbon sink projects, attract farmers and herdsmen to participate in ecological management positions, convert the ecological assets formed by green expansion into stable income, and open up realistic channels for ecological protection to drive income increase.

5.4 Improve the Cross-Regional Collaborative Governance System to Solve the Problem of Fragmented Governance

Relying on the cross-city/prefecture ecological unit attributes of Northwest Sichuan, establish a normalized cross-regional consultation platform, unify governance planning for contiguous spaces such as watersheds and grasslands, and eliminate regulatory gaps caused by administrative boundaries. Smooth out the business connection mechanisms among departments such as Development and Reform, Ecology and Environment, Forestry and Grassland, and Agriculture and Rural Affairs. Establish unified monitoring ledgers and joint law enforcement mechanisms to achieve the interconnection and sharing of monitoring data. Unify the list of collaborative governance goals and task sequences, avoid each region formulating its own control standards, and reduce redundant waste of governance investment. Construct cross-regional ecological risk joint prevention plans, carry out joint disposal for sudden problems such as grassland fires and watershed pollution, break the governance pattern of segmentation, and promote the coordinated implementation of the four tasks of carbon reduction, pollution reduction, green expansion, and growth.

5.5 Strengthen Technology, Finance, and Talent Empowerment to Activate the Endogenous Power of Green Development

Carry out the introduction and localization trials of applicable technologies for the special plateau environment, focusing on tackling key technologies such as degraded grassland restoration, low-cost governance of agricultural and pastoral pollution, and dynamic carbon sink monitoring. Build grassroots technology promotion stations to accelerate the on-site conversion of scientific research achievements. Improve plateau talent introduction and cultivation policies, cultivate local teams of ecological management, carbon accounting, and ecological economy professionals through project cooperation and temporary position training. Innovate green financial tools, launch carbon sink pledge loans and special credits for ecological restoration, and guide social capital to participate in ecological project construction. Deploy distributed ecological monitoring points, build a digital monitoring network, dynamically grasp changes in carbon emissions, pollution emissions, and vegetation, and rely on factor support to ensure the long-term operation of collaborative governance.

6. Conclusion

As a key ecological barrier in the source region of rivers, promoting collaborative governance of carbon reduction, pollution reduction, green expansion, and growth in Northwest Sichuan is an inevitable choice to hold the ecological bottom line and activate regional development potential. Research shows that regional collaborative governance still faces multiple constraints such as limited industrial transformation, difficulties in realizing ecological value, fragmented cross-regional governance, and weak factor support. Only by improving multi-dimensional coordination mechanisms, optimizing industrial layouts, continuously carrying out ecological restoration, strengthening cross-regional linkage, and consolidating the guarantee system relying on technology, finance, and talent, can we coordinate ecological protection with livelihood income increase. This study can provide ideas for the green transformation of Northwest Sichuan and similar plateau ecological function zones. Subsequent research needs to be deepened in combination with field monitoring data.

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