

# B O O K E X C E R P T

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## 14 Conclusions and Policy Recommendations

### 14.1 | Conclusions

In the contemporary global context, economic development transcends mere progress on GDP; it now emphasizes achieving a harmonious equilibrium between economic growth and environmental preservation. The true essence lies in fostering sustainable development for society as a whole. Amidst these challenges, a significant manifestation of the developmental paradox between regional socio-economic advancement and ecological environment preservation is evident in the realm of river basin ecology.

A river basin is not only the cradle of modern civilization but also a paramount natural ecosystem. Since the Industrial Revolution, population growth and rapid economic development have spurred a heightened demand for water resources and their exploitation. This has, in turn, led to various

degrees of impairment to the natural water cycle and its regenerative capacity, resulting in issues such as water scarcity, pollution, and declining groundwater levels. The United Nations' *World Water Development Report* highlights a concerning deterioration of rivers, lakes, and freshwater resources globally, with at least half of the 500 major rivers in the world are severely depleted or polluted. This crisis is mirrored in major Chinese river basins, especially in arid northern and northwestern regions in recent decades (Li et al., 2007). A river basin—a natural catchment unit from source to estuary—serves as a fundamental unit for unified water resource management. The river basin constitutes a discernible natural zone, demarcated by the convergence of geographical features and administrative delineations. It serves not solely as a hydrological ecosystem, but also as a distinctive economic and social framework that orchestrates and oversees the national economic activities (Zhao, 2007). Characterized by robust spatial cohesion and pronounced interconnection among regions, the natural components within the river basin are intricately interlinked. Moreover, the interdependencies among the middle and lower stretches, principal and subsidiary streams, and various territories are of considerable magnitude, exerting substantial mutual

influence (Chen, 2001). Often spanning multiple administrative jurisdictions, river basins give rise to conflicts of interest concerning the exploitation, allocation, and utilization of water resources between upstream and downstream areas. They also frequently engender a plethora of other challenges, encompassing pollution, environmental deterioration, and even jeopardizing the safety of water ecosystems across diverse administrative domains. These pressing issues demand immediate attention in the management of river basin ecology. Concurrently, the implementation of ecological compensation within river basins is characterized by distinct attributes that pertain to cross-regional administrative demarcations. Hence, it has emerged as a pivotal realm and formidable undertaking in both theoretical exploration and pragmatic application of ecological compensation on both domestic and international scales.

China's rapid economic growth, following its era of reform and opening up, has brought to the forefront issues surrounding river basin water resources and ecological environments. These challenges have hindered the sustainable and healthy progression of regional economies. The study of cross-regional river basin ecological compensation, which encompasses public ecological governance and

spatial environmental economics, stands as a focal point within ecological compensation research globally. This book analyzes both the theory and practice of river basin ecological compensation, aiming to explore the academic forefront of trans-regional river basin ecological compensation. It examines the ecological and environmental obstacles Chinese river basins face while implementing trans-regional administrative strategies. In this context, it concentrates on the research objective of basin ecological governance across administrative regions. The book summarizes and scrutinizes the fundamental theory and real-world cases of river basin ecological compensation. Employing theoretical normative analysis in tandem with empirical testing, it investigates the intricate dynamics and compensatory mechanisms inherent in river basin ecological compensation. Anchored in the sustainable development goals for river basin ecosystems, this book employs diverse research methods, including driving force analysis, comprehensive water quality and quantity indices, Gini coefficient analysis, willingness-to-pay assessment, behavioral strategies, compensation models, institutional design, and emission trading theory. Through these methods, the book aims to systematically scrutinize various facets of trans-regional river basin ecological compensation.

Consequently, the theoretical exploration and case analyses of trans-regional river basin ecological compensation have yielded several key findings and conclusions.

First, the theoretical foundation of river basin ecological compensation encompasses well-established theories such as sustainable development, public goods, environmental externality, ecological assets, ecosystem, ecological service functions, natural resource values, and ecological environment values. The two primary compensation policy directions include the “Pigouvian tax” and “property rights” approaches. River basin ecological environments exhibit characteristics of common-pool resources, involving multiple administrative jurisdictions. Consequently, China’s governance of river basin environmental externalities grapples with institutional insufficiencies and regulatory ineffectiveness.

Second, this book undertakes theoretical analyses and case studies to uncover dynamic compensation mechanisms within trans-regional river basin ecological compensation on both national and international levels. The author analyzes the driving forces behind ecological compensation in the Hunhe River Basin, a key tributary in the upper reaches of the Liaohe River. Seven pivotal driving forces contributing to the river basin ecological

compensation mechanism’s operation are identified. Using this analysis, an operational model for ecological compensation in the Liaohe River Basin is formulated. Mathematical models assess the driving forces of river basin ecological compensation and delve into the dynamic compensation mechanisms in China.

Third, the book introduces a calculation method for ecological compensation across administrative boundaries based on river water quality and quantity. This method aims to establish an integrated environmental management system, overseen by regional governments within the river basin. The approach involves setting comprehensive indicator values for river water quality and quantity at the basin’s administrative boundary to calculate ecological compensation. This pioneering endeavor utilizes a “comprehensive pollution index method” to evaluate water quality within the context of river basin ecological compensation. Additionally, it seeks to assess water flow through the basin by accounting for water rights and their contributions or ratios to GDP within the basin. This book further introduces principles, methods, procedures, and calculation models for measuring and calculating cross-regional river basin ecological compensation. Through theoretical calculations and practical examples,

it addresses unclear stakeholder responsibilities and the ineffective implementation of compensatory measures in basin ecology. Thus, it offers an implementation framework and foundation for the successful execution of river basin ecological compensation.

Fourth, drawing on a comprehensive analysis of the water environment Gini coefficient, the book introduces an innovative application of this concept to river basin ecological compensation research. The book begins by analyzing the characteristics of the Liaohe River Basin to calculate the water environment Gini coefficient index. Factors considered include water environment capacity, GDP contribution, and population. Utilizing an optimization equation based on the Gini coefficient, the study identifies the scenario in which cumulative Gini coefficients are minimized, determining the standard discharge of Chemical Oxygen Demand (COD). By considering the disparity between standard and actual discharge, along with the COD unit price, compensation amounts for each administrative unit within the Liaohe River Basin are calculated. Lastly, the results of Liaohe River Basin ecological compensation, as measured by the water environment Gini coefficient, are discussed and analyzed.

Fifth, within the context of

river basin ecological compensation, accurately assessing stakeholders' genuine willingness to provide compensation is essential. Through an exploration of residents' willingness to pay (WTP), the book analyzes and evaluates the value of river basin ecological compensation in the Liaohe River Basin. Comparative analysis reveals distinctions between residents' WTP and willingness to accept (WTA) compensation. Key contributing factors to these discrepancies are identified, including income effects, penalty effects, ambiguity, and socio-economic considerations.

Sixth, the implementation of ecological compensation is intricately tied to stakeholders' strategies and behaviors, particularly in the realm of compensation policies. The focus of trans-regional river basin ecological compensation primarily centers on establishing behavioral strategies between upstream and downstream governments to ensure equitable compensation. The goal lies in determining a fair compensation amount. This book, anchored in environmental WTP methodology, employs utility indifference analysis and complete information dynamic game analysis to establish the minimum threshold for the upstream government's WTA compensation and the range within which the downstream government is willing to provide compensation. Research findings

suggest that group cooperation yields a Pareto optimal outcome when compared to individual utility maximization. Field research reveals the upstream government's WTA compensation of 37.825 million yuan per year and the downstream government's willingness to pay compensation ranging from 37.825 million yuan to 49.08 million yuan per year. By engaging in this arrangement, both upstream and downstream governments experience an improvement in utility. The book demonstrates the advantages and disadvantages of game analysis in the context of upstream and downstream government's indifferent utility and uncertain payment in trans-regional river basins.

Seventh, this book is anchored in the theoretical foundations of new institutional economics to analyze China's ecological compensation institutional design. Using regulatory economics and environmental economics, it extensively examines the infusion of traditional Chinese thought, convention, habits, and culture into China's environmental institutional design. Through this analysis, the book examines environmental externalities, public property rights, and environmental institutions within China's environmental institutional design. It identifies the lack of an environmental property rights system and the institutional origins

behind ineffective government environmental regulation. This book highlights shortcomings in China's ecological compensation institutional design and provides instructive recommendations and conceptual design principles for China's environmental governance mechanism. The United States' ecological compensation banking system is introduced as a model for emission trading system initiation, content, site selection, design factors, and implementation process. Building on this analysis, the book expounds on China's ecological compensation system, addressing the main challenges and offering policy suggestions for the ecological compensation banking system within China's ecological compensation system's design.

Eighth, through an exploratory study, the book analyzes the stakeholders engaged in river basin ecological compensation from economic individuals and local government perspectives. The focus is on understanding payment behavior from both compensation payers and recipients, constructing payment behavior models based on WTP and WTA principles. The book proposes two beneficiary payment behavior models directed toward ecological policies, shedding light on the behavior of river basin ecological compensation payers and the relationship therein.

Ninth, by distinguishing

between resource-based and environment-based ecological compensation, the book employs river basin ecological compensation as a case study. Through the evolutionary game theory, it examines compensation strategies and outcomes. Key findings emphasize the need for moderate central government intervention in river basin ecological compensation to ensure maximum benefit for upstream governments. Government intervention seeks to enhance upstream government income while ensuring protection. Consequently, a long-term stable equilibrium is established between protection and compensation.

Tenth, focusing on Hebei Province, Inner Mongolia Autonomous Region, Jilin Province, and Liaoning Province where the Liaohe River runs through, the book studies the emission trading of chemical oxygen demand (COD) and ammonia nitrogen ( $\text{NH}_3\text{N}$ ) in sewage and industrial wastewater in the Liaohe River Basin. The Analytic Hierarchy Process is employed to determine the initial allocation of COD emission rights in the Liaohe River Basin, prioritizing fairness and considering pollution status, economic development, and technological level. Initial allocation values of COD emission rights are calculated as 562,400 tons (Hebei Province), 370,700 tons (Inner Mongolia Autonomous Region), 366,000 tons

(Jilin Province), and 459,000 tons (Liaoning Province), respectively. For  $\text{NH}_3\text{N}$  emission rights, initial allocation values are 57,800 tons (Hebei Province), 38,100 tons (Inner Mongolia Autonomous Region), 32,900 tons (Jilin Province), and 47,200 tons (Liaoning Province), respectively. These figures can be employed to establish an emission trading system in the Liaohe River Basin.

Eleventh, the book underscores the necessity and theoretical significance of ecological compensation performance evaluation. Taking 27 agricultural counties in eastern and southern Liaoning Province as examples, the book calculates the comprehensive performance of ecological compensation using the entropy method. After controlling the administrative division, time, environmental protection investment, and forest stock, panel regression analysis indicates a policy effect of 0.475. To avoid problems arising from sample selection, kernel matching is introduced and yields an average treatment effect of 0.783, suggesting policy effectiveness. In the regression analysis of the compensation group, it is observed that the proportion of administrative division and fiscal deficit exhibits a significant positive relationship. Among the economic factors considered, only GDP per capita shows significance, and all time variables are significantly positive,

indicating a gradual and converging emergence of the policy effect.

#### **14.2 | Policy Recommendations**

The effectiveness of ecological compensation's institutional design and mechanism lies in the scientific rationality of the framework and mechanism construction. This framework regulates interactions between humans, natural resources, and the ecological environment.

Based on research findings, this book integrates theoretical insights and practical perspectives on trans-regional river basin ecological compensation, and proposes policy recommendations for China's cross-regional river basin ecological compensation mechanism across four key areas.

To begin with, expediting the establishment of a comprehensive legal framework for integrated environmental management within river basins is imperative. This necessitates the prompt formulation and implementation of legislation and regulations pertaining to ecological compensation within China. Presently, there exists a dearth of legal provisions and policies in China's repertoire concerning ecological efficiency and the preservation of nature. This deficiency impedes China's capacity to cater to the ecological and environmental conservation requisites inherent in its vital

ecological functional domains—spanning the spectrum of upstream and downstream river basin areas, water resources, biodiversity preservation, land utilization, and mineral reservoirs. Consequently, the sole remedy to rectify the imbalance in the distribution of environmental resource advantages between bestowers of ecosystem service functions and their beneficiaries lies in the expeditious enactment of national-level legislation pertinent to ecological compensation. Lessons drawn from both domestic and international experience underscore the pressing need for China to establish specialized regulations and laws centered on ecological compensation. Prioritizing legislative efforts and the establishment of a robust legal framework stand paramount for effectively addressing this quandary. In tandem with revising existing statutes, China ought to distinctly delineate the foundational tenets, principal domains, and compensation modalities indispensable for the execution of river basin ecological environmental compensation. It is of utmost significance to demarcate the entitlements, responsibilities, and protective measures of all pertinent stakeholders involved. China should universally uphold the fundamental principles that those who undertake development, degradation, accrual of benefits, and pollution should bear

the responsibility of safeguarding, reinstating, compensating, and remunerating. On this foundation, China must transcend conventional administrative boundaries and forge a resilient, enduring mechanism for harmonizing cross-regional ecological compensation management within the nation, creating an ecological compensation mechanism with Chinese characteristics. To standardize and rectify the administrative management conduct of governments at all echelons across administrative territories within the river basin, China should also elucidate the interplay between the fundamental law of environmental protection and other legislation pertaining to the environment and natural resources. Establishing a unified, harmonized, and comprehensive system for compensating ecological benefits tied to natural resources is a

requisite step forward.

Second, China should establish a legally empowered trans-regional comprehensive management authority with comprehensive jurisdiction mandated by law. Presently, China's water pollution prevention and control efforts are supervised by the central-level environmental protection department, with the coordination of transportation, water conservancy management, and health departments. The absence of clear regulations regarding relationships between "unified supervision and management power" and the power of other water environment management authorities leads to competitive power dynamics and failure of accountability among departments, and hampers effective coordination.

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