
AI translation · View original & related papers at
chinaxiv.org/items/chinaxiv-201702.00138

Pathways and Mechanisms for Realizing Ecological Value: Postprint

Authors: Sun Zhi

Date: 2017-02-10T00:00:00+00:00

Abstract

Ecological value theory posits that fully embodying and increasing ecological value constitutes a crucial pathway for China to overcome development constraints imposed by resources and the environment. Ecological value can be broadly conceptualized across three dimensions: ecological elements of mineral resources, environmental elements such as clean air, water, and soil, and ecosystems. However, these currently face respective challenges including unclear property rights delineation, imperfect transaction pricing mechanisms, and insufficient incentives for ecological restoration. This article proposes firmly establishing the concept of ecological value and, according to the types of ecological environment resources, following the overall approach of “defining property rights, scientifically pricing, and better realizing and increasing ecological value.” Through targeted measures such as improving the property rights structure of mineral resources, perfecting the market system for ecological value, and implementing ecological restoration, ecological value can be maximally realized to promote green development.

Full Text

Preamble

Policy & Management Research

ChinaXiv Partner Journal

Approaching Method and Mechanism Construction of Ecological Value*

Postdoctoral Research Station, Chinese Academy of Fiscal Science, Ministry of Finance, Beijing 100820

Abstract

The theory of ecological value posits that fully reflecting and increasing ecological value represents a crucial pathway to resolve the constraints between development and resource-environment security in China. Ecological value can be broadly categorized into three dimensions: mineral resources as ecological elements, environmental elements such as clean air, water, and soil, and ecosystems. Currently, these dimensions face challenges including unclear property rights delimitation, imperfect transaction pricing models, and insufficient incentives for ecological restoration. This article proposes firmly establishing the concept of ecological value, following the general approach of “defining property rights, scientifically pricing, and better realizing and increasing ecological value” according to different types of ecological resources. Through targeted measures such as improving the power structure of mineral resource rights, perfecting the market system for ecological value, and implementing ecological restoration, ecological value can be maximally realized to promote green development.

Keywords: ecological value, approaching method, mechanism construction

DOI: 10.16418/j.issn.1000-3045.2017.01.010

For a long time, distorted or absent concepts of ecological value have prevailed, such as the notions that “resources are valueless and can be used without compensation” and “resources are ownerless and can be extracted by anyone.” This has caused severe divergence between private marginal benefits/costs and social marginal benefits/costs in consuming environmental resources, leading to ecological deterioration and a “pollute first, treat later” development model. Using ecological value as the main thread, this paper elaborates on the concept and research status of ecological value, analyzes the significance and problems of realizing ecological value in China, and proposes mechanisms, pathways, and future prospects for research and practice to promote ecological value realization.

1. Concept Definition and Research Status

Domestic and international theoretical research and practical development demonstrate that ecology has value. During the classical economics period, Adam Smith and Marshall studied the relationship between economy and natural resources from the perspective of free market scarcity, arguing that the value of scarce resources could be expressed through price. This scarcity-based value essentially represented an opportunity cost, focusing on the economic value of environmental resources. However, after experiencing severe ecological and environmental crises during the industrial civilization period, the connotation and extension of ecological value were further expanded. Research in ecological economics, environmental ethics, and sustainable human development elevated the concept of ecological value from traditional economic value to philosophical significance.

Qian Junsheng and Peng Dingyou argue that ecological value is an extremely important benchmark in the diverse value system of human society, represent-

ing the capacity of natural materials to satisfy social and human needs. Cheng Baoliang and Gao Li contend that the essence of ecological value is the subjective value reflection of the objective needs of human social systems for natural ecosystem service functions, reflecting the relationship between human social systems and natural ecosystems. Hu Anshui further refines this research, arguing that ecological value refers to the interdependent relationship between life phenomena and their environment to satisfy needs, specifically divided into four categories: environmental ecological value, lifeform ecological value, ecological element value, and ecosystem value. Regarding value phenomena occurring in the natural environment, the concept comprises two aspects: first, the ecological value of ecosystems and their elements as environments for humans and other life forms, including intrinsic value, use value, and aesthetic value; second, the ecological value of humans and other lifeforms to the natural environment, which can be manifested through stopping environmental destruction, improving damaged ecosystems, restoring ecological functions, and maintaining balance in undamaged portions.

Lu Biao synthesizes relevant research, arguing that ecological value refers to the intrinsic and service value of ecosystems. In terms of intrinsic value, it mainly includes three aspects: (1) creative value, i.e., natural productivity emphasized by Marx such as climate, water, soil, forest, and mineral resources; (2) balance value, as ecosystems are dynamic equilibrium systems—once severely damaged, human survival and development become impossible; (3) self-purification value, as ecosystems possess self-organization and self-regulation functions crucial for sustained existence and development. Service value mainly manifests as material cycling and energy flow, with food and natural resources provided by ecosystems forming the foundation of human survival. He also notes that ecological protection represents the primary stage of ecological civilization construction, while ecological restoration and creation constitute more effective pathways.

Ecology not only has value, but such value can be measured and calculated. In the 1930s, Dutch economist Jan Tinbergen proposed the shadow pricing method, using mathematical linear programming to determine the optimal allocation price of natural resources, i.e., the opportunity cost of inputs. Costanza proposed an ecological service pricing model and calculated that the total value of global natural capital exceeds the gross world product. Since the 1980s, developed countries have explored establishing natural resource accounting data and in 1981, Norway first published natural resource accounting data and in 1987 published a natural resource accounting report, conducting accounting for energy, fish, land use, forest, and mineral resources between 1978-1986. In 1997, the United Nations Statistics Division incorporated environmental resources into the national economic accounting system, forming the System of Environmental-Economic Accounting (SEEA), after which multiple countries established their own economic and ecological accounting systems.

Since the 1990s, China has continuously explored theories and practices of natural resource value accounting. In 1988, the Development Research Center of the

State Council conducted research on “incorporating natural resource accounting base periods into the national economic accounting system.” From 2004-2006, the Ministry of Environmental Protection and the World Bank implemented the project “Establishing China’s Green National Accounting System” and published partial accounting results. Xie Gaodi proposed an ecosystem service valuation method based on expert knowledge, deriving an ecosystem value assessment unit system for forests, grasslands, farmland, wetlands, and rivers through questionnaires of ecology professionals. The China Forest Resources Accounting Research Project Group quantified China’s forest resource assets, with research showing that the total value of ecological services provided by China’s forest ecosystems reaches 12.7 trillion yuan annually, equivalent to 22% of the 2013 national GDP.

Currently, ecological value remains a frontier research field in value philosophy, with its concept still under exploration and development. Summarized, ecological value represents the overall value of ecosystems, an organic integration of economic and environmental values. Specifically, it includes the value of good ecological products such as the cleanliness of air, water, and soil resources; the ecological value carried by mineral resources; the value contained in ecosystem integrity; and the value realized by humans through pollution reduction and ecological restoration.

2. Significance of Realizing Ecological Value

China still faces prominent environmental problems with severe air, water, and soil pollution. Simultaneously, as a developing country with unbalanced urban-rural and regional development, some ecologically fragile and underdeveloped regions maintain long-term pressure and demands for rapid economic growth. The concept and practice of ecological value fundamentally break the opposition between economic development and environmental protection, making environmental protection a new “growth pole” for economic development and economic development an endogenous driver for environmental protection.

2.1 Realizing Ecological Value Can Build New Economic Growth Points and Crack the Contradiction Between Economic Development and Environmental Protection

For a long time, due to the absence of ecological value concepts, ecological protection has been difficult to obtain corresponding value incentives. Local governments and market entities treat it as a burden, with insufficient government environmental investment and lax supervision. Enterprises tend to evade inspections and neglect using technological means to reduce environmental pollution, causing serious resource waste and environmental damage. The 18th Party Congress report elevated ecological civilization construction to an unprecedented height and explicitly proposed the ecological value concept, requiring “deepening the reform of resource product prices and taxes, establishing

a resource 有偿 use system and ecological compensation system that reflects market supply and demand, resource scarcity, ecological value, and intergenerational compensation.”

The transformation of this concept—that ecology has value and protecting ecology can realize value—not only makes ecological environmental protection no longer a burden for governments and market entities but also becomes a new growth point for economic development and a new path for creating and capturing value, effectively resolving the contradiction between economic development and environmental protection. For example, ecotourism has become an important economic and fiscal pillar in some regions of China. Internationally, according to World Bank statistics, the global carbon market value rose from \$11 billion to \$142 billion between 2005-2010. According to U.S. EPA statistics, the emissions trading mechanism saved industrial sectors \$1 billion in pollution reduction costs while controlling air pollution.

2.2 Realizing Ecological Value Is Key to Environmental Pollution Control and Sustainable Development

In recent years, China has focused on ecological civilization construction, targeting environmental quality improvement to address prominent environmental problems such as air, water, and soil pollution, achieving positive progress. However, the environmental situation remains extremely severe, with sustainable development facing significant threats. The 2015 China Environmental Status Bulletin shows that among 338 prefecture-level cities, 265 (78.4%) exceeded air quality standards; among 5,118 groundwater monitoring points, 42.5% and 18.8% were rated as relatively poor and very poor quality, respectively. Additionally, over 70% of rivers and lakes suffer varying degrees of pollution, with soil main pollutant point 超标 rates reaching 16.1%.

Faced with this grim situation, focusing on ecological value realization helps open new paths for environmental protection and ecological restoration. International experience shows this is an effective means to fundamentally cure environmental pollution and achieve sustainable development. For example, the U.S. established an emissions trading mechanism to address severe air pollution, incentivizing enterprises to work toward ecological value realization by internalizing pollution costs. Under the premise of not exceeding total control limits, factories could flexibly manage pollution and store verified “surplus” emission reductions in EPA-approved bank accounts for future use or trading. According to EPA statistics, the emissions trading mechanism not only limited enterprises’ pollution tendencies but also incentivized active pollution reduction measures. For river pollution, the U.S. earliest established a horizontal ecological compensation mechanism in the Catskill watershed in 1993, where New York City negotiated with upstream areas to ensure drinking water quality, with upstream implementing pollution control and the city bearing part of the costs, achieving good results.

2.3 Realizing Ecological Value Is the Value Orientation for Developing Green Economy and Promoting Economic Structural Adjustment

Environmental problems are essentially development problems, and focusing on ecological value realization can effectively 倒逼 and incentivize economic structural adjustment. First, it helps optimize industrial structure and establish a new system of resource-saving and environment-friendly industries. After the 2008 international financial crisis, as global climate change, energy security, and other ecological-environmental issues were placed on important agendas, China and other countries actively sought new economic structural arrangements, with technological revolutions in clean energy and energy conservation emerging. China has incorporated ecological restoration and environmental protection into local performance evaluation systems, suppressing backward productive forces with high energy consumption, high emissions, and high pollution while incentivizing advanced productive factors for clean, economical, and safe development. Under this policy orientation, China's industrial structure adjustment has accelerated significantly in recent years, with green, low-carbon, and circular economies gradually emerging.

Second, it helps narrow regional structural gaps and establish a coordinated development pattern among eastern, central, and western regions. Over 30 years of reform and opening up, China has developed rapidly to become the world's second-largest economy, but regional development remains unbalanced with obvious gaps in per capita GDP and fiscal revenue between eastern and western regions. Western regions are rich in ecological resources—according to Liu Chunla and Liu Weidong's calculations, Inner Mongolia, Tibet, Xinjiang, and other central-western provinces rank top nationally in ecological value equivalents, while Tianjin, Shanghai, and Beijing are relatively low. This means realizing ecological value will help narrow gaps between eastern, central, and western provinces.

3. Problems in China's Ecological Value Realization

Based on domestic and international theoretical research and policy practice, ecological value realization generally has three dimensions. Regarding mineral resources, many countries' legal systems stipulate state ownership of natural resources, and China has issued a series of guiding principles for mineral resource value compensation. Regarding clean air, water, and soil resources, market mechanisms such as emissions trading and carbon trading have been established—China launched emissions trading pilots in Zhejiang, Jiangsu, and other provinces in 2007, with 12 pilot provinces currently, and carbon emissions trading pilots in Beijing, Guangdong, Shanghai, and 7 other provinces/municipalities since 2011. Regarding ecosystems, horizontal ecological compensation mechanisms between regions have been explored for ecosystem restoration—since the “Eleventh Five-Year Plan,” over 20 provinces have introduced inter-regional ecological value compensation policies and explored various compensation models.

Overall, however, during China' s economic and social development, ecological value across these three dimensions has not been well reflected, with endogenous mechanisms to incentivize local governments and market entities to autonomously protect the ecological environment not yet fundamentally formed. Ecological value realization still faces multiple problems including unclear property rights delimitation, imperfect transaction pricing models, and insufficient ecological restoration incentives.

3.1 Problems in Mineral Resource Ecological Value Realization

First, owners are not in place and the power structure is incomplete. The current state ownership system of natural resources inherits the private law nature of traditional ownership in its value choices and premise assumptions, ensuring the owner' s exclusive rights to control, use, benefit from, and dispose of resources. However, natural resources simultaneously possess economic and ecological functions with inherent public welfare characteristics, making state ownership of natural resources objectively dualistic in private and public law nature, particularly requiring attention to management and planning functions inconsistent with the current private law-oriented power structure.

Second, there is emphasis on economic value over ecological value. Under the current legal framework, mineral resources nominally belong to the state, but due to vertical distribution of governance and administrative powers, governments at various levels and their functional departments have become the actual enjoyers, beneficiaries, and even decision-makers of mineral resources. Departmental and local interests focus more on the economic value of natural resources while neglecting their ecological value. Under the target orientation of maximizing local economic interests, the overall value of mineral resources is not fully reflected, especially the ecological value carried by state ownership of mineral resources regarding ecological security and sustainable development, resulting in excessive economic development and seriously insufficient ecological protection.

3.2 Problems in Clean Air, Water, and Soil Ecological Value Realization

First, basic rights such as the public' s right to clean air are inadequately protected. Research by R. H. Coase, Dong Jinming, Liu Chao, and others shows that unclear property rights delimitation not only hinders optimal allocation of environmental resources but also prevents the formation of endogenous drivers and incentive mechanisms for ecological protection. Article 26 of China' s Constitution explicitly stipulates that "the state protects and improves the living environment and ecological environment, and prevents and controls pollution and other public hazards," thereby granting the public basic rights to environmental protection and clean air. This means that air, water, and soil pollution from economic and social activities cannot exceed residents' tolerance capacity. However, in practice, vicious pollution incidents occur frequently, even chronically, with the public' s basic environmental rights not fully protected, urgently

requiring further refinement of relevant laws and regulations.

Second, total pollution and emission control is not strict, limiting the role of market mechanisms in realizing ecological value. Without fully guaranteeing the public's basic rights to clean air, localities maintain lax control over total pollution and emissions during carbon trading and emissions trading. Enterprises can easily obtain emission quotas for free from primary markets, reducing the necessity and enthusiasm for purchasing from secondary markets. Moreover, multiple administrative pollution control measures are used simultaneously, largely squeezing the market space for emissions trading.

Third, carbon trading and emissions trading markets are fragmented, preventing optimal allocation of trading resources. Local trading markets formulate relevant policies based on local conditions, with significant differences in trading policies, measurement standards, and supervisory bodies across regions, resulting in high transaction costs and hindering optimal allocation of trading resources on a larger scale. Additionally, effective environmental monitoring is crucial for realizing clean air, water, and soil ecological value through market mechanisms, but monitoring capabilities still need strengthening, and the flexibility in implementing reward-punishment mechanisms in actual practice dampens market participants' enthusiasm.

3.3 Problems in Ecosystem Ecological Value Realization

First, as public resources, ecosystems lack clear property rights and responsibility delimitation. For a long time, river ecosystems have been natural public resources with diffuse, fluid, and cross-regional characteristics, making clear property rights delimitation impossible. The current environmental management system is mainly territorially based, with poor upstream-downstream communication in many watersheds and low work efficiency, seriously restricting governance effectiveness such as ecological restoration implementation.

Second, understanding of ecosystem overall value is insufficient. Jiang Chunyun points out that for the entire biosphere, the service value provided by ecosystems ranges from \$16-54 trillion annually, averaging \$33 trillion, equivalent to 1.18 times the 1999 world GDP (approximately \$28 trillion). However, China's current understanding of ecosystem value is far from adequate, with the overall value of ecosystems not fully reflected.

Third, investment in ecological restoration and protection is insufficient, and inter-regional cooperation mechanisms are imperfect. China has launched watershed upstream-downstream horizontal compensation pilots in recent years, but only a minority of watersheds have established mechanisms, still far from meeting urgent demands for accelerating watershed governance and protection. Some key watershed provinces lack initiative in upstream-downstream negotiations, with certain wait-and-see attitudes and dependency mentality. Some key watersheds have difficulty reaching consensus on specific terms, with insufficient seeking common ground while reserving differences, affecting mechanism

construction progress. During initial pilot stages, central funds still account for a large proportion of ecological compensation, with long-term mechanisms not yet effectively formed. Compensation methods are mainly financial, with great potential for industrial transfer, talent training, and joint park development.

4. Mechanisms and Pathways to Promote China's Ecological Value Realization

Firmly establishing the concept of ecological value and accelerating its realization requires following the general approach of “defining property rights, scientifically pricing, and better realizing and increasing ecological value” according to ecological resource types. Targeted measures should be adopted to promote ecological value realization, using more economic means for environmental protection and ecological improvement to maximize ecological value and promote green development.

4.1 Improving the Ownership Power Structure to Promote Mineral Resource Ecological Value Realization

First, as mineral resource owners, states should optimize the allocation of resources' economic and ecological values. Land, minerals, and other natural resources are not only important production materials with significant economic value but also important ecological elements with ecological value. Therefore, as natural resource owners, states must optimize allocation between the dual values of natural resources during ownership exercise, both realizing economic value as production materials through rational and orderly development and utilization, and protecting natural resources as environmental elements to realize ecological value.

Second, based on ecological value objectives, expand the power structure of natural resource ownership. Drawing on experiences from France, Japan, and other countries, management powers should be clarified as part of state ownership in addition to current private law-oriented powers such as control, use, benefit, and disposal. For example, the French Civil Code clarifies that state ownership includes management powers, while Japan's state ownership power structure comprises management and disposal powers. Specifically for China, management powers of state ownership include formulating natural resource development, utilization, and protection strategies and planning natural resource development and utilization. For natural resources where ecological value exceeds economic value, economic development could be withheld to fully realize ecological value functions, legally establishing the premise that state ownership emphasizes natural resource ecological value.

Third, improve the national natural resource asset management system and build constraint mechanisms for local natural resource utilization. Gradually explore compiling national and provincial/city/county natural resource balance sheets for overall central department planning and use, implement natural re-

source asset departure audits for local leading cadres, and establish green GDP-oriented incentive mechanisms. Accelerate the transition from physical to value accounting in natural resource accounting, incorporate resource and environmental 损耗 into performance evaluation systems, and 倒逼 local governments to coordinate economic and ecological values of natural resources.

4.2 Improving Market Transaction Mechanisms to Promote Clean Air, Water, and Soil Ecological Value Realization

Starting from protecting the public' s environmental rights and basic rights to clean air, water, and soil, ensure that total pollutant emissions are strictly defined within citizen tolerance limits. Drawing on mainstream international experience, improve the “total control-trading” model to achieve incentive compatibility between economic development and ecological protection.

First, scientifically set emission totals and reasonably determine initial allocation schemes. Regarding total setting, given that China' s emissions trading and carbon trading are still in pilot stages lacking relevant data foundations, a bottom-up total formulation method can be adopted. After accumulating several years of pilot experience, historical emission data methods can be used to formulate more scientific and strict emission totals. Regarding initial allocation, the EU Emissions Trading System approach can be referenced, adopting a method of free allocation first, then gradual auctioning. During the initial exploration phase, free quota allocation can be used to maximally encourage relevant industries and enterprises to actively participate in carbon trading and other market mechanisms, with auction-based allocation gradually introduced in second or third phases.

Second, strengthen environmental monitoring and emission supervision, and improve information network platforms. Conducting environmental monitoring and ensuring data authenticity and reliability form the foundation for healthy development of emissions trading and carbon trading markets. Enterprises must install “environmental black boxes” and pollutant automatic monitors at discharge outlets to keep enterprise discharge behaviors under constant monitoring. Increase supervision efforts, establish and improve trading supervision systems, form specialized agencies responsible for monitoring, verification, and other transaction work, and pre-define penalty mechanisms for non-compliant enterprises. Simultaneously, strengthen market information construction by establishing unified emissions trading and carbon trading information platforms to provide price and supply-demand information for trading parties and reduce transaction costs.

Third, improve laws and regulations to promote unified market construction. Unified laws and regulations are prerequisites for ensuring the legality of emissions trading and carbon trading and building a nationally unified market. The success of U.S. and EU carbon trading and emissions trading has been achieved by first formulating and promulgating relevant laws and regulations to estab-

lish the legality of carbon trading and regulate market development through legal rules. Therefore, China needs to strengthen legislative and policy research, formulate and issue emissions trading management measures, climate change response laws, or carbon trading management measures, and other relevant laws and regulations to provide legal support for market 规范 development while clarifying the legal basis for carbon trading.

4.3 Promoting Ecosystem Restoration Through Inter-Regional Compensation to Promote Ecosystem Ecological Value Realization

Further improve policy support systems and clarify responsibility boundaries for ecosystem protection and restoration.

First, further increase investment and improve inter-regional ecological compensation mechanisms. With China's vast territory and unbalanced development, promoting horizontal ecological compensation mechanisms between regions is an effective measure to resolve current prominent contradictions in water environmental protection, an important institutional guarantee for using market mechanisms to allocate ecological environmental resources, and an important policy lever to promote joint prevention and control of ecological environmental protection in relevant regions. Simultaneously, compensation methods should be innovated, combining upstream-downstream regions' basic conditions and actual needs while considering operational costs, allowing both parties to negotiate and select compensation methods such as financial compensation, remote development, technical assistance, employment resolution, and targeted poverty alleviation to fully mobilize local enthusiasm for ecosystem protection.

Second, actively carry out mountain-water-forest-farmland-lake ecological protection and restoration to improve the service functions of key ecosystems and supply capacity of good ecological products. For a long time, due to high-intensity territorial development and excessive historical debts, China's ecology has been severely damaged and degraded. Targeting the goal of ensuring China's long-term ecological security and overall ecosystem service function improvement, priority should be given to supporting regions with the highest ecological importance and most fragile ecosystems in China, promoting cross-regional coordinated linkages, and implementing major ecological protection and restoration projects according to systematic and holistic principles. Comprehensive efforts should be made in mine environment governance, water environmental protection and governance, land consolidation and restoration, and biodiversity protection. Establish a collaborative work pattern among government departments to truly change the situation where tree-planting departments only plant trees, water management departments only manage water, and farmland protection departments only protect farmland, promoting holistic protection and systematic restoration of ecosystems.

5. Conclusion

Ecological value is an important field in theoretical research and policy practice, especially for China. Theoretically, ecological value represents philosophical deepening and theoretical extension of the status and role of ecology, environmental economics, and environmental ethics, with considerable room for research in basic category and connotation/extension delimitation, as well as quantification research on various types of ecological environmental resources, representing important future research directions. In policy practice, building socialist ecological civilization is a systematic project. Taking the establishment of ecological value concepts and realization and increase of ecological value as the main thread, we must further optimize and clarify property rights delimitation for various ecological environmental resources, gradually establish and improve legal systems and environmental monitoring mechanisms for ecological value realization, and research and expand pathways for ecological value realization such as market transactions, government-society cooperation, and government public investment to continuously improve development quality and efficiency.

References

1. Ma Yonghuan, Chen Liping, Shen Lei, et al. International progress and main recommendations on natural resource asset management. *Land and Resources Information*, 2014, (12): 2-8.
2. Holmes Rolston, Yang Tongjin. *Environmental Ethics*. Beijing: China Social Sciences Press, 2000.
3. [Reference 3 appears to be missing from the original text]
4. [Reference 4 appears to be missing from the original text]
5. Qian Junsheng, Peng Dingyou. Basic concepts of sustainable development. Beijing: The Commercial Press, 2012.
6. Cheng Baoliang, Gao Li. Ecological value: An extremely important benchmark in the value system. *Social Sciences in Yunnan*, 2002, (10): 13-15.
7. Hu Anshui. The meaning and classification of ecological value. *Dongyue Tribune*, 2006, 27(2): 78-82.
8. Lu Biao. Ecological value and its practical thinking from an ecological perspective. *Social Scientist*, 2013, (9): 20-23.
9. Costanza R, d' Arge R, De Groot R, et al. The value of the world' s ecosystem services and nature. *Nature*, 1997, 387(6630): 253-260.
10. Xie Gaodi. A valuation method for ecosystem services based on expert knowledge. *Journal of Natural Resources*, 2008, 23(5): 911-919.

11. China Forest Resources Accounting Research Project Group. *China Forest Resources Accounting Research in the Construction of Ecological Civilization Institutions*. Beijing: China Forestry Publishing House, 2015.
12. Song Haiyun, Cai Tao. Carbon trading: Market status, foreign experience, and China' s reference. *Ecological Economy*, 2013, (1): 74-77.
13. Ministry of Environmental Protection. 2015 China Environmental Status Bulletin. [2016-6-2], http://www.zhb.gov.cn/gkml/hbb/qt/201606/t20160602_353138.htm.
14. Liu Chunla, Liu Weidong, et al. Research on ecological compensation standard based on ecological value equivalence. *Resources Science*, 2014, 36(1): 148-155.
15. R. H. Coase. The problem of social cost. *Journal of Law and Economics*, 1960, 3: 1-44.
16. Dong Jinming. Analysis based on the operation of natural resource state ownership. *Economic Review*, 2013, (4): 7-13.
17. Liu Chao. Institutional reflection and power reconstruction of natural resource state ownership. *Journal of China University of Geosciences (Social Sciences Edition)*, 2014, 14(2): 50-58.
18. Jiang Chunyun. *China' s Ecological Evolution and Governance Strategy*. Beijing: China Agriculture Press, 2005.

Author Information

Sun Zhi, Postdoctoral Fellow at the Postdoctoral Research Station of the Chinese Academy of Fiscal Science, Ministry of Finance, primarily engaged in research on market economy and fiscal and taxation system reform. E-mail: huanzichu@sina.com

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv –Machine translation. Verify with original.