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Mechanisms and Paths for Realizing the Value of Karst Ecological Products in Hebei Province

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Abstract

The northern karst region is an important area for the implementation of China's sustainable development strategy, and at the same time, it is also an area with extremely fragile ecological environment and concentrated distribution of soil erosion, but the research on the mechanisms and paths of realizing the value of ecological products in the northern karst region has been less involved. Taking the Zunhua study area in Hebei and the Wolf Tooth Mountain study area as an example, we constructed an ecological product value accounting index system based on different types of ecosystems and quantitatively analyzed the GEP of the two study areas. The results show that the GEP of Zunhua study area in Hebei Province in 2022 is 76.575 million yuan, of which the value of regulating services is the highest, accounting for 93.89 % of the total value of GEP; the value of cultural services is the lowest, accounting for 0.41 % of the total value of GEP; and the value of material services accounts for 5.70 % of the total value of GEP. In 2022, the GEP of the Langyashan Study Area in Hebei Province was 122,408,000 yuan, with the highest value of regulating services, accounting for 89 % of the total value of the GEP; the lowest value of material goods, accounting for 1 % of the total value of the GEP; and the value of cultural services, which accounted for 10 % of the GEP. suggests that the regulating services provided by ecosystems in the two study areas contribute the most to human well-being and are the most significant components of the GEP. And closely around the karst ecological products value accounting, value realization mechanism and path of basic cutting-edge research for the whole chain design, integrated deployment, module to promote systematic research, for the northern karst ecological restoration areas and ecological protection areas to practice the theory of the “two mountains”, to promote the formation and optimization of the ecological industry, and to promote the revitalization of the countryside to provide scientific references. Scientific reference.

Keywords: karst, ecological product, value realization, ecological protection and restoration

1. Introduction

The In 2010, China's National Main Functional Zoning Plan was released, and the concept of ecological products was first put forward in government documents. With the improvement of people's living standards, the demand for ecological products has been increasing, and the lack of ecological products in terms of both quality and quantity has been regarded as one of the biggest social contradictions in the new era (Zhang, 2020). In addition, agricultural products, industrial products, service products and ecological products are jointly listed as products necessary for human beings and can be consumed. The concept of ecological products and the realization of its value represent a major ideological shift in China's ecological civilization construction, and is a concrete application of the theory of “green water and green mountains are golden silver mountains” in practice. Application of the theory of “Green Water, Green Mountains is Golden Silver Mountains” in practical work (Yu et al., 2020). The Twentieth Party Congress further emphasized the construction of an ecological civilization, the accelerated implementation of the protection and restoration of important ecosystems, and the need to establish a mechanism for realizing the value of ecological products. At present, the research on value realization of ecological products is still in the exploratory stage. The mechanism of realizing the value of ecological products includes the mechanism of promoting the realization of the value of ecological products such as policy, market and technology, and it is a theoretical path to transform the “green mountains” into “silver mountains” by using a variety of policy tools to intervene and establish a long-term mechanism, a mechanism adapted to the new productivity of the

ecological environment. It is a theoretical path to transform “green mountains and green hills” into “mountains of gold and silver”(Gao et al., 2020). Ecological product value realization path is ecological products according to various realization mechanisms through various ways to realize the economic value, the study of ecological product value realization path can reflect the great value contained in ecological products. Eco-products are proposed in the context of building an ecological civilization, meaning that eco-products are the final products or services provided by the biological production in the ecosystem and the social production of human beings together for the well-being of the human society, and they are the necessities of life that satisfy the needs of human beings for a better life alongside agricultural products and industrial products, including eco-material services, regulating services, and cultural services (Zhang et al., 2019, Gao et al., 2020).

The realization of the value of ecological products is of great significance in consolidating the stage-by-stage results achieved in karst, promoting the comprehensive revitalization of villages and building a high-quality ecological civilization. At present, there are scientific problems and scientific and technological needs in the karst area of Hebei Province, where the mechanism for realizing the value of ecological products has not yet been perfected. Therefore, Zunhua-Huangtuling and Yixian-Langyashan, which represent the overall structure of the northern karst ecological environment in the Yanshan-Taibang Mountain area, were selected as the study areas, and an ecological product value accounting index system was constructed according to different types of ecosystems, and the values of ecological products in the two study areas were calculated, and the whole chain of design was carried out by closely focusing on the basic cutting-edge research of the karst ecological product value accounting and value realizing mechanisms and paths, integrated deployment, and promote systematic research by modules.

2. Study Area and Methodology

2.1 Study Area

(1) Zunhua Watershed Study Area (“Zunhua Study Area”): Located in Zunhua City, Hebei Province, North China (117°45′11″E-118°14′6″E, 39°55′30″N-40°21′22″N), it belongs to the temperate karst low hill landscape, which is more typical of the northern karst region, and is an important part of the construction of Yanshan-Taipei Hangshan water-source culverting forests and soil erosion control. Warm temperate semi-humid monsoon climate zone, four distinct seasons, average annual temperature of 10.9 ℃, annual precipitation of 724.7 mm. complete development of geomorphology, located in the end of the Yanshan mountain range, mainly pure dolomite or gray dolomite composed of elevation of 600-1813 m. The city is located at the end of the Yanshan mountain range, mainly pure dolomite or gray dolomite composition.

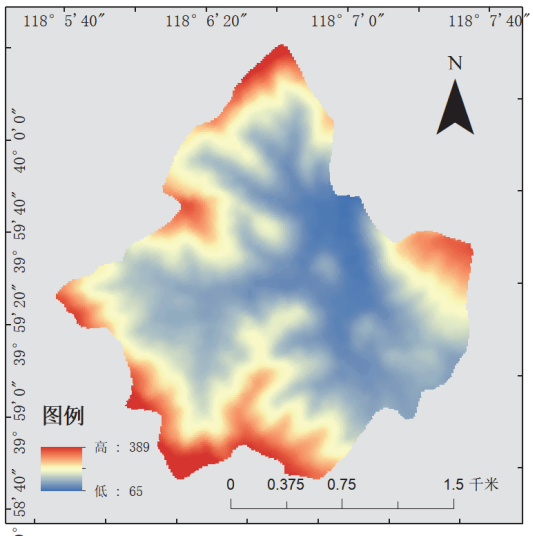

Figure 1. Zunhua Study Area

(2) Langyashan Watershed Study Area (“Langyashan Study Area”), Langyashan National Forest Park, Yixian County: Located in the eastern foothills of the Taihang Mountains (114°51'-115°37'E, 39°02'-39°35'N) in the western part of Yixian County, Baoding City, Hebei Province, North China, it is an important part of the Yanshan-Taihang Mountain water source conservation forest construction and soil erosion control. The study area belongs to the typical karstic low-middle hill landscape in Taihang Mountains, and the soil in the area is mainly dolomite

weathered thin limestone soil, with an average elevation of 300 m. It belongs to the temperate continental monsoon climate, with an average annual temperature of 13.0°C and a precipitation of 532 mm.

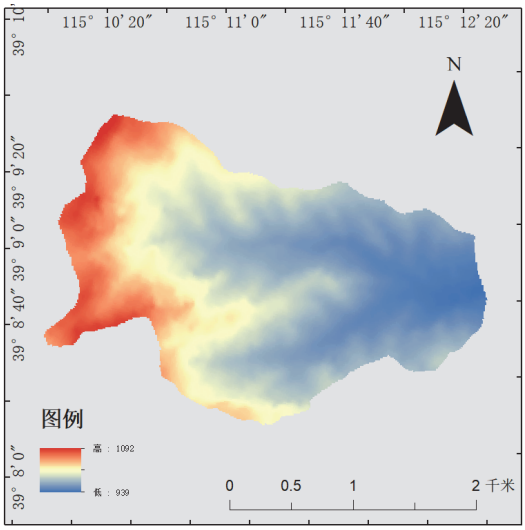

Figure 2. Langyashan Study Area

2.2 Sample Collection

The soil layer in the study area is shallow, with soil depths not exceeding 30 cm in most places, and the bottom of the soil layer is usually accompanied by soil-filled cracks (about 5-30 cm wide). Three 0-30 cm soil cores were obtained from each sample plot. Soil samples were collected at 10 cm intervals and mixed with three samples of the same depth. It was then divided into two parts: one part was placed in glass vials for elemental analysis of carbon, nitrogen, and potassium, and the other part was placed in an aluminum box and dried at 105°C for 24 hours to determine its soil moisture content.

2.3 Method

Accounting for the value of ecological products refers to the theory and methodology of accounting for the value of ecosystem service functions by scholars such as Ouyang Zhiyun (OUyang et al., 1999). It is expressed as the sum of the value of material services, the value of regulating services and the value of cultural services, and the value of ecological products is calculated in accordance with the "Ecosystem assessment Guidelines for gross ecosystem product accounting". Therefore, this paper constructs the ecological product value accounting index system, as shown in Table 1.

Table 1. Indicator system and methodology for accounting for the value of ecological product

Tier 1 indicators	Secondary indicators	Tertiary indicators
Material services	Agricultural products	Primary products from agro-ecosystems
	Forestry products	Forest products, forest products and primary products related to forest resources
	Livestock products	Products obtained by raising livestock, utilizing grazing, penning or a combination of the two
Regulatory services	Forest ecosystems	Soil conservation, water conservation, climate regulation, atmospheric purification, carbon sequestration, oxygen release, pest control
	Scrub ecosystems	Soil conservation, climate regulation, atmospheric purification, carbon sequestration, oxygen release, pest control
	Agro-ecosystems	Soil conservation, water conservation, climate regulation, atmospheric purification, carbon sequestration, oxygen release, pest control
	Grassland ecosystems	Soil conservation, water conservation, climate regulation, atmospheric purification, carbon sequestration, oxygen release

Cultural service	Leisure tourism	Intangible benefits obtained through tourism and recreation
	Landscape value	The function of ecosystems to provide human beings with aesthetic experiences and spiritual pleasures, thereby increasing the value of neighboring land and properties

2.3 Data Sources

Based on the ecological product value accounting method proposed in the previous paper, from the trial calculation of the ecological product value of the Zunhua study area in Hebei and the Langyashan study area. The basic data of this study were obtained from experimental data and relevant statistics, and the relevant statistics data were obtained from the Specification for Accounting of Gross Ecological Product (GEP), the Law of the People's Republic of China on Taxation for Environmental Protection (LEPT), Theory and Methods of Accounting for Gross Ecosystem Product (GEP), the Statistical Bulletin of the National Economy and Social Development of Yixian County and Zunhua City for the year of 2022, the Macroeconomic Data Base of Hebei Province, the People's Governments of the counties, and the Remote sensing data and information from literature (Cao,2011, Gao et al., 2015, Li,2015, Yang,2015, Ge,2017, Wang et al., 2017, Li,2019, Liu et al., 2023), market prices, etc. were adjusted through the China Agricultural Information Network (http://www.agri.cn/), the Huinong Network (https://www.cnhnb.com/hangqing/), and field research indices.

3. Results

3.1 Results and Analysis of Value Accounting

Table 2. Accounting results

Tier 1 indicators	Secondary indicators	Clarification	Zunhua Study Area(Million /RMB)	Langyashan Study Area(Million /RMB)
Material services	Agriculture, forestry and fisheries	Grain, vegetables, fruit, meat, milk, eggs	436.2	109
Regulatory services	Soil conservation	Reduction of surface pollution Maintaining soil fertility Reduce sedimentation	755.3	902.8
	Cimate regulation	Plant transpiration	5970.9	9028.4
	Water conservation	Water conservation	-23.6	-11.0
	Carbon sequestration	Sulfur dioxide purification Nitrogen Oxide purification Smoke (dust) purification	3.9	8
	Oxygen release	Oxygen release	57.6	128.4
	Atmospheric purification	Atmospheric purification	286.1	663.2
	Pest control	Pest control	139.6	212.4
Cultural service	Leisure tourism	Aesthetic landscapes of woodland, arable land and grassland	31.5	74.9
	Landscape value	The function of ecosystems to provide human beings with aesthetic experiences and spiritual pleasures, thereby increasing the value of neighboring land and properties	——	1140

The 2022 GEP for the Zunhua Study Area in Hebei Province is CNY 7657.5 million. In terms of GEP composition, the value of regulation services is the highest at CNY 7189.8 million, accounting for 93.89 % of the total GEP value; Cultural services have the lowest value at CNY 315,000, or 0.41 % of the total GEP; The value of material services was CNY 4,362,000, or 5.70 % of the total value of GEP. Of the regulating services, climate regulation and soil conservation contributed the most to GEP, with the combined value of the two service products amounting to CNY 67,262,000, or 93.55 % of the regulating services, and 87.84 % of the total value of GEP, while the remaining categories of regulating services accounted for a smaller share of the value. It indicates that the regulating services provided by ecosystems in the Zunhua study area contribute the most to human well-being and are the most important component of GEP, with material services contributing the second most and cultural goods the least.

In terms of GEP composition, the value of regulating services is the highest at CNY 109,366,000, accounting for 89 % of the total GEP value; The value of material goods was the lowest at CNY 893,000, accounting for 1 % of the total value of GEP; The value of cultural services was CNY 12,149,000, or 10 % of GEP. It indicates that the regulating services provided by the ecosystems in the Wolverhampton study area contribute the most to human well-being and are the most significant component of GEP, with cultural services contributing the second most and material goods the least. Among the regulating services, climate regulation and soil conservation contributed the most to GEP, with the combined value of the two service products amounting to CNY 99,312,000, accounting for 90.81 % of the regulating services and 81.13 % of the total value of GEP, while the rest of the categories of regulating services accounted for a smaller share of the value of regulating services; The value of cultural services is dominated by the value of recreational tourism, with the value of aesthetic landscapes accounting for a relatively small proportion.

Table 3. Zunhua Study Area

Land use type	Soil conservation	Cimate regulation	Water conservation	Carbon sequestration	Oxygen release	Atmospheric purification	Pest control
Forest of trees	253.5	1642.8	——	10.6	55.1	1.3	27.9
Low wood	202.4	202.9	——	4.6	23.8	0.1	6.4
Garden area	37.8	558.2	——	7.8	40.7	0.4	13.5
Grasslands	109.2	2966.2	——	0.5	2.5	1.8	——
Arid	152.4	600.7	——	34.2	163.9	0.3	——

Unit: CNY 10,000/year

Table. 4 Langyashan Study Area

Land use type	Soil conservation	Cimate regulation	Water conservation	Carbon sequestration	Oxygen release	Atmospheric purification	Pest control
Forest of trees	322.2	6489.9	——	48.3	251.6	6	127.2
Low wood	188.4	2210.8	——	57.2	298.4	1.8	80.4
Garden area	77.4	171.2	——	14.1	73.8	0.1	4.8
Grasslands	174.8	16.7	——	0.0031	0.02	0.01	——
Arid	140.1	139.8	——	8.8	39.3	0.08	——

Unit: CNY 10,000/year

The total GEP value of the Langyashan study area was calculated to be higher than that of the Zunhua study area, with the value of the Langyashan study area's regulating and cultural services being higher than that of the Zunhua study area, and the value of its material goods being lower than that of the Zunhua study area. Among the different land use types in the Langyashan study area, the total value of forest ecosystem services was the highest at CNY 72.452 million, accounting for 59.19 % of the total value, followed by shrub ecosystems and farmland ecosystems,

accounting for 23.18 % and 5.47 %, respectively; Among the different land use types in the Zunhua study area, the total value of grassland ecosystem services was the highest at CNY 30.802 million, accounting for 40.22 % of the total value, followed by forest systems and farmland ecosystems, accounting for 26.00 % and 21.02 %, respectively.

3.2 Issues Constraining the Realization of The Value of Ecological Products

3.2.1 Zunhua Study Area

- Weak basic support for the realization of the value of ecological product

Provide The industrial base of agro-ecological products is weak and there is a gap with the development of agricultural modernization. On the one hand, infrastructure development is not yet perfect, irrigation and other water facilities in agricultural parks need to be upgraded, irrigation capacity is limited, the ability to withstand natural disasters is not high, and the support for agricultural microclimate monitoring equipment is weak, so there is an urgent need to make up for the shortcomings. On the other hand, the scattered distribution of arable land, agricultural organization, the degree of intensification is low, the degree of standardization is not high, which restricts the Zunhua research area of agricultural mechanization, the development of agricultural industrialization and the popularization and application of new agricultural technologies, the cold chain logistics storage and transportation facilities and equipment are also insufficient, and the agricultural products logistics system has to be further improved.

- Inadequate trading platforms

Ecological product trading currently rely on market transactions to complete, the current trading mode is purely in the form of commodity trading as the main form of commodity price development on the one hand, with reference to the market feedback, on the other hand, with reference to the basic use value of ecological products, but the ecological value of the local ecological products of the ecological value of the premium is difficult to be reflected, the ecological value of ecological value involves the product certification, standardization, market regulation, the same kind of comparative advantage embodied in many aspects. The embodiment of ecological value involves product certification, standard determination, market supervision, comparative advantages of similar products and other conditions, so it is necessary to set up a specific trading platform to complete the value identification and assessment of ecological agricultural and livestock products, and finally realize the ecological value of the products.

- The contradiction between the demand for arable land and the trend of arable land degradation remains prominent

The Zunhua study area has carried out ecological restoration and management to achieve human-land balance and sustainable development, but due to the fragility and fragmentation of the karst ecosystem and the crude production methods of farmers, there are still some difficulties in realizing eco-agriculture and regional sustainable development.

3.2.2 Langyashan Study Area

- Uncertainty in the assessment of the value of landscape appreciation ecological products

Its natural landscape is part of the experience economy, characterized by public goods and externalities. Landscape appreciation tourism, in the process of tourists experiencing the value of the landscape, will simultaneously produce food, lodging, travel, tourism, shopping, entertainment and other ancillary economic value, subject to the preferences of tourists, age, gender and other multiple factors, the value of the existence of uncertainty.

- Ambiguity in the boundaries of public resource development

“Green water and green mountains” are both ecological resources and public resources. In the case of rural tourism B&Bs, for example, villagers, tourists, capital and others have the right to use them. In the development process, villagers are at a relative disadvantage and there is a clear imbalance in the distribution of value. In the process of using public resources for value allocation, the lack of integrated planning has led to disorderly development and utilization of public resources, the destruction of local ecological resources, and damage to the public interests of society.

- Weak scientific, technological and human resources support

The support of science, technology and human resources plays an important role in promoting the comprehensive development of the region. The Wolverhampton study area has superimposed karst and mountainous terrain, and the level of economic development differs greatly from that of regions in the same city and province, and is clearly at a disadvantage in the attraction and retention of talent, and in the application of science and technology and

innovation. And due to the higher altitude than other cities and provinces, fragile ecological environment, backward infrastructure construction and other conditions, it is difficult to attract the gathering of talents and scientific and technological investment.

- Government-led Dilemma

The social subject is an important participant in the realization of the value of ecological products, and it is an important link in the formation of government-led, market-oriented operation and the participation of all sectors of society in promoting the realization of the value of ecological products in ethnic areas. Through the research found that at present the social main body to participate in the process of regional ecological products management and development process still exists in the attraction is not enough, the benefit distribution mechanism is not sound, the legal and regulatory system is not perfect, the logistics system is lagging behind the construction of the dilemma.

4. Mechanisms And Paths for Realizing the Value of Ecological Products

4.1 Zunhua Study Area

- Accelerating the ecological restoration process and strengthening the basic support for the realization of the value of ecological products

The Zunhua study area focuses more on ecological restoration projects, such as slope-to-stair conversion and other projects, which play a great role in enhancing the stability and integrity of the ecosystem in the karst restoration area, and also provide a material basis for the realization of the value of the ecological products of karst restoration, and the realization of the value of the ecological products will transform the restored ecological resources into economic benefits, which will consolidate the foundation for the effectiveness of the restoration. However, due to transportation, facilities, public awareness and other reasons, the realization of the value of rural ecological products in the restoration area still faces multiple difficulties such as realizing and trading, and the ecological restoration process should be accelerated to strengthen the basic support for the realization of the value of ecological products.

- Market trading platform established

The Zunhua study area has a wide variety of ecological agricultural products with great development potential, and it is constantly carrying out cultivation measures to reduce soil erosion and effectively protect arable land, and has developed and formed characteristic fruits such as apples, walnuts, red fruits and peaches on a large scale. In the future, we should make full use of Internet technology to develop “Internet +” eco-products e-commerce system, certification system, traceability system, etc., to create an eco-industry system and intelligent consumption system, and to guide the development of eco-products production, eco-products circulation, eco-products trade and eco-products consumption (Gu et al., 2020).

- Playing a leading role in government

The value of ecological agricultural and livestock products cannot be realized without the leading role of the government. The government is the system provider, regulator and participant in the transformation of the value of ecological products. First, the government, as the regulator of the transformation of the value of ecological products, should guarantee the fairness in the process of market transactions of ecological material services by virtue of legal means and administrative measures; Secondly, the Government needs to give full play to the market's decisive role in resource allocation and provide a good institutional environment for the direct trading of ecological products; Thirdly, the Government should revise and improve administrative laws and regulations for specific ecological agricultural and livestock products, clarify the relevant trading rules, build a reasonable operating mechanism, and apply effective policy tools and other means to promote and safeguard the production, consumption and realization of the value of ecological material services (Chen,2023).

4.2 Langyashan Study Area

- Promoting ecological compensation for ecological reserves to raise the standard and expand the coverage

Actively strive for centralized transfer payments, increase ecological awards and compensation projects, strengthen counterpart support, and explore the establishment of a watershed ecological compensation mechanism. At the same time, build a standardized, effective, open and transparent government service platform, and actively absorb social and corporate capital into the field of ecological compensation (Macroeconomic Research Institute et al., 2015); In the process of implementing ecological compensation, such as transfer payments for ecological protection zones, consideration can be given to increasing the weight of the Wolf Tooth Mountain study area located in the Xiongan New Area, paying attention to both incremental and stock, and awarding compensation for indicators such as forest and grassland areas, so as to increase the amount of compensation for the study area in

the basic allocation.

Strengthening and upgrading the capacity of government public services such as medical care, education, culture, pension, social security, etc., and upgrading the level of basic public services, so that the public can invest in ecological protection and ecological industry without any worries; Improve and perfect the ecological care public welfare positions and other transfer employment system, so that part of the masses to transfer to professional forest patrol, ecological monitoring, facilities maintenance, community services and other positions, improve the post assessment management system and technical support, improve the fairness and effectiveness of post management, and improve the performance of ecological compensation funds; Accelerate the construction of a multi-dimensional compensation model in the upstream and downstream of the watershed with government compensation as the main focus and market compensation and NGO compensation as the supplement; in addition to financial compensation, the downstream region can also consider providing compensation for the Langyashan region in the form of talent training, counterpart support and other horizontal projects (Wang and Hou, 2013, Ji, 2018).

- Accelerating the promotion of specialty industries

In order to enrich the industrial form of the Langyashan study area, we should vigorously promote the development of characteristic industries, develop ecological industries, and broaden the channels for poor people to increase their income (Li, 2018) , especially need to focus on supporting eco-tourism and other industries. Under the premise of strictly controlling the scale and limited new supporting facilities, local residents' residences and ecological environment monitoring facilities are fully utilized to upgrade eco-tourism into high-end eco-experience (Xiang and Zeng, 2017); The unique cultural resources in the park are excavated in depth, and the idle labor force is organized in the form of cooperatives to develop characteristic economic forests, and new technologies and techniques are actively introduced to enrich and improve the processing of persimmons, sweet potatoes and other main products, forming an industrial chain integrating green and characteristics (Liu et al., 2019).

5. Discussion

Ecological restoration realizes win-win ecological-economic-social benefits of ecosystem services. Since ecological restoration is socio-economically driven, the main challenges facing ecological restoration today include restoring ecosystems while promoting multi-stakeholder sustainable development and realizing a win-win situation for ecological restoration, ecosystem services and socio-economic well-being. In the implementation of ecological restoration projects, in some critical ecological zones, additional key scientific issues should be considered, such as the selection of ecological restoration scenarios and adaptation studies in the context of climate change, the potential contribution of restoration projects to sustainable development goals, the baseline for effective assessment and comparison of cost-benefit assessment with various restoration contexts, and the sustainability of restoration measures. Dynamic cost-benefit assessment and accounting can effectively help the government to choose better restoration strategies and improve the ecological and economic benefits of future ecological restoration projects. Quantitative assessment of the social benefits of ecosystem services is an important element of cost-benefit analysis. For the current ecological restoration, it is necessary to strengthen the research on the interaction between social benefits, economic benefits and ecological benefits, to further carry out effectiveness assessment at the regional and even national scales using typical cases and demonstration projects, to standardize the relevant evaluation methodologies, to expand the linkage between ecosystem functions-services and well-being of the population, and to innovate the policy of ecological restoration and service assessment. (c) Policies for ecological restoration and service assessment. China needs to implement further ecological protection and restoration projects through the effective combination of policy, industry, technology and market, explore the path of realizing the value of ecological products, and implement a sustainable green transformation. Combining ecological restoration with regional economic and social development, ecological compensation and other socio-economic issues, and exploring mechanisms for realizing the value of high-quality ecological products.

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