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Mechanisms and Realization Pathways for Integration of Scientific Poverty Alleviation and Ecosystem Services Enhancement

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Abstract

On the basis of eliminating absolute poverty and resolving overall regional poverty, it is urgent to consolidate the achievement of poverty alleviation and promote the effective connection of comprehensive poverty alleviation and the strategy of rural vitalization after targeted poverty alleviation. Taking the ecological governance and scientific poverty alleviation in southwest karst region as an example, we firstly systematically reviewed the rocky desertification treatment and its effectiveness and benefits. Then we revealed the scientific poverty alleviation systems proposed by Chinese Academy of Sciences (CAS) with the combination and integration of ecological governance and poverty relief and regional development. These effective poverty alleviation methods include environmental migration, poor population relocation, ecological derivative industry cultivation, and ecosystem services enhancement. We also analyzed and discussed of the principal problems of current practices of ecological governance and poverty alleviation. To realize the integration of scientific poverty alleviation and ecosystem services enhancement, we suggest to explore available realization pathways, that is, we should pay more attention to coordinate the integrated regional governance and systematic restoration at regional scale, propose forest landscape restoration, develop sustainable ecological derivative industry, balance ecological restoration and local community development, and establish policies for the regionalization of important ecological function areas. The proposed realization pathways could promote the hematopoietic function of regional development and will also enhance the effectiveness and benefits of poverty alleviation and the implementation of the strategy of rural vitalization.

Keywords

scientific poverty alleviation; rocky desertification; ecosystem services enhancement; realization pathways; karst

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Abstract: On the basis of eliminating absolute poverty and resolving overall regional poverty, it is urgent to consolidate the achievement of poverty alleviation and promote the effective connection of comprehensive poverty alleviation and the strategy of rural vitalization after targeted poverty alleviation. Taking the ecological governance and scientific poverty alleviation in southwest karst region as an example, we firstly systematically reviewed the rocky desertification treatment and its effectiveness and benefits. Then we revealed the scientific poverty alleviation systems proposed by Chinese Academy of Sciences (CAS) with the combination and integration of ecological governance and poverty relief and regional development. These effective poverty alleviation methods include environmental migration, poor population relocation, ecological derivative industry cultivation, and ecosystem services enhancement. We also analyzed and discussed the principal problems of current practices of ecological governance and poverty alleviation. To realize the integration of scientific poverty alleviation and ecosystem services enhancement, we suggest exploring available realization pathways. That is, we should pay more attention to coordinating the integrated regional governance and systematic restoration at regional scale, proposing forest landscape restoration, developing sustainable ecological derivative industry, balancing ecological restoration and local community development, and establishing policies for the regionalization of important ecological function areas. The proposed realization pathways could promote the hematopoietic function of regional development and will also enhance the effectiveness and benefits of poverty alleviation and the implementation of the strategy of rural vitalization.
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As a national strategic scientific and technological force, the Chinese Academy of Sciences has thoroughly implemented the spirit of General Secretary Xi Jinping's important instructions on fight against poverty and rural revitalization, and has actively carried out the responsibility of the national strategic scientific and technological force. In May 2020, as one of the four designated national poverty-stricken counties of the Chinese Academy of Sciences, the Huanjiang Maonan Autonomous County of Guangxi Zhuang Autonomous Region (hereinafter referred to as "Huanjiang County") in the karst region of Southwest China has lifted itsself out of poverty. General Secretary Xi Jinping has given important instructions to the Maonan people to lift the whole ethnic group out of poverty: "I hope fellow villagers will take "poverty alleviation" as a new starting point for a better new life and continue your efforts to make the days more prosperous." Huanjiang County is an ecologically fragile area typical of karst rocky desertification. In recent years, through organically combining rocky desertification governance with poverty alleviation and regional development, the Chinese Academy of Sciences has formed a scientific poverty alleviation system of "environmental migration–poor population relocation–ecological derivative industry cultivation–ecosystem services enhancement" and explored a long-acting poverty alleviation mechanism for promotion of ecosystem services and development of characteristic industries, providing technical support and model samples for targeted poverty alleviation in ecologically fragile areas of karst in Southwest China [1–3].

On the basis of eliminating absolute poverty and resolving the overall regional poverty, it is urgent to consolidate the achievement of poverty alleviation and promote the effective connection of comprehensive poverty alleviation and the strategy of rural vitalization after targeted poverty alleviation. Compared with fight against poverty, it's a more urgent, broader, and long-term demand for sci-tech support for ecological civilization construction and rural revitalization. According to the Strategic Plan for Rural Revitalization

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(2018–2022), the overall requirement of rural revitalization is thriving industries, livable ecology, civilized custom, effective governance, and prosperous life, with industrial development as the primary task. Industrial prosperity is the focus of rural revitalization and the basis for increasing farmers' income, agricultural development, and rural prosperity. Therefore, after elimination of absolute poverty and settlement of regional poverty, the achievement of fight against poverty should be consolidated and effectively connected with the rural revitalization strategy. The primary industry should be the basis but not the limitation. Instead, on the basis of optimizing the primary industry, the secondary industry and the tertiary industry should be developed vigorously to promote the integration and development of the primary, secondary, and tertiary industries and form a sustainable industry.

Reports of the 19th National Congress of the Communist Party of China (CPC) and the Second, Third, and Fourth Plenary Sessions of the 19th CPC Central Committee explicitly proposed to speed up comprehensive treatment of soil erosion and land and rocky desertification, conservation of biodiversity, and construction of solid ecological security barrier. The Master Plan for Major Projects for the Protection and Restoration of Key Ecosystems in China (2021–2035) also specify the important objectives of national ecological protection and restoration in the next 15 years as follows: to adhere to the new development concept, coordinate the integrated protection and restoration of mountains, rivers, forests, fields, lakes, and grasses, improve the quality of natural ecosystems, and enhance the supply capacity of ecological products. The main contents of ecological products are: ecosystems provide material and service products for human beings without compromising the stability and integrity of the ecosystem, which include headwater conservation, soil and water conservation, pollutant degradation, carbon sequestration, climate regulation, and other regulatory services, as well as cultural services such as recreation, knowledge, education, and landscape aesthetics derived from ecosystem structure and process, with ecosystem services as the core.

Therefore, it is urgent to complete the organic combination of poverty eradication and ecosystem services for construction of the national ecological civilization, strategy of rural revitalization strategy, consolidation of the achievement of fight against poverty, and requirement of the Master Plan for Major Projects for the Protection and Restoration of Key Ecosystems in China (2021–2035). It has become a major scientific and technological demand for consolidating the achievements of poverty alleviation and implementing the strategy of rural revitalization to think about how to realize the integration of sustainable characteristic industry development and ecosystem service enhancement [4]. What's more, it's of great significance for further consolidating the achievement of fight against poverty in poverty alleviation areas and fully promoting the rural revitalization strategy to comb and summarize the practical experience of scientific ecological governance and poverty alleviation in karst region in southwest China, to analyze the main problems in current ecological governance and poverty alleviation, and to put forward the mechanism and realization approach of integrated scientific poverty alleviation and ecosystem service enhancement.

1 Ecological governance of karst region in southwest China

1.1 Rocky desertification treatment of karst

The global karst landform covers an area of 2.2×10^7 km^2, accounting for 15% of the earth's land area. The karst landform area in China accounts for 1/3 of the total national land area, which includes 5.4×10^5 km^2 of contiguous bare area concentrated in southwest China. The China karst owns typical development and complete geomorphologic types, involving 465 counties (cities, districts) in 8 provinces of Guizhou, Yunnan, Guangxi, Hunan, Hubei, Chongqing, Sichuan, and Guangdong [5]. High-intensity agricultural activities under huge population pressure have caused the southwest karst area the main ecologically fragile area of rocky desertification in China. Compared with drought, land and rocky desertification in semi-arid areas is a land degradation process occurring in humid and semi-humid areas, which is a special type of desertification. This rocky desertification area is also the largest contiguous poverty-stricken area in China, and its population accounts for about 40% of the national poor population. There were 211 concentrated contiguous counties with special difficulty and major counties with national poverty alleviation and development (at the end of 2017), with large poverty areas and deep poverty levels.

The Chinese government attaches great importance to the rocky desertification treatment: In 2008, the State Council officially approved the Outline of the Comprehensive Treatment Plan for Rocky Desertification in Karst Areas (2006–2015), and the rocky desertification treatment was officially launched as an independent ecological project. In 2016, the 13th Five-Year Construction Plan (2016–2020) for the Comprehensive Treatment Project of Rocky Desertification in Karst Areas was formally implemented. In June 2020, the Master Plan for Major Projects for the Protection and Restoration of Key Ecosystems in China (2021–2035) was issued and implemented, which further defined the tasks of comprehensive treatment of rocky desertification in the upper and middle reaches of the Yangtze River, Hunan, and Guangxi in the next 15 years, and planned to treat rocky desertification by an area of 3.94×10^4 km^2. Under the large-scale ecological restoration, the rocky desertification area in China has also decreased from 1.296×10^5 km^2 in 2005 to 1.007×10^5 km^2 in 2016 [6].

1.2 Achievement of rocky desertification treatment

The core of rocky desertification treatment is to adjust the contradiction between man and land. ① The high-intensity population pressure in karst areas has been eased through labor export (migrant workers), urbanization, fight against poverty, poor population relocation, and other social co-governance model. The process of social and human development has reduced the dependence on land and promoted the ecological restoration of rocky desertification areas [1]. ② As for in-situ rocky desertification treatment and development of characteristic ecological derivative industries, technologies such as efficient utilization of karst water resources, soil loss/leakage resistance control, optimal allocation of drought-resistant vegetation communities, and compound management of vegetation have been broken through, and ecological derivative industries have been cultivated such as alternative herbivorous animal husbandry, characteristic economic fruit forest, and understory Chinese herbal medicines. Besides, a coordinated development model of rocky desertification treatment and poverty alleviation by ecological industry has been proposed, thereby setting a model for global karst ecological management [3,7–11].

The general evolution trend of karst rocky desertification in China has changed from continuous increase before 2011 to continuous net reduction, with decreased degree of rocky desertification and improved construction, especially the obvious reduction of severe rocky desertification [6]. Compared with that in the neighboring countries in Southeast Asia, the ecological restoration in karst areas in southwest China is remarkable. Rocky desertification treatment and ecological restoration in karst areas have made significant contributions to the improvement of China's carbon sequestration capacity. Carbon sequestration from vegetation aboveground biomass in 2002–2017 offset 33% of CO_2 emissions from human activities in the region in the previous six years. Specifically, the contribution rate of natural restoration and artificial afforestation to carbon absorption in the whole region reached 14% and 18%, respectively, effectively mitigating the impact of global climate change [12,13]. On the global scale, the karst region in southwest China is one of the hot spots with significant increase in global vegetation coverage from 1999 to 2017. And 55% of the vegetation biomass in southwest China (8 provinces) is still significantly increased, of which about 3.0×10^5 km^2 is mainly distributed in karst region, accounting for 64% of the total karst area in southwest China and 5% of the region with significant increase in global vegetation biomass [14].

In the process of rocky desertification treatment, the poverty-stricken counties in Yunnan, Guangxi, and Guizhou have achieved remarkable results in poverty alleviation in the concentrated distribution areas of rocky desertification. The number of reduced impoverished counties ranks first among the 14 contiguous poverty-stricken areas in China, and the number of poor people decreases from 28.98 million in 2010 to 4.76 million by the end of 2018. This has greatly promoted China to continuously lead the global poverty reduction. "Any poor area or poor people cannot be left behind," and China will eliminate absolute poverty by 2020, making an important contribution to promoting the realization of the primary goal of the UN Sustainable Development Goals (SDG1)—"poverty elimination" [1].

2 Practice and mechanism exploration of integration of poverty alleviation and regional development and ecological governance

The Chinese Academy of Sciences is a national forerunner and main force in scientific poverty alleviation. Since 1994, when the Institute of Subtropical Agriculture, the Chinese Academy of Sciences undertook the designated task of helping the national poverty-stricken country—Huanjiang County, a county-level scientific poverty alleviation system has been established to enhance the "hematopoietic function" of regional sustainable development with the support of the scientific and technological forces of the whole academy, and the Maonan ethnic group has lifted out of poverty in 2020. Besides, the institute has provided technical support and model samples for targeted poverty alleviation in ecologically fragile areas in southwest China.

2.1 Launch demonstration of poverty alleviation by environmental migration and poor population relocation in karst mountainous areas, with rocky desertification treatment as the core

For problems such as ecologically fragile environment, serious rocky desertification, and extremely prominent contradiction between man and land in concentrated contiguous poverty-stricken areas in karst, ecological governance and poverty alleviation and regional development have been organically combined, and ecological migration has been implemented in areas with serious rocky desertification on the basis of the research on the environmental capacity of rocky desertification areas and their limiting factors. On the premise of reduced population density, the emigration areas have implemented the cultivation of alternative herbivorous animal husbandry combining planting and raising and ecological restoration. The immigration areas (resettlement areas) have adopted the supporting advantages of water and soil resources to improve soil and fertility and develop karst characteristic economic fruit forest industry. From 1994 to 2016, the vegetation coverage rate in the emigration areas has increased by 40%, soil erosion decreased by 30%, rainwater utilization rate increased by 30%, and annual per capita net income increased from CNY 290 to CNY 8,200. The vegetation coverage rate in resettlement areas has increased by 20%, rainwater utilization rate rose by 40%, and annual per

capita net income increased from CNY 350 to CNY 18,000. Thus, the ecological environment in emigration areas has been restored and the income of immigrants in relocation settlement areas has been increased, and a scientific poverty alleviation system of environmental migration-poverty alleviation has been formed in karst mountain areas, providing practical experience and scientific basis for relocation migration in national targeted poverty alleviation [2,4].

2.2 Develop characteristic ecological derivative industry and improve ecosystem services and people's livelihood on the basis of "turning green" of rocky desertification

Under the large-scale ecological protection and restoration, net reduction in area and improvement in degree have been achieved in the comprehensive treatment of rocky desertification. Adhered to the new concepts of "poverty alleviation green ecological development" and "poverty alleviation by characteristic industries," and based on clarifying the process mechanism of regional ecological restoration, technologies such as close-to-nature transformation of degraded vegetation, compound utilization of artificial vegetation, and ecological derivative industry cultivation have been developed, and scientific poverty alleviation systems such as economic fruit forest, planting and processing of traditional Chinese herbal medicine, and planting grass for cattle have been cultivated. These have helped farmers increase annual per capita income by more than CNY 1,600, and finally a long-term poverty alleviation mechanism of "ecological management–scientific poverty alleviation–ecological derivative industry cultivation" has been formed (Fig. 1) [2]. On the basis of large-scale artificial afforestation, the development models of industries such as alternative herbivorous animal husbandry, traditional Chinese herbal medicine, and characteristic fruits have been put forward, a scientific poverty alleviation system with vegetation compound management and cultivation of characteristic ecological derivative industry has been formed, and the first agricultural sci-tech and characteristic demonstration district in Guangxi were established. By the end of 2019, 65,900 poor people in Huanjiang County had lifted out of poverty, with the poverty incidence dropped to 1.48%. On May 20, 2020, General Secretary Xi Jinping gave important instructions to the Maonan people on the poverty elimination of the whole ethnic group, and fully affirmed the achievement of Huanjiang County in fighting against poverty.

The cultivation of ecological derivative industry has reduced the over-exploitation and utilization of fragile ecosystems by human beings, and also significantly improved the overall condition of regional ecological environment and ecosystem structure and service functions. The rocky desertification areas in Huanjiang County had decreased by 38.5% from 2005 to 2016, especially the obviously decreased rocky desertification area above severe level. Besides, the Net Primary Productivity (NPP) of plants in the county showed a significant increase trend, with an increase rate of 0.87

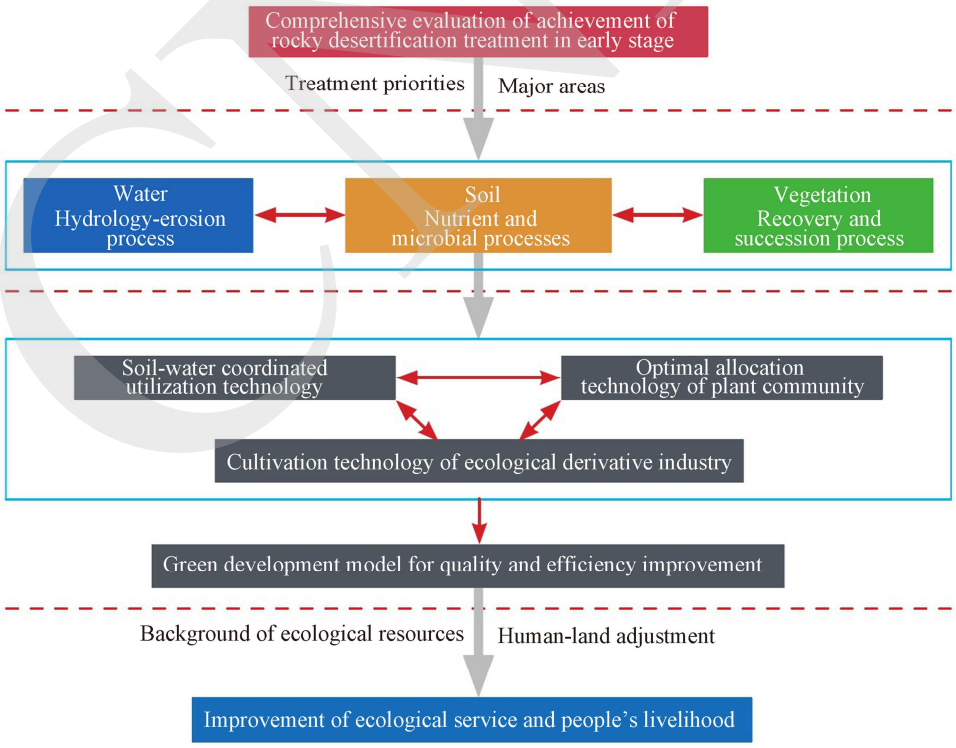

Fig. 1 Comprehensive treatment of rocky desertification oriented to improvement of ecosystem service and people's livelihood

$gC \cdot m^{-2} \cdot a^{-1}$ ($p < 0.05$), and the area where NPP changed significantly was 1,193.63 km^2, accounting for 27.58% of the total area of the county. On the whole, the county continued to perform the carbon sink function, with a total carbon fixation of 21.45 TgC in the past 35 years. The soil erosion modulus decreased from 76.36 $t \cdot km^{-2} \cdot a^{-1}$ in 1990 to 49.60 $t \cdot km^{-2} \cdot a^{-1}$ in 2010, and the total soil erosion decreased from 3.476×10^5 t to 2.258×10^5 t. At the same time, the survey found that 72% of the farmers believed that the forest cover has increased significantly, and they also thought that the increased forest land had a positive effect on their lives and significantly improved the ecological environment. And 65% of the surveyed farmers deem that this is closely related to the rocky desertification treatment, artificial afforestation, closing hillsides to facilitate afforestation, etc. by the government, suggesting that farmers also perceive the positive effect of the government's comprehensive rocky desertification treatment on the ecological environment improvement.

2.3 Promote scientific and technological innovation by targeted poverty alleviation and form an advantageous team and platform for global karst ecological research

With the strong support of the Chinese Academy of Sciences, the Ministry of Science and Technology of the People's Republic of China, and the Guangxi Zhuang Autonomous Region Science and Technology Department, the Institute of Subtropical Agriculture, Chinese Academy of Sciences is responsible for the sustainable development of social economy in Guangxi under the major demand of the national rocky desertification treatment and fight against poverty. In view of the problems such as low regional matching of rocky desertification treatment technology and model, lagging restoration of ecosystem services, and poor sustainability of ecological industries, the institute has established the national field scientific observation and research station of Guangxi Huanjiang karst farmland ecosystem/Huanjiang karst ecosystem observation and research station of Chinese Academy of Sciences (hereinafter referred to as "Huanjiang Station") through carrying out the research on development and demonstration of major technologies of "regional ecological pattern–soil and water process–service function improvement-adaptive regulation." Futhermore, the institute has constructed a major scientific and technological infrastructure platform in key karst zones and innovated the sustainable development model integrating rocky desertification treatment and ecological derivative industry, forming a long-term mechanism for scientific poverty alleviation and providing significant sci-tech support for the successful selection of Huanjiang karst into World Natural Heritage sites [1]. In the last ten years, the karst research team of the Institute of Subtropical Agriculture, Chinese Academy of Sciences has published 20% of the world's international papers on karst ecology. In the last five years, Huanjiang Station has been "excellent" in the annual assessment and the five-year overall assessment of 53 national field ecological stations of the Ministry of Science and Technology of the People's Republic of China. The research results have been successively published in international high-level academic journals such as *Nature Sustainability* and *Nature Communications*, and have been highly praised and affirmed by *Nature*, enabling the research team to become an advantageous team in the field of international karst ecological research [12–15].

3 Main problems in current ecological governance and poverty alleviation

(1) Poverty-stricken areas and ecologically fragile areas are highly overlapping, and there remains prominent contradiction between regional "turning green" and "growing rich." A good ecological environment is the coincidence point for poverty relief and rural revitalization in space, but poverty-stricken areas are often also ecologically fragile, with severe natural conditions and seriously degraded ecosystem under the high-intensity development and utilization. China continuously strengthens ecological protection and restoration, and large-scale afforestation and natural restoration have significantly increased regional vegetation coverage, with ecologically fragile areas markedly "turning green." Especially from 2000 to 2017, China saw a 25% of the global increase in vegetation growth, and karst region in southwest China has become one of the regions with the fastest vegetation restoration in the world [15,16]. However, in poverty alleviation and regional development, large-scale planting and constructing of contiguous economic fruit forest, fast-growing timber forests, and other artificial forests have resulted in problems such as single ecological service function without sustainability to varying degrees. In the development of characteristic industries, there also emerge problems such as local land degradation and insufficient long-term effect and sustainably of poverty alleviation and regional development in some areas.

(2) Too much attention is paid to the economic indicators of poverty alleviation in the process of fight against poverty, without inadequate attention to the actual needs of new types of poverty groups. Poverty alleviation is often limited to short-term goals and direct effects, and mainly focuses on the explicit and rigid economic poverty reduction such as income and lifting impoverished people, villages, and counties out of poverty. However, there is a lack of attention to new types of poverty groups, such as left-behind farmers, landless farmers, and migrant workers in cities [17]. For left-behind farmers, they are facing the overall backward village infrastructure and public services, as well as incomplete functions of individual family structures. For landless farmers, in addition to the cause of land compensation, there is also unsustainable livelihood due to the adjustment of income structure and changes in living expenditures, as well as deficiencies in

social security systems such as unemployment, medical care, and old-age care. However, because of urbanization, migrant workers who left their homes and lands not only have unstable income and few opportunities for development, but also are short of social insurance, which makes them easy to return to poverty again due to external risks.

(3) There is great pressure to consolidate the achievement of poverty alleviation, and there is a lack of enthusiasm of social forces to participate in the fight against poverty. The current work of poverty relief is mainly dominated by government. As a political task, targeted poverty alleviation in some poor counties is conducted in debt, with a risk of government debt, and there is a huge pressure to repay the principal and interest after lifting themselves out of poverty [17]. In addition, poverty-stricken areas are still lag behind in development after eliminating poverty, having weak basis for sustained and stable income increase and low ability of self-development. Furthermore, with insufficient incentive mechanism, enterprises, institutions, social organizations, and other social forces are not fully involved in poverty alleviation. They often regard poverty eradication as an indicator task by the government, and even some enterprises and units obtain political capital and material benefits by poverty alleviation, resulting in poor social poverty alleviation results. Moreover, there has not formed a long-term mechanism for social forces to participate in poverty alleviation, with many acting in formality, and the participation of enterprises in assistance is not constant.

(4) There has not formed an effective connection between fight against poverty and rural revitalization strategy, as well as a long-term and stable mechanism for scientific poverty alleviation. On the basis of absolute poverty, it is also necessary to effectively link up poverty reduction with rural revitalization strategy, in order to rise people out of poverty and move them towards prosperity. Scientific and technological innovation is an important support for fight against poverty and rural revitalization. Therefore, the Chinese Academy of Sciences has implemented such development models as "poor population relocation," "poverty alleviation through shareholding system," "poverty alleviation by technology import," and "poverty alleviation relying on long-term field observation stations." It opened up a new way for scientific poverty alleviation to promote the development of county economy, realizing the coordination between science and technology and poverty alleviation [4]. At present, there is no special coordination organization and mechanism for scientific poverty alleviation nationwide, and thus the management is chaotic and the science and technology promotion system is weak. Besides, anti-poverty projects through science and technology are often dominated by government, and the multi-subject investment system for scientific poverty relief has yet been taken shape. Furthermore, the marketization degree of anti-poverty projects through science and technology is low, and thus there lack reasonable methods for project selection and evaluation. Also, there is a shortage of effective incentive mechanism for scientific anti-poverty personnel who have been sticking to the frontline for a long time. Therefore, it is urgent to establish a long-term and stable anti-poverty mechanism through science and technology in order to achieve long-term and sustainable poverty alleviation and regional development.

4 Approaches to integration and promotion of scientific poverty alleviation and ecosystem services

The Chinese government has implemented the grandest major ecological protection and restoration projects in human history, and currently remarkable achievements have been made in stages. In 2018, *Nature* published a long commentary "Satellite images show China going green," highly affirming China's achievements in ecological restoration [15,18–20]. China accounts for only 6.6% of the global vegetation area. But in the past 20 years, China accounted for 25% of the net increase in global vegetation leaf area, with afforestation contributing 42% to the increase in vegetation [16].

Under the national strategy of ecological civilization construction and rural revitalization, and to consolidate the achievement of poverty reduction and meet the major demand of the Master Plan for Major Projects for the Protection and Restoration of Key Ecosystems in China (2021–2035), it is urgent for ecological protection and restoration in China to shift from mainly pursuing "greening" of vegetation coverage to improving the quality of ecosystem services and regional development. In addition, it aims to enter a new stage where ecosystem service functions were improved and characteristic industries had integrated development, to promote the overall improvement of the ecosystem quality and comprehensive enhancement of the supply capacity of ecological products. Therefore, in the future, ecological protection and restoration should focus on realizing the promotion and integration of scientific poverty alleviation and ecosystem services, revealing the human-land coordination mechanism of sustainable ecological restoration in regions, and proposing a key scheme for ecological space control (Fig. 2) that organically combines ecological restoration, conservation through closure, and moderate development, providing significant sci-tech support for implementing major project of national ecological protection and restoration in 2035 and realizing the UN Sustainable Development Goals in 2030.

(1) The integral treatment and systematic restoration of poverty-stricken areas should be coordinated. With sticking to prioritizing ecology, the conviction that "lucid waters and lush mountains are invaluable assets" should be firmly established to promote green development, and restoration of ecosystem element and single ecosystem should be converted to integral treatment and high-quality development in poor

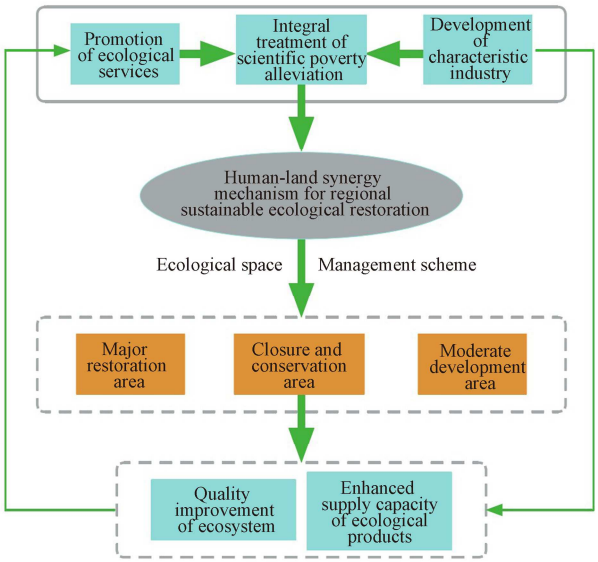

Fig. 2 Approaches to promotion of ecosystem service and integration of characteristic industry development

areas. Based on the integrity of ecosystem, continuity of physical geographical units, connectivity of species habitats, and sustainability of social and economic development, the protection and restoration of ecosystem above and below mountains and ground as well as in the upper, middle, and lower reaches of the river basin should be systematically arranged; respective afforestation, water conservancy, and field protection, as well as compartmentalization and fragmentation in ecological protection and restoration should be changed to improve the efficiency of ecological restoration and thoroughly enhance the ecosystem quality and stability and supply capacity of high-quality ecological products.

(2) The restoration of vegetation landscape in poverty-stricken areas should be promoted. On the basis of initial "turning green" in the area and the increase in vegetation cover, and in accordance with the principle of matching tree species with the site (the site conditions and tree species characteristics adapt to each other), it is appropriate for arbor to be arbor, shrub to be shrub, and grass to be grass, to accelerate the restoration of vegetation landscape and restore the integrity of forest ecosystem in felled or degraded forest landscape. This is a process of increasing human well-being. Vegetation landscape restoration aims not only at increasing artificial afforestation and forest cover, but at restoring the quality, structure, and function of vegetation, and enhancing the material products, service function, and ecological process of vegetation in large landscape space. The integrity of the ecosystem should be restored, including the closure and management of natural forests, structural adjustment and directional breed of natural secondary forests, habitat restoration of seriously degraded natural forests, close-to-nature transformation and industry cultivation of artificial forests, and reconstruction of shoreline vegetation zones; in addition, the versatility of forest landscape should be restored and enhanced.

(3) Sustainable ecological derivative industry should be developed. On the basis of eliminating extreme poverty, the achievement of poverty alleviation should be consolidated, preventing poverty-returning and new poverty generation. The effective connection between overall poverty alleviation and rural revitalization, as well as the smooth transformation of poverty reduction strategy and work system should be promoted continuously, with the above work integrated into the rural revitalization strategy. According to the Strategic Plan for Rural Revitalization (2018–2022), the focus and foundation of rural revitalization are to develop industries and explore the advantages of ecological resources in ecologically fragile areas. The secondary industry and the tertiary industry should be developed on the basis of optimizing the characteristic primary industry, to promote the integrated development of the primary, secondary, and tertiary industries, and realize sustainable improvement of farmers' livelihood. Besides, the advantages of ecological resources should be transformed into those for social and economic development, and the industrial development mode and transformation mechanism of "lucid waters and lush mountains into invaluable assets" should be proposed, to enhance the service capacity of the overall regional ecosystem.

(4) The synergy between ecological treatment and green development of community should be enhanced. The existing researches on ecological protection and restoration mainly focus on the changes in structure and function of natural ecosystem, and ignoring the contradiction between ecological treatment and green development of community. The rapid development of social economy and urbanization has led to the migration and flow of rural population to cities and towns (such as urbanization and migrant workers), resulting in a significant decrease in the permanent resident population in rural areas. On the one hand, this has eased the high-intensity population pressure in ecologically fragile areas and promoted the restoration of regional ecology. On the other hand, it has also caused hollow rural communities and old and weak rural labor force, making the contradiction between ecological treatment and green development of community more prominent. Thus, it is urgent that relevant research and work should shift from focusing on natural ecosystem to coupling and feedback of natural-social economic system. That kind of research should expound the evolution and coordination mechanism of man-land system and find the coordinated promotion pathway of human-land system under the changing environment; in addition, the regional sustainable development level under different development pathways and scenarios should also be defined, and the optimal regulatory scheme for regional human-land system should be put forward.

(5) Policies for the regionalization of important ecological spaces in poverty-stricken areas should be established. With the focus on the red line of ecological protection and nature

reserves, and according to the natural regional differentiation, social and economic development level, and functional orientation of development in poverty-stricken areas, optimal zoning of ecological space in poor areas should be carried out to achieve differentiated and precise management of important ecological space. Besides, long-term mechanism for ecological compensation and multi-channel funding mechanism for ecological construction should be established, with investment patterns of government-leading and social participation actively promoted. Regions should be encouraged to coordinate multi-field funds at multiple levels and attract social capital to actively participate in the construction and management of major ecological protection and restoration projects, and explore effective models for market-oriented construction, operation, and management of major projects. In addition, supervision and performance assessment system of different types of ecological environment space should be constructed, and systems such as property right management of natural resources, utilization control, and spatial planning should be improved, to reduce the institutional obstacles of the protection and utilization of ecological space.

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