

Strategic Tasks of Land Resource Development in Mountainous Areas of China

Mingling YAO¹, Yimei HE^{2*}, Shiqin YANG³, Fuluan YANG¹

1. School of Public Finance and Management, Yunnan University of Finance and Economics, Kunming 650221, China; 2. School of Tourism and Hospitality Management, Yunnan University of Finance and Economics, Kunming 650221, China; 3. Institute of Land Resources and Sustainable Development, Yunnan University of Finance and Economics, Kunming 650221, China

Abstract This paper first analyzes the fundamental characteristics and the advantages and disadvantages in the development and utilization of land resources in China's mountainous areas. It then explores the five major strategic tasks facing the sustainable development and utilization of mountainous land resources in China. From the perspective of human-land coordination and sustainable development, the paper proposes countermeasures and recommendations for the sustainable development and utilization of land resources in China's mountainous areas.

Key words Mountainous areas, Development of land resources, Strategic tasks, Sustainable utilization of land

0 Introduction

Land is the source of food and clothing, and the foundation of a nation. Land resources have always been the fundamental resource upon which human beings rely for survival and development. Against the backdrop of China's social and economic development, population expansion, and intensifying contradictions between land supply and demand, land resources have increasingly become the core of contradictions among China's population, resources, environment, and social and economic development. China is a typical mountainous country, with nearly two-thirds of its terrestrial area consisting of mountainous areas and a relatively small proportion of plain areas. Mountainous areas are distributed across all 31 provincial-level regions except Shanghai, among which 25 provincial-level regions have mountainous areas exceeding half of their territorial area^[1]. As the world's most populous country facing increasingly scarce land resources, China's national social and economic development must pay greater attention to the sustainable development and utilization of land resources in its vast mountainous areas.

China's mountainous areas serve as vital support for the Chinese nation's survival and development, forming the environmental and ecological foundation for the country's social and economic development. These regions are simultaneously resource-rich areas, ecologically vulnerable zones, and economically underdeveloped areas, holding extremely important strategic positions in sustainable development. The development and utilization of land resources in China's mountainous areas bear major strategic responsibilities including resource reserves, ecological barriers, economic growth, ethnic unity, and social harmony, endowing them

with significant resource, economic, and ecological strategic importance^[2]. However, the inherent ecological fragility of mountainous environments combined with long-term extensive development and utilization has resulted in low utilization efficiency and poor comprehensive benefits in most Chinese mountainous land resource development. In some regions, this has even led to ecological environment degradation and frequent natural disasters, posing serious threats to sustainable social and economic development at both regional and national levels^[3–5]. Therefore, analyzing the fundamental characteristics and advantages and disadvantages of mountainous land resource development, further clarifying the major strategic tasks in China's mountainous land resource utilization, and proposing countermeasures for sustainable development and utilization of these resources hold significant importance for promoting sustainable use of mountainous land resources, resolving development dilemmas in mountainous areas, and advancing China's sustainable economic development.

1 Basic characteristics of land resources and social and economic conditions in mountainous areas

1.1 Basic characteristics land resources in mountainous areas

1.1.1 Three-dimensionality and diversity of land types. Three-dimensionality is an inherent characteristic of mountain land resources and the primary distinction between mountain resources and flatland resources. Mountainous areas are three-dimensional spatial regions with specific absolute altitude and relative height, length, and width. Their climate, hydrology, soil, and natural resources all exhibit the vertical distribution characteristics. The higher the mountain altitude and greater the relative height, the more pronounced the vertical distribution characteristics of natural resources become. The three-dimensionality of mountain resources is manifested not only in the vertical distribution of surface natural resources but also in the three-dimensional distribution of underground resources from the surface downward, with the multi-spatial distribution of various underground mineral resources being

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Mingling YAO, master's degree candidate, research fields: land resources and land use, urban and rural development and rural revitalization.

* Corresponding author. Yimei HE, associate researcher, research fields: land use and urban-rural development, rural revitalization.

a typical example. Furthermore, under the combined influence of interactions between land components such as climate, soil, slope gradient, hydrology, vegetation, and regional differentiation patterns, mountain land types exhibit distinct vertical differences and prominent horizontal differentiation^[6-7]. The land use types are rich and diverse, demonstrating clear zonal differentiation characteristics, which form the natural foundation for implementing differentiated land utilization approaches.

1.1.2 The diversity of land ecological functions and the externalities of land utilization. The complex ecosystem structure endows the extensive mountainous areas in China with diversified ecosystem service functions, where mountainous areas exhibit strong ecological conservation functions and land development and utilization demonstrate highly significant external characteristics. Benefiting from their unique natural geographical environmental conditions, mountainous areas foster extremely abundant biological resources, playing crucial roles in biodiversity conservation, hydrological regulation, soil and water conservation, and enhancement of carbon sequestration capacity. The superior ecological environment in mountainous areas serves as an important safeguard for the ecological security and sustainable development of plain regions and even the entire nation. Dominated by mountainous topography with higher elevations, these areas belong to high gravitational potential energy zones. Influenced by gravitational potential energy gradient differences and intense surface material transport forces, mountain land resource development exhibits significant externalities. The extensive mountainous areas in China, particularly western mountainous areas, constitute the headwaters or upper reaches of numerous rivers, serving as critical sources of water, sediment, and pollutants for the central-eastern plains of China. The quality of their ecological environment not only directly affects regional social and economic development but also determines the ecological security of China's eastern plains and the whole country^[8].

1.1.3 The vulnerability of land ecological environment and the high incidence of mountain disasters. Mountain ecosystems exhibit "innate" vulnerability, while their inherent mountainous characteristics tend to make material and energy transfer predominantly export-oriented, exacerbating the susceptibility of mountain ecosystems and the difficulty in enhancing biological productivity. This also results in weak feedback mechanisms and lagging ecological restoration capabilities in mountain ecosystems^[9-10]. China is a country prone to frequent mountain disasters, with 71.4% of its county-level administrative regions facing extremely severe mountain disaster issues^[11]. Mountain disasters are characterized by regional specificity, chain-network effects, sudden onset, and severe destructiveness. They not only threaten the safety of human lives and property in mountainous areas but also lead to deterioration of living environments, impede sustainable development in these regions, and even jeopardize ecological security in plain areas and the entire nation. Mountain disasters are natural phenomena resulting from the comprehensive interaction of various natural

factors within specific mountainous environments, belonging to the category of natural calamities that have existed since ancient times. However, irrational human activities often act as driving factors exacerbating mountain disasters. Under the dual pressures of intensifying climate change impacts and continuously increasing human activity intensity, the vulnerability of China's mountain ecosystems will become more pronounced, hindering sustainable development of mountain land resources and constraining the modernization process of agricultural production.

1.1.4 The diversity and abundance of mountain resources and the difficulty of sustainable development and utilization. Mountain land resources constitute a comprehensive and three-dimensional concept, encompassing not only the land and soil itself but also its underground strata, surface features, and associated spatial dimensions. Due to their unique natural geographical environment, mountainous areas have become concentrated zones for numerous resources and energy reserves in China. China's mountainous areas boast abundant flora and fauna resources, serving as the nation's species gene pool. In addition, they possess rich land and vegetation resources, prominent advantages in hydropower and mineral resources, and distinctive climatic and tourism characteristics. Mountain resources demonstrate diversified categories, unique attributes, distinct ecological value, and significant economic potential. However, mountainous areas are often accompanied by complex geographical environments. Due to steep slopes, thin soil layers, limited operational space, relatively isolated transportation systems, and obstructed material circulation, their development and utilization have far more challenges than in plain regions, making large-scale land utilization difficult to achieve. Furthermore, owing to inherent ecological fragility and long-term irrational human exploitation, severe soil erosion has emerged in some mountainous areas, with frequent natural disasters such as landslides and debris flows, sharp declines in biodiversity, and gradual ecological deterioration. These factors collectively intensify the difficulties in sustainable development and utilization of mountain land resources, hindering further realization of mountainous land potential and impeding the sustainable development of mountain economies and societies.

1.2 Social and economic development situation Mountainous areas occupy the majority of China's territory, supporting nearly 40% of the national population and over 60% of ethnic minority populations^[12]. They serve as core zones of ecological security barriers, key areas for national strategic resource reserves, crucial regions for border stability and ethnic unity, yet simultaneously remain underdeveloped in national economic and social development. Most mountainous areas in China, constrained by natural conditions, historical foundations, and early policy orientations, are confronted with problems including relatively low economic development levels, comparatively weak infrastructure, and insufficient public service provision. Although China has eradicated absolute poverty, relative poverty will persist long-term, with the distribution of relatively impoverished areas essentially overlapping

with national mountainous areas^[13–14]. The development of China's mountainous areas remains relatively backward, showing significant disparities compared to plain regions and coastal developed areas. Internal development within China's mountainous areas also exhibits pronounced regional imbalances similar to national development patterns^[15], where urban-rural development disparities have caused severe rural population outflow and "hollowing-out" problems. Furthermore, current industrial structures in most mountainous areas still depend primarily on traditional agriculture and resource rough processing, requiring strengthened development of non-agricultural industries while confronting prominent contradictions between ecological protection and resource utilization. Although comprehensive victory has been achieved in the targeted poverty alleviation campaign, most remote mountainous areas currently face constraints including insufficient endogenous momentum for rural revitalization, poor policy coordination, and imperfect ecological compensation mechanisms, which continue to restrict further enhancement of sustainable development levels in mountainous areas.

2 Important strategic tasks of land resources development in mountainous areas

2.1 Promoting regional economic prosperity and meeting the needs of people's lives and social development

Land resources constitute the foundation for the development of various national economic sectors and industries. Land resource development represents an economic activity conducted to meet the production and living needs of the populace, with its ultimate objective being the attainment of optimal comprehensive benefits through rational and efficient utilization of limited land resources within their carrying capacity, thereby satisfying the requirements of people's livelihoods and the sustainable healthy development of the economy and society. The fundamental purpose of developing and utilizing mountainous land resources lies in providing basic guarantees for industrial production, vigorously developing regional economies, enhancing overall regional economic development levels, and obtaining optimal economic benefits. Secondly, the ultimate goal of land resource development and utilization is to serve humanity, fulfilling diversified survival needs and social development demands^[7–9]. The development and utilization of mountainous land resources must not only produce abundant products to satisfy the diverse needs of the population but also, through rational layout of infrastructure, efficient provision of public goods, and effective maintenance of ecological environments, maximize the fulfillment of material, cultural, and living environment requirements for both urban and rural residents, thereby achieving optimal social and ecological benefits.

2.2 Protecting key ecological areas and building a national ecological security barrier

The majority of China's mountainous areas are located at river sources or upper reaches of rivers, constituting source regions of the national ecological security barrier. Their special geographical positions, combined with complex and

diverse climatic and geomorphological conditions, have nurtured exceptionally abundant biological resources. These areas serve as China's natural gene bank and form an extremely crucial ecological security barrier, holding pivotal ecological strategic significance^[1,3,8]. The development and utilization of mountainous land resources not only affect the social and economic development of mountainous areas but also influence the ecological security and social and economic development safety of plain areas and even the entire nation. Therefore, the rational and efficient development of China's mountainous land resources and the protection of ecological environments in river sources or upper reaches represent an inescapable responsibility and obligation for vast mountainous areas. The Party and the state have attached great importance to ecological environmental protection and ecological civilization construction in mountainous areas. The development of mountainous land resources shoulders significant ecological strategic missions, which must implement eco-friendly land resource utilization methods tailored to local conditions, pursuing a "win-win" path of protection and development^[15].

2.3 Strictly safeguarding the red line of protecting 1.8 billion mu (120 million ha) of farmland to safeguard national food security

Grain is a critical strategic material vital to the national economy and people's livelihood, while land resources serve as the foundational underpinning for ensuring food security. As a populous country with limited arable land reserves, resolving the food supply issue for over 1.4 billion people remains the paramount task of national governance. China's per capita arable land area is merely approximately 933 m², combined with generally suboptimal land quality and an increasingly severe trend of arable land reduction, making the mission to safeguard food security remain arduous and long-term^[16–18]. As the predominant part of China's territory, mountainous areas must collaborate with plain regions to jointly shoulder the responsibility of ensuring national food security. Most mountainous areas in China possess limited cultivable land with low multiple cropping indices, generally inferior land quality, and relatively low comprehensive grain productivity. The originally scarce arable land resources are also irreversibly trending toward non-agricultural conversion and non-grain utilization, intensifying the growing contradictions between farmland protection, food security, and economic development^[19]. Therefore, the development and utilization of mountainous land resources must, within the allowable range of ecological carrying capacity, integrate their unique land resource characteristics and advantages. This approach should focus on the national strategic framework of food security and sustainable land resource utilization, implement the concept of diversified food systems and comprehensive agricultural development according to local conditions, enhance comprehensive grain production capacity in mountainous areas, and safeguard regional and national food security.

2.4 Consolidating poverty alleviation achievements and solidly advancing comprehensive rural revitalization

Mountainous areas constitute highlands in topographical location yet low-

lands in economic development. Numerous studies indicate that poverty incidence rates are influenced to some extent by terrain conditions and locational factors, with regions possessing poorer terrain and locational conditions generally exhibiting higher poverty rates^[20–22]. Although China has achieved comprehensive victory in its poverty alleviation campaign, resolving regional overall poverty, for many out-of-poverty households in remote mountainous areas, while basic living needs are guaranteed, their incomes remain unstable and relatively low, with fragile out-of-poverty foundations and high risks of returning to poverty. This signifies that although absolute poverty has been eliminated in China, relative poverty will persist long-term. The prominent issue in China's current regional development lies in the issues concerning farmers, agriculture, and rural areas, with the most acute and outstanding manifestations of these "three rural" issues still concentrated in mountainous areas. The realization of development in mountainous areas inevitably requires the development and utilization of their land resources. Therefore, the utilization of mountainous land resources in China bears the significant mission of consolidating poverty alleviation achievements and solidly advancing comprehensive rural revitalization. Industrial development constitutes the fundamental strategy for achieving poverty eradication and prosperity. For most impoverished mountainous areas, the crucial path to fully realizing rural revitalization lies in cultivating effective industrial systems tailored to local conditions to enhance the self-development capacity and self-reliance of the impoverished population^[22–25]. Vast mountainous areas must fully leverage their advantageous resources, develop and utilize land resources in accordance with sustainable utilization requirements, cultivate characteristic industries based on local conditions, continuously broaden farmers' income channels, improve farmers' welfare, and boost revitalization of mountainous areas.

2.5 Maintaining border stability, promoting national unity and safeguarding national unity China's mountainous areas are predominantly distributed across border regions such as the northeast, northwest, southwest, and southeast. A notable characteristic of the population composition in China's mountainous areas is the high proportion of ethnic minorities, with over 80% of the nation's ethnic minority populations residing in mountainous areas, and more than 90% of the national border lines also located within these regions. Mountainous areas serve as the primary settlements for most of China's ethnic minorities. Among the 55 officially recognized ethnic groups, except for a few such as the Manchu and Hui ethnic minorities that predominantly inhabit plains and urban areas, the vast majority of ethnic minorities dwell in plateau mountainous areas and remote areas, forming unique traditional settlement patterns^[1,26]. Development constitutes a crucial factor for maintaining stability and unity. The social and economic development of mountainous areas directly impacts border stability, ethnic unity, and national unification. The development and utilization of mountainous land resources hold significant importance for promoting local economic growth, facilitating ethnic integration

and exchange, and strengthening local ethnic autonomy capabilities. Therefore, the development and utilization of mountainous land resources in China shoulder the strategic mission of "maintaining border stability, promoting ethnic unity, and safeguarding national unification." Throughout the utilization process, it is imperative to conscientiously consider the intricate national conditions involving "ethnicity and borderlands," emphasize the prevention of major risks and hidden dangers in the ethnic domain, and steadfastly advance ethnic unity^[27].

3 Strategies for sustainable development and utilization of land resources in mountainous areas

The development of land resources in mountainous areas in China has its inherent advantages, but there are also many constraints. The sustainable development and utilization of land resources in China's mountainous areas bears the key strategic responsibilities of resource reserve, ecological barrier, economic development and national unity. In the future land development and utilization, mountain areas must base on the needs of economic and social development, combine the inherent characteristics of land resources and the advantages and disadvantages of development and utilization, develop and utilize land resources sustainably according to local conditions, and effectively undertake its strategic tasks. Based on the above analysis, we come up with the following countermeasures and recommendations.

3.1 Adhering to the organic integration of development and protection of land resources in mountainous areas, and promoting the construction of ecological environment in mountainous areas Ecology constitutes the foundation for survival, and the environment serves as the cornerstone for development. China's mountainous areas function as crucial water source regions and national ecological security barrier zones. However, due to inherent ecological fragility compounded by external factors, prominent ecological environmental issues emerge during land resource development and utilization processes^[8–9]. To consolidate the national "Three Zones and Four Belts" ecological security barrier project, mountain land resource development must achieve coordination between exploitation and protection, strengthening ecological conservation and construction while utilizing mountain resources. (i) It is imperative to strictly implement land resource protection and supervision responsibilities based on regional ecological characteristics and practical environmental protection conditions, adhering to the principles of "prioritizing both protection and development," "combining prevention with governance," and "addressing urban and rural areas simultaneously," while substantially enhancing ecological preservation and intensifying environmental remediation efforts. (ii) It is essential to scientifically and rationally formulate strategies for mountain land resource development and utilization in China, while earnestly advancing a series of key projects related to mountain ecological construction and environmental protection. Guided by the concept of "Green Mountains and Ecological Mountains," this approach must persist

in pursuing the path of industrializing ecological construction and industrial development in the ecological manner^[28]. (iii) Concrete efforts should be made to implement key ecological projects including forest resource management, rocky desertification control in mountainous areas, and the Grain for Green Program (returning farmland to forests and grasslands), with strengthening comprehensive land remediation to safeguard mountain ecological biodiversity.

3.2 Adhering to the direction of comprehensive utilization of land resources in mountainous areas and developing characteristic industries in mountainous areas in accordance with local conditions

Mountainous areas represent the most severely affected regions by China's current "three rural" issues. The development and utilization of their land resources bear the strategic mission of "consolidating poverty alleviation achievements and advancing rural revitalization." Consequently, while prioritizing ecological benefits in mountainous areas, social and economic benefits must also be accorded due attention^[29]. The complex and distinctive natural geographical conditions of China's mountainous areas have fostered three-dimensional land resource structures, diversified land types, multifunctional ecological services, and abundant mountain resources, creating favorable conditions for comprehensive utilization of mountainous land resources. However, given the extensive coverage of mountainous areas and the disparities in natural environmental conditions, developmental foundations, and existing challenges between eastern-western and border-inland mountainous areas, each region must seek development pathways that align with its specific local realities^[30]. To achieve this, all mountainous areas in China must comprehensively employ modern engineering and technological measures while fully respecting and understanding natural laws. Adhering to the principle of integrated land resource utilization, differentiated development strategies should be implemented based on distinct land types. It is crucial to cultivate characteristic industries tailored to local resource endowments and environmental conditions, thereby transforming resource advantages into social and economic development drivers and income growth opportunities for residents^[31–32]. This requires developing mountain-specific industrial systems through localized approaches, enhancing land resource utilization efficiency and productivity without compromising ecological integrity, and promoting resident income growth, economic prosperity, and social progress.

3.3 Strictly implementing the farmland requisition-compensation balance system, rigorously controlling the total farmland area, and improving the quality of farmland

Farmland constitutes the lifeline of grain production and the foundation for the sustainable development of the Chinese nation. Farmland protection has always been a fundamental and strategic priority highly emphasized by the Party Central Committee. Farmland conservation must ensure both quantitative compliance and qualitative enhancement. Given China's actual circumstances of reduced farmland area by 7.53 million ha between 2009 and 2019, strictly im-

plementing the national farmland requisition-compensation balance system and promoting farmland resource protection have become critically imperative. (i) It is essential to rigorously control the scale of farmland occupation by other land uses, resolutely implementing the quantitative balance, quality balance, and productivity balance mandated by the farmland requisition-compensation balance system^[33]. (ii) Stringent enforcement of "teeth-bearing" rigid measures must be ensured to fully consolidate farmland protection responsibilities. This involves strengthening the primary accountability of local Party committees and governments in farmland protection, clarifying and refining protection objectives and tasks, and strictly implementing the joint accountability system for Party and government leadership^[34–35]. (iii) Systematic advancement must be prioritized by integrating farmland protection into the framework of Chinese-style modernization characterized by harmonious coexistence between humanity and nature. This requires coordinated alignment with major functional zone planning, advancing integrated management and coordinated protection of mountains, rivers, forests, farmlands, lakes, grasslands, and deserts. (iv) Emphasis should be placed on the sustainable utilization of farmland resources. This includes intensifying comprehensive improvement of saline-alkali land, properly balancing short-term interests with long-term development, preserving and enhancing existing land resources, and reserving greater developmental space for future generations.

3.4 Strengthening the comprehensive prevention and control of mountain disasters and promoting the protection and restoration of ecosystems in fragile areas

As a typical mountainous country with mountainous areas accounting for over two-thirds of its national land territory, China accommodates 25% of its total population, where over 71% of its districts and counties suffer from extremely severe mountain disaster issues. Mountain disasters significantly impact the development of land resources in mountainous areas, not only causing reduced grain production and threatening national food security, but also damaging infrastructure and housing, endangering people's lives and property safety. Therefore, it is crucial to strengthen comprehensive prevention and control of natural disasters^[36], establish a sound disaster prevention and mitigation system, and build a solid safety barrier for industrial production and people's lives and property. All provincial-level regions must thoroughly implement the General Secretary Xi Jinping's safety concept of "putting people and life first", strictly implement a series of new concepts, ideas and strategies proposed by the Party Central Committee regarding disaster prevention, mitigation and relief^[37]. (i) It is necessary to improve relevant policies and regulations to strengthen geological environmental protection, formulate scientific geological disaster prevention and control plans, enhance scientific prevention and control of geological disasters, and improve the management level of geological disaster prevention and control, aiming to minimize the negative impacts of geological disasters. (ii) It is necessary to strengthen technology-driven initiatives, further plan the construction of flood and

drought disaster prevention systems, develop comprehensive scientific emergency plans for pre-disaster, during-disaster and post-disaster phases, and comprehensively enhance modernization capabilities for flood and drought disaster prevention; (iii) It is necessary to strengthen agricultural infrastructure construction, improve agricultural production conditions, and promote sustainable development and utilization of land resources. (iv) It is necessary to implement leadership responsibility systems and departmental responsibility systems for geological disaster prevention and control, strengthen responsibility implementation, improve disaster prevention and control capabilities, thereby promoting sustainable development and utilization of land resources.

4 Conclusions

From the perspective of national strategy, the development of mountainous land resources in China not only requires coordination between resource endowment and ecological fragility, but also needs to shoulder five core tasks: promoting mountainous economic development, constructing a national ecological security barrier, ensuring grain and vital agricultural product supply, advancing rural revitalization, and consolidating border stability. This reflects both the strategic position of vast mountainous areas in the nation's overall development framework and highlights the multi-functional attributes of mountainous areas as ecological resource-rich areas, grain security reserve zones, and ethnic integration frontier regions. At the practical implementation level, the sustainable development and utilization of China's mountainous land resources must adhere to the fundamental principle of "prioritizing ecological protection with rational development as a supplement". Through comprehensive measures including coordinated advancement of ecological restoration and industrial upgrading, enhanced farmland improvement and geological disaster prevention, and integrated promotion of policy innovation with technological application, the ultimate goal is to achieve organic integration of economic, ecological, and social benefits. Furthermore, the process of mountainous land resource development must fully respect regional characteristics and socio-economic developmental disparities in mountainous areas, abandoning the application of homogenized development models. It should explore flexible and diversified resource development pathways and economic growth patterns tailored to local natural geographical conditions and resource endowment characteristics. With the accelerated modernization of China's national territorial spatial governance system, mountainous land resource development needs to be further integrated into strategic national frameworks such as the "dual carbon" goals, "rural revitalization," and "ecological civilization construction". Through more systematic and scientific institutional designs, it aims to resolve deep-seated contradictions between resource conservation and utilization in mountainous areas, promoting their transformation from singular "resource potential zones" into comprehensive "high-quality development demonstration zones." Only through such approaches can the ecological and resource advantages of mountainous areas be transformed into enduring drivers for national sustainable development, thereby solidifying the foundation and expanding the development space for comprehensively building a modern powerful socialist country.

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