

ORIGINAL RESEARCH ARTICLE

Study on the current situation of grassland resources and ecological environment protection countermeasures in Sichuan Province

Changuang Shi^{1,2}, Qunying Zheng¹, Su Zhou^{1,2*}, Gang Liu^{1,2}, Yan Lu³, Xuxiao Zhang³, Bingxue Xiao^{1,2}, Hongxuan Zhang^{1,2}

¹ Sichuan Grassland Science Academy, Chengdu 611743, China. E-mail: zhousu666@163.com

² Tibetan Plateau Alpine Grassland Ecological Restoration Engineering Technology Research Center, Chengdu 611743, China.

³ Sichuan Grass Technology Research and Extension Center, Chengdu 610041, China.

ABSTRACT

Sichuan Province is rich in grassland resources which is one of the five pastoral areas in China. It is an important part of the national Qinghai–Tibet plateau ecological barrier area and has a very important strategic position in the country. Starting from the current situation of grassland resources in Sichuan Province, based on the achievements and existing problems of grassland ecological protection, this paper puts forward countermeasures for grassland ecological protection in Sichuan, aiming to better promote the high-quality development of grassland in Sichuan and the construction of ecological barriers in the upper reaches of the Yangtze River and the Yellow River.

Keywords: Grassland Resources; Grassland Degradation; Ecological Protection; Compensation Mechanism; Qinghai-Tibet Plateau

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1. Introduction

Located in the southeast edge of the Qinghai–Tibet Plateau, the grassland in Sichuan Province is an important part of the ecological barrier area of the Qinghai–Tibet Plateau. It is the second largest Tibetan area, the first largest Yi area and the only Qiang inhabited area in China. It plays a very important role in the protection and construction of the ecological environment, the maintenance of national ecological security, the structural adjustment of animal husbandry, the economic development and social stability of ethnic areas. Since the 18th CPC National Congress, the quality of grassland ecological environment in Sichuan Province has shown a steady and positive trend, and the service function of grassland ecosystem has been steadily improved, laying a solid foundation for the decisive victory in building a moderately prosperous society in all respects. At the same time, affected by the continuous increase of population and material demand, the current grassland natural ecosystem in Sichuan Province is still relatively fragile, with insufficient ecological carrying capacity and environmental capacity, and the pressure of ecological protection brought by economic development is still large. Strengthening the research on ecological protection of grassland in Sichuan is the basic requirement to further strengthen the national ecological security barrier, and it is also a concrete manifestation of the further practice of Xi Jinping's ecological

civilization construction in the new era.

2. Overview of grassland resources in Sichuan Province

2.1 Distribution of grassland resources in Sichuan Province

The grassland area of Sichuan Province is 21 million hectares, accounting for 43% of the total area of the province. The available natural grassland area is 18 million hectares, accounting for 84.7% of

the total grassland area in the province. There are 16 million hectares of natural grassland in the province, which are concentrated and distributed in Ganzi, Aba and Liangshan Autonomous Prefectures, mainly in the area with an altitude of 2,800–4,500 m. It borders Tibet, Qinghai, Gansu, Yunnan, Guizhou, Chongqing and Shaanxi provinces (cities and districts), and is one of the five major pastoral areas in China^[1].

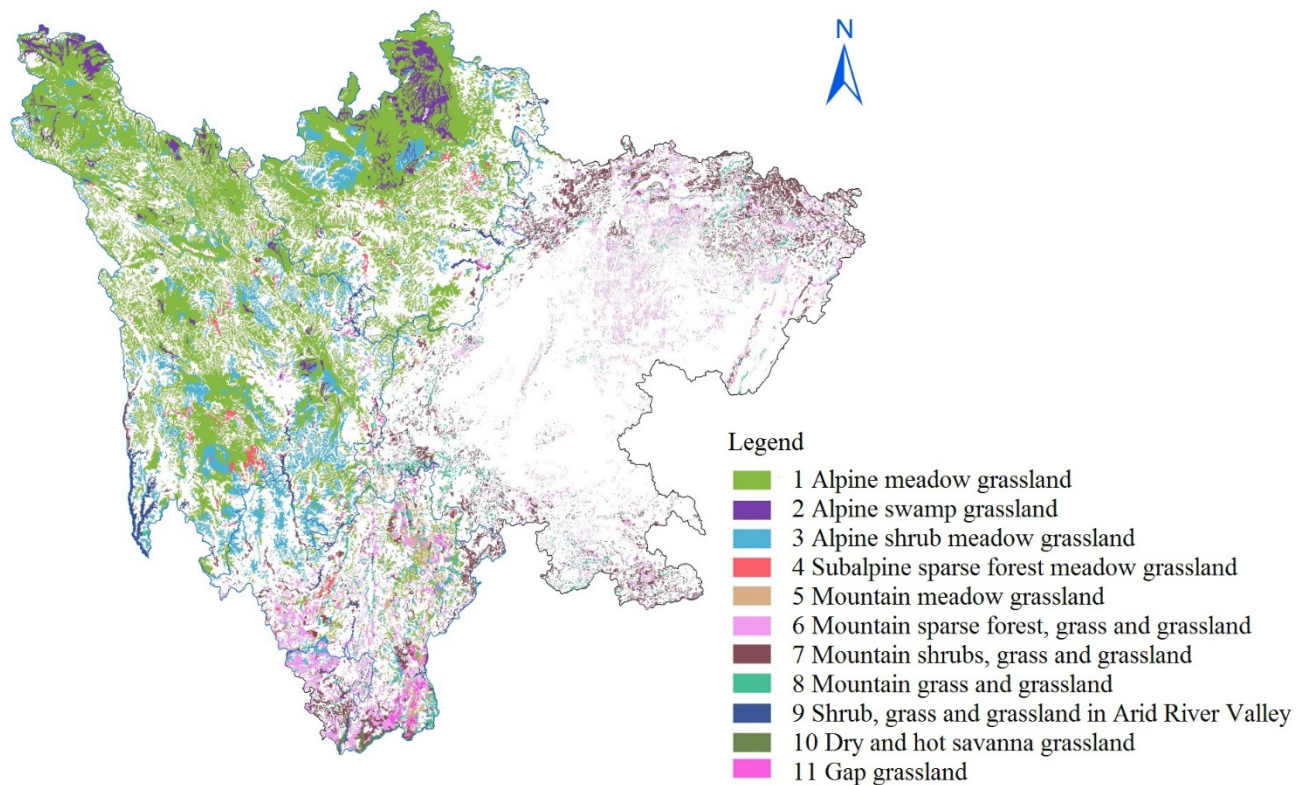


Figure 1. Distribution of grassland types in Sichuan Province.

The grassland distribution areas in the province have complex landform, uneven distribution of hydrothermal conditions, diverse vegetation types, and frequent natural disasters such as grassland snow disaster, fire, debris flow and so on. The west is the eastern extension of the Qinghai–Tibet Plateau, with an average altitude of about 4,000 m. The relative altitude difference in the northwest of the plateau is 50–100 m. The terrain is open and flat, the climate is cold, and the sunshine is strong. 80% of the precipitation is concentrated in May–August. The grassland is mainly alpine meadow and alpine shrub grassland. The southeast of the plateau is

Hengduan Mountain area, with vertical and horizontal high mountains and valleys, wide height differences, significant microclimate effects, obvious vertical changes, large temperature differences, and distinct dry and wet seasons. The grassland is dominated by mountain meadow grassland and mountain shrub grassland. Southwest Sichuan is a mountainous area, with an altitude of 1,000–3,500 m. The landform is similar to that of Yunnan–Guizhou Plateau. Some areas have a subtropical climate, with long warm seasons and high heat. The vertical distribution of grassland resources in the area is obvious. From high to low, there are subalpine

meadows, mountain meadows, mountain shrub grass, and dry valley shrub grass. The interior of the basin is dominated by plains and hills. The climate is mild, the soil is fertile, and the land reclamation and utilization is high. There are mainly agricultural gap grassland and sporadic shrub grassland.

2.2 Characteristics of grassland resources in Sichuan Province

There are various grassland types in Sichuan, including 11 categories, 35 groups and 126 types, with an altitude of 270–5,500 m. The top three types of grassland with the largest area are alpine meadow grassland, alpine shrub grassland and mountain shrub grassland, accounting for 49%, 15% and 9% of the total grassland area of the province, respectively. The natural grassland is mainly composed of Gramineae, Cyperaceae, Leguminosae and miscellaneous grasses, of which 355 species belong to 107 genera of Gramineae vegetation and 213 species belong to 64 genera of Leguminosae plants.

In 2017, the province's natural grassland fresh grass output was 86.97 billion kg, and the average yield of available natural grassland fresh grass per acre was 327.5 kg/667 m². Among the 11 types of grassland in the province, the usable grassland area of four types of grassland, including alpine meadow grassland, alpine shrub grassland, mountain shrub grassland and mountain sparse forest grassland, account for 80% of the grassland in the province, of which the output of fresh grass is 67.01 billion kg, accounting for 77.0% of the total output of the province; and the output of fresh grass is 227.5–458.0 kg per 667 m². According to statistics, the grassland area in Sichuan ranks fifth in the country, but the grassland productivity per unit area ranks first in the five pastoral areas in the country, and the total output of fresh grass in natural grassland ranks second in the country.

3 Current situation of grassland resources in Sichuan Province

3.1 Protection and effectiveness of grassland resources in Sichuan Province

Since the 13th Five-Year Plan, the Sichuan provincial Party committee and government have put grassland ecological protection in a more prominent position, always strengthened the upstream awareness, strengthened green development, continued to strengthen projects such as returning grazing to grassland, returning farmland to grassland, grassland ecological protection and restoration, and steadily implemented policies such as subsidies and incentives for grassland ecological protection. The quality of grassland ecosystem has been improved, and grassland ecological functions have been gradually restored. According to statistics, Sichuan Province has implemented the project of returning grazing to grassland since 2003. The project has covered 48 counties, 1,110 towns and townships in Ganzi, Aba and Liangshan prefectures, more than 1.07 million herding households and more than 4.13 million herdsmen. By 2019, a total of 9.421 million hectares of fences for returning grazing to grassland will be assigned (including 2.35 million hectares of grazing prohibition, 5.963 million hectares of rest grazing, and 1.017 million hectares of regional rotational grazing), 2.446 million hectares of grassland supplementary sowing improvement, 72,700 hectares of artificial feeding grassland construction, 47,000 households will be assisted in the construction of sheds, 17,300 hectares of black soil beach treatment, 13,300 hectares of toxic grass treatment. The total investment is 4,709.44 million yuan, including 3,672.37 million yuan from the central government and 1,037.07 million yuan from local supporting facilities.

3.2 Degradation status of grassland resources in Sichuan Province

At present, the grassland natural ecosystem in Sichuan Province is still fragile on the whole, with insufficient ecological carrying capacity and environmental capacity. The pressure of ecological protection brought by economic development is still large, and the contradictions accumulated by emphasizing development and neglecting protection in some areas are becoming increasingly prominent. According to statistics in 2018, the degraded area of natural grassland in the province was 9.814 million

hectares, accounting for 69.59% of the total area of natural grassland in the province. Among them, the area of rats and pests is 3.3707 million hectares, accounting for 34.35% of the degraded area of the province; the area of poisonous weeds is 2.7342 million hectares, accounting for 27.86% of the degraded area in the province; the area of grass hard-

ening is 3.3402 million hectares, accounting for 34.04% of the degraded area in the province; the desertification area of grassland is 215,800 hectares, accounting for 2.20% of the degraded area of the province; the pasture disease area is 153,000 hectares, accounting for 1.56% of the degraded area in the province (see **Table 1**).

Table 1. Distribution area of degraded grassland in Sichuan Province (10,000 Hectares)

Name of prefecture and city	Total area of degraded grassland	Rodent infestation area			Distribution area of poisonous weeds			Grassland hardening area	Grassland desertification area	Pasture disease area
		Subtotal	A plague of rats	Insect pest	Subtotal	Poisonous grass	Of which: crofton weed			
Total of the whole province	981.40	337.1	265.9	71.18	273.42	273.42	15.94	334.02	21.58	15.3
Ganzi Prefecture	700.10	214.99	178.13	36.86	128.53	128.53	0.37	334.02	10.81	11.73
Aba Prefecture	245.10	106.82	76.98	29.85	125.33	125.33	-	-	10.3	2.64
Liangshan Prefecture	36.19	15.25	10.78	4.78	19.55	19.55	15.78	-	0.46	0.92
Other cities	0.004	-	-	-	0.004	0.004	-	-	-	-

The lightly degraded grassland area in the province is 4.5708 million hectares, the moderately degraded grassland area is 3.1007 million hectares, and the severely degraded grassland area is 2.1425 million hectares, with a total area of 9.814 million hectares. The three prefectures are the main areas of grassland degradation in Sichuan Province, including 2.6536 million hectares of mild degradation, 2.6371 million hectares of moderate degradation and 1.7103 million hectares of severe degradation in Ganzi Prefecture, with a total degradation area of 7.001 million hectares, accounting for 71.34% of the grassland degradation area in the province; Aba Prefecture has slightly degraded 1.8198 million hectares, moderately degraded 294,300 hectares, and severely degraded 336,900 hectares, with a total degraded area of 2.451 million hectares, accounting for 24.97% of the grassland degraded area in the province; Liangshan Prefecture has slightly degraded 97,400 hectares, moderately degraded 169,300 hectares, and severely degraded 95,200 hectares, with a total degraded area of 361,900 hectares, accounting for 3.68% of the grassland degraded area in the province; other cities have

slightly degraded 0.04 thousand hectares, without moderate and severe degradation (see **Table 2**).

4. Existing problems of grassland resource protection in Sichuan Province

4.1 Insufficient understanding of grassland resources

On the one hand, the base number of grassland resources is unclear. Grassland data has not been separated from the extensive stage of “statistics + estimation”, which is highly subjective. The grassland monitoring network in the whole province has not been effectively established, and the grassland monitoring and evaluation lacks integrity and systematicness. The current monitoring system mainly relies on quadrat data, which is highly arbitrary, and focuses on resource monitoring and construction protection project monitoring. It lacks systematic monitoring of grassland resources and ecosystem processes. The value of grassland ecosystem services, the benefits of grassland ecological engineering, the balance between grassland and livestock, and the assessment of grass-

Table 2. Summary of grassland degradation degree and area in Sichuan Province (10,000 Hectares)

Serial number	Name of prefecture and city	Total	Mild degradation	Moderate degradation	Severe degeneration	Proportion of grassland degradation area in the whole province (%)
	Total	981.40	457.08	310.07	214.25	100
1	Ganzi Prefecture	700.10	265.36	263.71	171.03	71.34
2	Aba Prefecture	245.10	181.98	29.43	33.69	24.97
3	Liangshan Prefecture	36.19	9.74	16.93	9.52	3.68
4	Other cities	0.004	0.004	-	-	0.0004

land disasters are still in the primary stage, grassland resource data can no longer effectively support the needs of grassland ecological protection and high-quality development at this stage^[2,3].

On the other hand, there is insufficient understanding of the versatility of grassland. grassland has the functions of ecological environment maintenance, the development of agriculture, animal husbandry and people's livelihood, the bearing function of traditional culture, the supply function of industrial raw materials, and the support function of social stability. In the past, based on the needs of social development stage, the grassland function was mainly reflected in animal husbandry production, and other functions were not fully played, which was difficult to meet the needs of high-quality grassland development in Sichuan Province at this stage and in the future^[4,5].

4.2 The carrying capacity of grassland resources is overburdened

In recent years, due to the rapid growth of the population in pastoral areas, the per capita grassland area has continued to decrease. According to statistics, the per capita grassland area in Ganzi, Aba and Liangshan prefectures has decreased from 12.37 hectares, 6.23 hectares and 0.75 hectares in the 1980s to 7.49 hectares, 4.18 hectares and 0.44 hectares now, with a decrease of 39.5%, 32.9% and 41.1%, respectively. The contradiction between population growth and the shortage of grassland resources has become increasingly prominent, resulting in serious phenomena such as over grazing,

indiscriminate cultivation and excavation, illegal requisition and occupation of grassland, grazing by looting, grazing by theft, grazing by disorder, and so on, which makes the grassland unbearable. In 2017, the overload rate of grassland livestock in pastoral areas of the province was 9.23%, and the overload rate of some pastoral counties and some towns was as high as 20%–30%.

4.3 Systematic deficiencies in grassland ecological protection and restoration

It does not fully follow the succession law of grassland natural ecosystem and give full play to the self-healing ability of grassland ecosystem, which is still far from the concepts and requirements of overall protection, system restoration and comprehensive management put forward in the *Master Plan of Major National Ecosystem Protection and Restoration Projects (2021–2035)*^[6]. The construction objectives, construction contents and treatment measures of some ecological projects are relatively simple, and some construction projects still have problems of patchwork, as well as the neglect of natural endowments such as water resources, soil, light and heat, and protozoa. The overall improvement of regional ecosystem service functions is not obvious.

4.4 Unreasonable investment in grassland ecological protection funds

First, the standard of grassland subsidy policy is low. After the implementation of grazing prohibition and grass livestock balance system, there is a

large gap with the original income level of herdsmen, resulting in the low enthusiasm of farmers and herdsmen for ecological construction, and the achievements of grassland ecological protection cannot be effectively consolidated. Second, the project of returning grazing to grassland and the subsidy standard are low. The current national investment standards for returning grazing to grassland projects are difficult to match the high-quality construction of grassland protection on the Qinghai–Tibet Plateau, and the lack of post construction management and protection funds makes it difficult to ensure the effectiveness of grassland ecological engineering construction. Third, there is a lack of funds for the construction of grassland animal husbandry infrastructure. The construction of productive facilities such as feeding grassland, livestock sheds, emergency channels for disaster prevention materials, drinking water for human and livestock, and processing of livestock products lags behind, and the transformation and upgrading of grassland animal husbandry is slow, which is difficult to support the sustainable ecological environment protection of grassland^[7].

4.5 Imperfect grassland ecological protection mechanism

First, there is a lack of participatory management and operation mechanism and mode of herdsmen. Herdsmen are isolated from the protection project and have low participation. The construction of ecological protection projects failed to achieve “from the pastoralists, for the pastoralists and to the pastoralists”, and the actual results of the project implementation are far from expected. Second, the diversified investment mechanism has not been established. Ecological protection and restoration work have obvious public welfare and externality, and there is a lack of effective policies and measures to encourage social capital investment in ecological protection and restoration. Third, the lack of grassland ecological industry guidance mechanism. Insufficient support for socialized services, imperfect institutional guarantee mechanism for herdsmen to participate and share benefits, backward infrastructure conditions in pastoral

areas and other subjective and objective difficulties have seriously limited the development of grassland ecological animal husbandry^[8].

4.6 Scientific and technological support capacity needs to be strengthened

The construction of ecological protection and restoration standard system, the promotion of new technologies, the transformation of scientific research achievements and other aspects are still lacking. There is a certain degree of disconnection between theoretical research and engineering practice, and the systematicness and long-term effectiveness of key technologies and measures are insufficient. The scientific and technological service platform and service system of grassland resource protection are not perfect, and the grassland ecological protection and restoration industry is still in the cultivation stage. In addition, the ability of investigation, monitoring, evaluation and early warning to support grassland ecological protection and restoration is insufficient, and the inter departmental information sharing mechanism has not been established.

5. Countermeasures and suggestions

5.1 Establish regular grassland investigation and routine monitoring system

Organize and carry out grassland monitoring throughout the province, implement decadal, monthly and annual regular grassland monitoring, issue monitoring reports, timely provide information on grassland productivity, grassland comprehensive vegetation coverage, grassland degradation, grassland overload, and the implementation effect of ecological restoration projects, and provide technical support for agriculture, animal husbandry, people’s livelihood, production and life, and grassland management departments to formulate grassland ecological protection policies. Regularly carry out grassland resources investigation, implement the system of grassland resources inventory every 5 years and general survey every 10 years, and timely find out the current situation of grassland area, grassland type, grassland grade, grassland produc-

tivity, grassland degradation and other resources in the province.

5.2 Strengthen the spatial management of grassland resources

Strengthen the preparation of grassland ecological space planning and the delimitation of grassland ecological protection red line, study and clarify the control boundary of grassland resource use, grasp the changes of grassland resources involved in the development of land space in each county, strengthen the conversion management of grassland ecological space to other natural ecological space, explore and study the grassland ecological environment damage assessment and compensation system, establish a dynamic monitoring account, and strengthen real-time control. Vigorously build a digital grassland, plan and establish a provincial grassland big data center, strengthen the construction of grassland data collection, resource management, monitoring and early warning, data release and other information platforms, and comprehensively improve the level of grassland information management.

5.3 Strengthen the systematic repair of zoning and classification

With the goal of improving the self-healing ability of grassland ecosystems in Sichuan Province and effectively enhancing the stability of ecosystems, we will scientifically layout and organize the implementation of major projects for the protection and restoration of important ecosystems. According to the types and levels of different degraded grasslands, on the basis of adjusting measures to local conditions and seeking truth from facts, fully combine the wishes of local farmers and herdsmen, pay attention to the improvement of ecological quality and ecological risk response, scientifically allocate protection and restoration, natural and artificial, biological and engineering measures, improve the follow-up management measures and standards of ecological engineering, and promote the integrated ecological protection and restoration of grasslands in Sichuan Province.

5.4 Strengthen scientific and technological

support ability

Increase support for scientific research on grassland resources, ecological environment monitoring, biodiversity protection, etc., and focus on scientific and technological problems in the protection and utilization of grassland resources and research on technological bottlenecks restricting development; establish and improve the system of scientific and technological support services, strengthen extensive docking and cooperation with domestic and foreign scientific research institutions, share scientific research achievements, and promote the application and practice of scientific and technological achievements; in order to cultivate practical talents who can be used and retained, local governments, provincial forestry and grass administration, relevant colleges and universities and scientific research institutions should strengthen the joint training of “targeted students” of grassland talents, strengthen the study and training of professional knowledge, and strengthen the talent reserve.

5.5 Establish and improve the economic compensation mechanism

Under the protection of the system of laws and regulations, give full play to the incentive role of interests, guide and encourage the participation of enterprises, people and other social investment subjects. Form a new pattern of ecological protection dominated by the government and jointly participated by multiple subjects, establish a mechanism for interest expression, regulation and compensation, and stimulate the enthusiasm of local farmers and herdsmen to participate in protection and management; reasonably formulate the economic reward and subsidy mechanism for planning grassland and residents, and appropriately improve the standard of grassland reward and subsidy.

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Conflict of interest

The authors declared no conflict of interest.

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