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Synergistic Development Pathways for National Parks and Local Regions: Shared Socioeconomic Pathway Scenario Forecasting and Optimization

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Abstract: National parks play a crucial role in protecting ecosystems and biodiversity while facing challenges in balancing nature conservation and economic development. However, because of the difficulty in the unified simulation of natural protection functions and regional socioeconomic development, there is a lack of integrated prediction research on the comprehensive development pathways of national parks and their surrounding areas. This study adopts the Shared Socioeconomic Pathway (SSP) framework that links climate change research with socioeconomic development paths, taking China's first national park—Sanjiangyuan National Park—region as an example, to conduct research on the synergistic development path of regional socioeconomic development and national parks. The model design includes five typical paths to cover a wide range of socioeconomic development possibilities. These paths are based on different assumptions, including factors such as population growth, economic development, energy use, technological progress, and policy choices. By applying scenario planning methods, optimal development pathways are identified based on environmental, economic, and social priorities. The results show that GDP growth is fastest under the sustainable development and fossil fuel development pathways. By 2050, the population difference under different pathways will approach 100,000, and the GDP gap will be close to CNY 200 billion. This study provides valuable insights for the planning, decision-making, and management of Sanjiangyuan and similar national parks and their surrounding areas, contributing to the promotion of sustainable ecological and economic development of national parks and their regions.

Keywords: national parks; regional coordinated development; scenario planning; shared socioeconomic pathways; Sanjiangyuan National Park; sustainable development

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1. Introduction

Over the past century, national parks have become an important means to meet the needs of ecological environmental protection and human activities, playing a key role in protecting ecosystems and biodiversity [1]. National parks give priority to conservation while emphasizing the rational use of natural resources, which is also consistent with the United Nations SDGs (Sustainable Development Goals), especially SDG15 [2]. However, national parks objectively impose certain restrictions on regional economic development and the improvement in local residents' welfare. This trade-off relationship has been widely discussed since the 1980s [3], and it is an important area of exploration [4]. The development of national parks is related to the economy and quality of life of local residents and, at the same time, the attitude and support of local residents also greatly affect the sustainable development of parks [5].

Because of the difficulty in conducting comprehensive research on natural environmental elements and economic elements, comprehensive prediction research on national parks and regional economic development is still rare. Traditional development planning generally only focuses on one aspect. For example, the planning issued by the natural resources management department often only focuses on natural factors [6–8]. While the regional planning of social and economic development only considers social and economic indicators and rarely pays attention to climate or natural indicators [9–11]. In the context of climate change, especially in ecologically fragile areas with climate change sensitivity and the climate change amplifier effect, such as the Qinghai–Tibet Plateau [12–14], it is important that national parks integrate changes in natural conditions into development planning and comprehensively consider the development of natural conditions and economic factors.

The Shared Socioeconomic Pathways (SSPs) proposed by the Intergovernmental Panel on Climate Change (IPCC) is a forecast scenario framework shared by social economists and natural scientists [15]. It links the characteristics of economic development paths with different emission features, and further with different warming effects, taking into comprehensive consideration the factors of climate change and economic development. However, development planning often faces dynamics, complexity, and uncertainty in the future, with difficulties in developing path planning. This can be remedied through the use of the scenario planning analysis method.

Scenario planning is a method used to describe the future state of a system and its development path through the arrangement and combination of a series of key variables based on the development law and trend of things. It is a typical process method and one of the most commonly used tools in strategy formulation [16,17]. Compared with traditional planning, the advantages of scenario planning are mainly reflected in the following two aspects:

On the one hand, scenario planning predicts the future based on a variety of possibilities, and it can provide action plans and measures for different situations. This is conducive to avoiding subjective influence, thus increasing the multiple possibilities of thinking results [18]. Also, it can reduce frame bias, which has a more positive impact on the quality of decision-making [19].

On the other hand, scenario planning helps to improve the participation of multiple subjects. Planners incorporate the different values and expected views of stakeholders into different scenarios and infer, identify, and address various disagreement points according to the actual situation and their professional experience, so as to finally achieve adaptive layout planning and play a role in integration [20,21]. At present, most of the research methods for scenario planning assume that the formulation of scenarios is based on the assessment of the macro external environment [18], which is widely used in urban planning and public policies [22,23]. It has also been maturely applied in many national parks, which is conducive to coping with the increasingly complex and changeable external environment and challenges, and thus effectively connected with the trend in the adaptive management of protected areas in the future.

In addition, national parks are affected by the political, economic, and cultural traditions of different countries, leading to differences in the national park management systems adopted [24]. China is currently adopting a unique approach to the management and development of national parks [25]. For one thing, in contrast to the United States, where national parks are largely free of indigenous people, most of China's protected areas are surrounded and inhabited by people who engage in economic activities. Compared with national parks in the United States, which implement a "separation of management and operation" and do not engage in any for-profit commercial activities, national parks in China shoulder more responsibility for economic development in addition to ecological protection, so national parks must consider the development of the local economy [26]. On the other hand, China is different from Japan and other countries that adopt a management group system. In Japan, the management group system of national parks is organized by civil organizations or citizens. A public welfare legal person or non-profit legal person is appointed by the national park and approved by the Minister of Environment and is fully responsible for the daily management of the park. In contrast, China's management system has more efficient macro-control and fund distribution capabilities, which is especially conducive to the establishment of large-scale ecological projects and the implementation of compensatory economic measures [25].

Therefore, this study adopts SSPs and uses Sanjiangyan National Park as an example of the region's prospective socio-economic development status. On this basis, we used the scenario planning method to arrange a series of key variables and describe the future state of the system and its development path. The optimal scheme of the management system, mechanism, and path under different development modes was constructed to provide a reference for the planning decision-making, management practice, and public participation of other national parks.

The main contributions of this paper are as follows: first, it organically combines ecological and environmental protection with corresponding economic development and emphasizes the construction of a "social–ecological" system. In the research on national park planning, the current research mainly focuses on tourism management [27], management based on natural environment protection [7], management based on biological protection [8], zoning management [28], and performance evaluation [29]. With the integration of interdisciplinary approaches, the attention of current research is gradually turning to the well-being of human society, emphasizing the "socio-ecological" system [30]. Thus, it is necessary to find an appropriate balance between environmental protection and economic development to promote the achievement of the long-term goals of the SDGs. Second, it focuses on dynamic, complex, and uncertain issues in development and puts forward development forecasts according to different management paths. This compensates for the fact that other current research findings and recommendations are mainly based on the status quo and the past. Third, it emphasizes the diversity of participants, increases the participation of research subjects, and predicts the future based on a variety of possibilities. This addresses the problem associated with current research subjects that are relatively single and only start from the single perspective of management institutions or tourists and residents.

2. Materials and Methods

2.1. Introduction of the Sanjiangyuan National Park

Sanjiangyuan National Park is located on the Qinghai–Tibet Plateau, with a well-developed water system; it is the birthplace of the Yangtze River, Yellow River, and Lancang River (known as the Mekong River abroad). With an average altitude of over 4700 m, the main mountain ranges include the Kunlun Mountains and its branches, such as the Hoh Xil Mountains, Bayan Har Mountains, and Tanggula Mountains. The central, western, and northern parts are valley mountains, with many wide and flat beaches, hosting vast alpine meadows and marsh wetlands based on frost-heave mounds. The northern foothills of the Tanggula Mountains in the southeast are dominated by plateau low hills, plateau river-lake basins, and periglacial permafrost landforms. The alpine ecosystem in Sanjiangyuan is typically unique, fragile, and sensitive, mainly including alpine meadows, alpine steppes, alpine wetlands, forest shrubs, and alpine deserts. As shown in Figure 1, Sanjiangyuan National Park is divided into three regions, namely the Yangtze River zone, the Yellow River zone and the Lancang River zone. The jurisdiction of the Yangtze River Zone mainly involves Haixi and Yushu Prefectures, the jurisdiction of the Yellow River Zone mainly involves Guoluo Prefecture, and the jurisdiction of the Lancang River Zone mainly involves Nagqu and Yushu Prefectures. The residents of Sanjiangyuan National Park are mainly Tibetan, accounting for over 97% of the total population, involving 27,956 households and 115,597 individuals. Among them, 21,452 households and 81,339 individuals are from 15 townships and 69 administrative villages in 5 counties in Qinghai Province. The relevant areas managed by the Tibet Autonomous Region north of Tanggula Mountains within the administrative region of Qinghai Province involve 6504 households and 34,258 individuals.

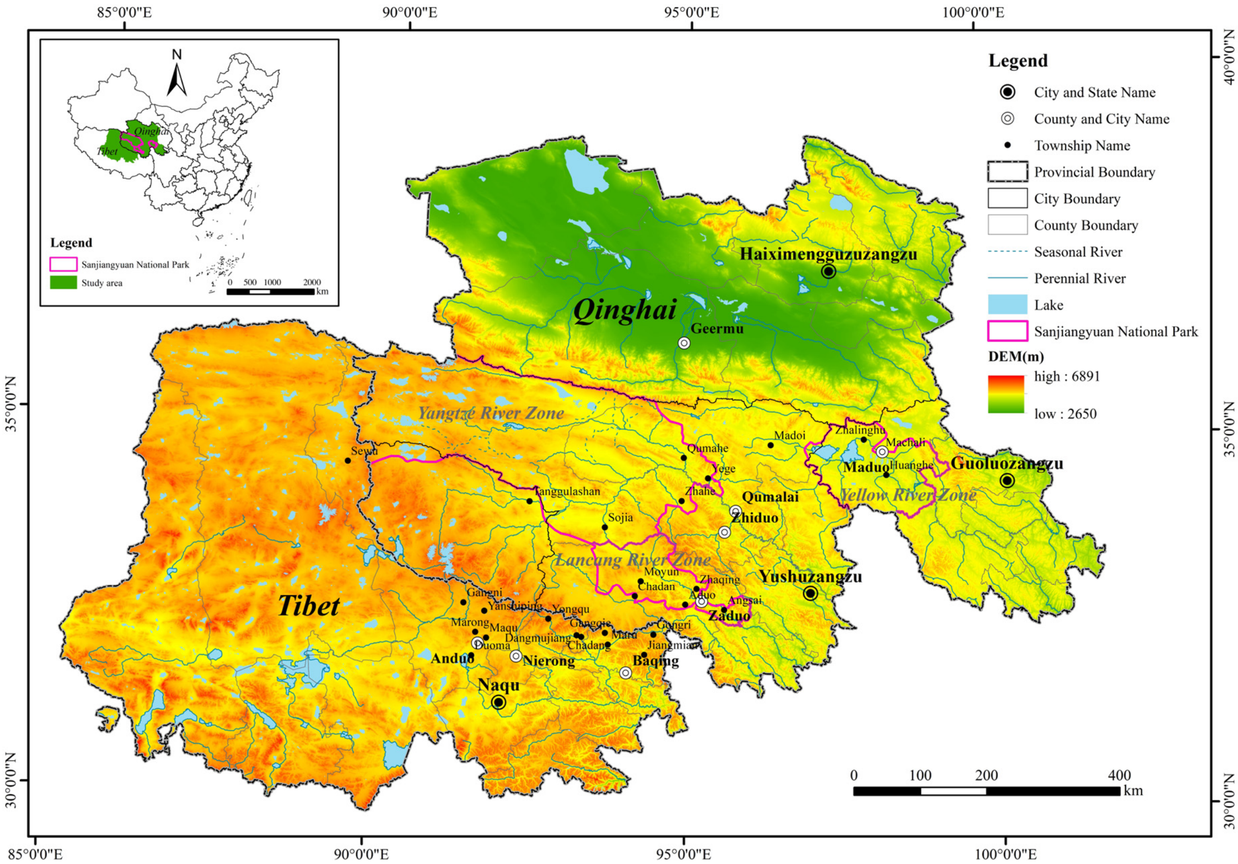

Figure 1. Overview of the study area (Sanjiangyuan National Park).

2.2. Scenario Planning Framework of Sanjiangyuan National Park

2.2.1. Principle

Utilizing the SSPs compatible with climate change prediction from the IPCC, we demonstrate the future socio-economic development status of Sanjiangyuan National Park and its surrounding areas. We achieved this by employing scenario planning to describe the state of the future system and its development path through the permutation and combination of a series of key variables. This allowed us to construct optimal management institutional mechanisms under different development models, providing a reference for planning decisions, management practices, and public participation in other national parks.

2.2.2. Technical Framework

The technical framework proposed in this paper is illustrated in Figure 2, which integrates SSPs and scenario planning for regional sustainability research. It begins with constructing integrated SSP scenarios based on projected data such as population, GDP, and total factor productivity. Then, key local factors are identified and combined with SSP scenarios to determine scenario variables. Subsequently, narratives are constructed for different scenarios based on SSP1-5. Finally, a vision for sustainable development and corresponding action plans are formulated based on the scenario narratives.

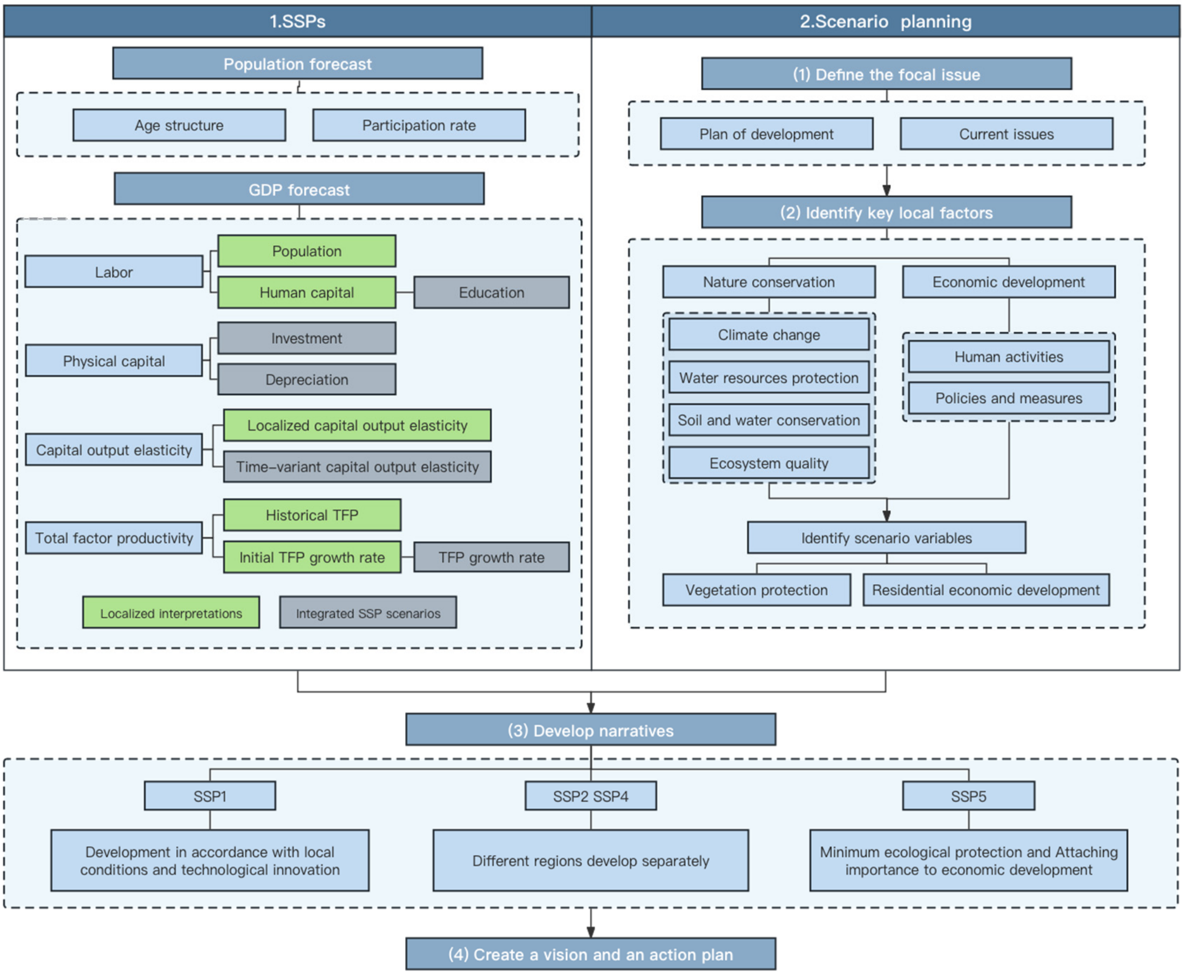

Figure 2. Flowchart of the technical process.

2.3. Simulation of Socioeconomic Factors Based on the SSPs

2.3.1. Shared Socioeconomic Pathways

Shared Socioeconomic Pathways (SSPs) are a new generation of scenario portfolios constructed by the IPCC to facilitate integrated analysis of future climate change impacts, adaptation, and mitigation. It enables the integration of future climate and social change so that natural and social scientists "share" a unified scenario simulation framework to jointly model the socioeconomic and climate change effects of future development pathways. The SSP design includes five typical paths to cover a wide range of socioeconomic development possibilities. These paths are based on different assumptions, including factors such as population growth, economic development, energy use, technological progress, and policy choices.

SSP1: Sustainable development—the green path. The core feature is to increase the environmental awareness of societies around the world, gradually shift to a less resource-intensive lifestyle, and take the path of a "green economy". This needs to be driven by innovation and requires the availability of adequate human and financial resources.

SSP2: The middle way—SSP2 is the path of development consistent with the typical pattern of historical experience observed over the past century. It is a dynamic path in which future changes in various elements are consistent with intermediate expectations.

SSP3: Regional competition—the hard road. Based on the assumption that globalization trends can be reversed by events, regional competition reduces support for international institutions and development partners, thereby undermining progress toward development goals.

SSP4: Inequality—the path to fragmentation. High levels of inequality and investment in human capital, combined with growing disparities in economic opportunities and political power, have over time led to greater disparities among regions and increased potential for conflict, with consequences for economic growth, technological development, environmental policies, and more.

SSP5: Fossil fuel development—Taking the high-speed development path. This path brings rapid technological progress and human capital development mainly through competitive markets, innovation, and social engagement, but with a heavy reliance on fossil fuels and a lack of environmental concern.

These five pathways provide a framework to assess the potential impacts of different socioeconomic development strategies on climate change and to develop adaptation and mitigation measures accordingly. The characteristics of the different development pathways can be quantified as the characteristics of the grown in different socioeconomic elements, as shown in Table 1.

Table 1. SSPs features.

Aspects Involved in SSPS	SSP1	SSP2	SSP3	SSP4	SSP5
Economic growth	High	Middle	Low	Middle	High
Population growth	High	Middle	High	Middle	Low
Technology development	High	Middle	Low	Middle	High
Environmental policy	Improve management of local and global issues; better control of pollutants	Just focus on local pollutants, with only moderate success	Environmental concerns have low priority	Focus on the environment in areas with high-level development; less attention paid to vulnerable areas	Focus on the local environment with obvious improvements but little attention paid to global issues
Environment	Improve conditions over time	Continuous degradation	Severe deterioration	High/middle income areas are highly improved; otherwise, the areas are degraded	Highly engineered method; successful management of local problems

In the present study, the key driving factors of SSPs include population [31,32], economic growth [33,34], and urbanization [35,36]. These projections and their underlying narratives form the essential elements of SSPs and are further used to develop integrated scenarios, such as Daigneault and Favero's application to modeling the forest sector [37], Yang et al.'s measure of the social cost of carbon [38], and Zang et al.'s exploration of the spatio-temporal characteristics of landscape pattern changes and LER in the Fujian Delta region [39].

2.3.2. Population–Development–Environment Model

The basic data for the population prediction in this paper are mainly based on the data from the sixth and seventh national censuses, including the number of men and women in 21 age groups, the total fertility rate, and the average life expectancy. The method used for prediction is primarily the PDE (population–development–environment) model [40,41]. The core idea of the PDE model is to regard the population as an ecosystem, with the future population status determined by the current population size and structure, influenced by fertility, mortality, immigration, and emigration, which in turn affect a region's future population renewable capacity. The specific mathematical expression of the PDE model for population calculation in a particular region is:

$$P_{(t+1,n+1)} = P_{(t,n)} \times (1 - D_{(t+1,n+1)}) + M_{(t+1,n+1)} \quad (1)$$

$$P(0, n+1) = \sum_{t=15}^{49} \left[F_{(t,n+1)} \times FR_{(t,n+1)}\right] \times \left(1 - D_{(0,n+1)}\right) \quad (2)$$

$$F_{(0,n+1)} = P_{(0,n+1)} \times f\_r_{n+1} \quad (3)$$

$$P\_Zn + 1 = \sum_{t=1}^{m} P_{(t,n)} + P_{(0,n+1)} \quad (4)$$

where t represents the age, n represents a specific year, P represents the population size, D represents the mortality rate, M represents the net migration (positive for net inflow and negative for net outflow), F represents the number of females, FR represents the fertility rate for a specific age group, f_r represents the proportion of females in the newborn population, and P_Z represents the total population. The labor force participation rate LFPRq1 of the working-age population aged 15–64 under different SSP paths is set in Table 2.

Table 2. Different SSPs under the 15–64 working-age population labor participation rate LFPRq1 setting.

Pathway	SSP1	SSP2		SSP3	SSP4		SSP5
Convergence target (numeric value)	0.68	Low and middle income	0.7	0.6	Low income	0.71	0.8
		High and middle income	0.7		Low and middle income	0.74	
		High income	0.7		High income	0.78	
Convergence time (years)	120	Low and middle income	120	80	Low income	200	100
		High and middle income	100		Middle income	150	
		High income	80		High income	100	

SSP1 describes an ideal state of sustainable development, which not only realizes low-carbon economic development but also realizes normal population replacement. Given low mortality rates and a higher life expectancy, the fertility rate allows for population replacement, i.e., the population replaces itself from generation to generation. In terms of housing, compact and intensive urban forms make people's lives more convenient and are more effective in improving the efficiency of energy and resource utilization, so the speed of urbanization is faster.

SSP2 represents a moderate development path, with moderate income growth. It follows a path where social, economic, and technological trends do not deviate significantly from historical patterns. This path faces uneven development and income growth, with some regions making relatively good progress and others falling short of expectations. The environment, despite some improvements, has mainly experienced degradation, with a decline in resource and energy use intensity. Population growth is moderate, and income inequality persists or is slow to improve.

SSP3 depicts a fragmented social state with weak economic growth and prominent social contradictions. People are pessimistic about the future, the fertility rate decreases, and the transition of the population development state is basically stagnant. Lack of income, anxiety, and emotional tension lead to a higher mortality rate and reduce the life expectancy of people. There are many social barriers, poor urban planning and "urban disease", and slow rural–urban migration.

SSP4 is a state of unbalanced development. Because of China's overall low birth level, every city in the future is expected to maintain a low fertility level and a medium mortality level. However, there is a slight difference in urban–rural migration: high-income provinces have medium–fast urbanization, while people in middle-income and low-income provinces are rapidly moving from rural to urban areas because of the need to make a living.

SSP5 is based on fossil fuel development, which has high carbon emissions and faces greater challenges in mitigating climate change. In this scenario, social development focuses on technological progress and human capital investment, and a large amount of income is obtained through fossil energy development. The fertility rate remains at a medium-high level, and the mortality rate is low. The increase in wealth makes people more able to move from rural to urban areas; thus, there is rapid urbanization.

The description of these path characteristics can be represented in Table 3.

Table 3. Setting of the SSPs population scenario.

Paths	Fertility Rate	Mortality Rate	Life Expectancy	Speed of Rural–Urban Migration
SSP1	High	Low	High	Fast
SSP2	Medium	Medium	Medium	Medium
SSP3	Low	High	Low	Slow
SSP4	Low	Medium	Medium	High-income provinces, medium Low- and middle-income provinces, fast
SSP5	High	Low	High	Fast

2.3.3. GDP Forecasting Model

The Gross Domestic Product (GDP) forecast proposed in this paper is based on the IPCC SSPs future scenario framework and the neoclassical economic model. The Cobb—–Douglas function is used as the basic analysis tool, and the parameters are set according to the long-term historical data of China's economic and population development [42].

The Cobb–Douglas function is algebraically solvable and provides a reasonably good statistical fit for the production process. Its basic form is as follows:

$$Y_{(t)} = A_{(t)} K_{(t)}^{\alpha} L_{(t)}^{1-\alpha} \quad (5)$$

where Y is output (GDP), A is total factor productivity (TFP), K is capital stock, L is labor input, α is the output elasticity of capital, and t represents a certain period. In the following, we will elaborate on the specific calculation methods and the design of future scenarios for each driving force element of economic growth.

The calculation method of labor input is from the SSP population forecast [43]. The working-age population is the basis of production labor factors, but it is also relevant to the entire population. In the Cobb–Douglas production function, the production factor of labor consists of the following three components: the working-age population (*WAP*), the labor force participation rate (*LFPR*), and education (*H*). Labor input L is calculated as follows:

$$L(t) = \sum\nolimits_q H_{(t)} \times LFPR_{(q,t)} \times WAP_{(q,t)} \quad (6)$$

The time index t and the indicator q that distinguish between two age groups are included in the equation. Here, *q1* represents the working-age population aged 15–64, and *q2* represents the working-age population aged 65 and above. Each of these working-age groups has a specific labor force participation rate (*LFPR*). Based on the historical development trajectory of labor participation rates in different age groups and national census data, it is assumed that in different SSP scenarios, the future *LFPR* of the 15–64 age group will converge to different levels, as shown in the table. It is assumed that high economic growth in SSP5 requires a high labor participation rate. In contrast, under SSP3, which represents a very different development path, a very low labor participation rate is assumed. In SSP1 and SSP2, a moderate level of labor participation rate is assumed.

By multiplying the labor participation rate by the corresponding forecast working-age population, we obtained the actual labor population. Next, we considered differences in quality due to different levels of education. This paper uses the Mean Years of Schooling (MYS) of the working-age population as a measure of education [43].The Mean Years of Schooling was obtained from the "China Human Capital Report 2017", and the calculation of human capital in this report adopts the following formula:

$$H = \begin{cases} e^{0.134 \cdot MYS}, & MYS \leq 4 \\ e^{[0.536+0.101\cdot(MYS-4)]}, & 4 < MYS \leq 8 \\ e^{[0.94+0.068\cdot(MYS-8)]}, & MYS > 8 \end{cases} \quad (7)$$

Referring to the historical growth trend in the average years of schooling of the national labor force in the past 30 years (1985–2015), the future changes in the years of schooling are set by linear growth, as shown in Table 4.

Table 4. Changes in MYS of years of schooling under different SSPs.

Pathway	SSP1	SSP2		SSP3	SSP4		SSP5
Annual changes (years)	0.10	Low and middle income	0.04	0.02	Low income	0.03	0.10
		High and middle income	0.06		Middle income	0.04	
		High income	0.08		High income	0.07	
2050 expected target (national average, year)	13.6	Low and middle income	11.5	10.8	Low income	11.2	13.6
		High and middle income	12.2		Middle income	11.5	
		High income	12.9		High income	12.6	

Capital stock was estimated using the perpetual inventory method. The current capital stock price of the whole country and each province in 2015 was estimated.

$$K_{(t+1)} = (1 - d) \cdot K_{(t)} + I_{(t)} \quad (8)$$

where d is the depreciation rate; this paper adopts the calculation result of Shan Hao-jie [44], and the depreciation rate is also uniformly taken as 10.96% in the provincial estimation. t represents the time indicator, and investment I increases the stock of physical capital K, which represents the total capital formation in a region and can be obtained from the data published in China's statistical yearbooks. Then, investment I is further decomposed into $Y(t) * i$. In long-term forecasting, this paper depicts scenarios for the depreciation rate d and the investment rate i based on different development paths and regional development levels.

Considering the sensitivity of capital stock estimation to changes in depreciation rates, this paper sets a relatively long convergence time for depreciation rates under different scenarios, as shown in Table 5. Under SSP1, regions have a higher level of resource utilization technology, resulting in higher capital utilization efficiency and lower depreciation rates, but this takes a longer time to achieve. The SSP2 scenario is closest to the current development path. SSP5 represents an extensive model of high input, high output, and high wastage, and in order to maintain high growth, the depreciation rate also remains at a high level. Under SSP4, high-income regions can access more economic and lending opportunities, enabling them to reach a higher depreciation rate at a faster speed. However, for high- and middle-income regions, as well as low- and middle-income regions, because of weaker political power and limited economic development opportunities, lower depreciation rates are not due to improved resource utilization efficiency but rather are due to a lower level of resource utilization. The SSP3 scenario is opposite to SSP5. Because of regional competition, fragmentation, and even social unrest and conflicts, its technological progress is slow, resulting in higher depreciation rates.

Table 5. Capital depreciation rate under different SSP settings.

Pathway	SSP1	SSP2		SSP3	SSP4		SSP5
Convergence level (numeric value)	9.20%	Low and middle income	10.80%	11.90%	Low income	11.10%	12.80%
		High and middle income	10.30%		Middle income	11.50%	
		High income	9.80%		High income	12.30%	
Convergence time (years)	150	Low and middleincome	100	50	Low income	150	100
		High and middle income	100		Middle income	120	
		High income	100		High income	100	

According to the development experience of developed countries and the historical trajectory of China's investment rate growth, the investment rate i of different development paths is assumed. In order to maintain high growth, it is necessary to maintain a high investment level under SSP5. Under SSP3, the investment rate reduces because of technology stagnation caused by regional competition and rupture. Under SSP4, the decline in investment rates is generally large and highly unequal. High-income regions have more investment opportunities and greater economic capacity than other regions, so future investment rates will remain high. Under SSP1, because of technology progress and breakthrough, the level of dependence on investment is less. The SSP2 scenario most closely resembles the current development trajectory, with the investment rate declining at a moderate speed overall. High-income regions are likely to achieve breakthroughs in science and technology, resulting in higher resource utilization efficiency, and therefore the decline in investment rate will be faster than in the other two regions. Table 6 sets the changes in investment rates under different SSPs.

Table 6. Changes in the investment rate under different SSPs set.

Pathway	SSP1	SSP2		SSP3	SSP4		SSP5
Convergence level (%)	−0.54	Low and middle income	−0.44	−0.70	Low income	−0.61	−0.31
		High and middle income	−0.47		Middle income	−0.52	
		High income	−0.50		High income	−0.37	
Convergence time (%)	27	Low and middle income	30	20	Low income	24	35
		High and middle income	29		Middle income	27	
		High income	28		High income	33	

Total factor productivity (TFP) measures the quality of a country's economic development. A higher TFP means that more output can be produced with the same amount of resources. The current approach to providing TFP inputs to GDP forecasts is based on the assumption of empirically observed growth patterns in the form of exponential growth trajectories. Historical TFP (*Ahis*) is estimated based on the underlying Cobb–Douglas function and its empirical data components including GDP (Y), capital stock (K), and labor (L) in period t:

$$Ahis_{(t)} = \frac{Y_{(t)}}{K_{(t)}^{\alpha(t)}\ L_{(t)}^{1-\alpha(t)}} \tag{9}$$

In both the SSP1 and SSP2 scenarios, the convergence target of α is significantly decreased because of the gradual transformation of the talent structure and the rationalization of factor allocation. Compared with SSP1, SSP2 makes slower progress in achieving structural transformation and increasing education investment. In SSP3, the convergence speed of this elasticity parameter is slower, while in SSP4, α performs slightly better than in SSP3. In the SSP5 scenario, characterized by high international cooperation and high growth, significant capital accumulation is required to sustain its momentum. Table 7 sets capital output elasticities under different SSPs.

Table 7. Setting of capital output elasticities under different SSPs.

Pathway	SSP1	SSP2	SSP3	SSP4	SSP5
Convergence level (numeric value)	0.65	0.65	0.55	0.60	0.75
Convergence time (years)	100	150	150	100	250

For medium- and long-term TFP projections, A_L can be calculated by the following formula:

$$A_{L(t)} = Ahis_{(2015)} * \prod_{i=2016}^{t} \left[1+g_{L(i)}\right] \tag{10}$$

where t represents a certain period and $g_L(i)$ is the predicted value of the TFP growth rate in different periods. The weighted average method is used to calculate the TFP change in each region from t = 2005 to 2015 as the initial value of TPF change g_A.

$$g_A = \frac{\sum_t \left(t \cdot log \frac{Ahis_{(t)}}{Ahis_{(t-1)}} \right)}{\sum_t t} \tag{11}$$

The hypotheses for the future growth rate of TFP are shown in Table 8.

Table 8. TFP growth rate under different SSP sets.

Pathway	SSP1	SSP2		SSP3	SSP4		SSP5
Convergence level (%)	0.90	Low and middle income	0.90	0.20	Low income	0.30	1.20
		High and middle income	1.00		Middle income	0.50	
		High income	1.10		High income	1.00	
Convergence time (years)	50	Low and middle income	100	20	Low income	100	50
		High and middle income	100		Middle income	80	
		High income	100		High income	50	

Adopting a framework based on the conditional convergence hypothesis applied in the neoclassical growth framework, we utilized a modified OECD sectoral index convergence model that reflects the growth convergence trends in terms of per capita output, technological progress, and other aspects among economic regions with similar structural characteristics [45,46].

$$E_{(t)} = E_A^L + \left(E_{(0)} - E_A^L\right) \cdot e^{-\Delta t \beta} \tag{12}$$

where $E(t)$ represents the convergence value at time t, E_A^L represents the medium-to long-term convergence target, $E(0)$ represents the initial value, and β denotes the convergence control parameter for a specific region.

2.4. Scenario Planning

2.4.1. Introduction to Scenario Planning

Most scholars believe that the practice of scenario planning is based on the case study of Shell documented in Wack's paper [47–49]. Regarding the applied effect of scenario planning, some scholars believe that scenario planning is only related to strategic development; for example, MacKay and McKiernan define scenario planning as "a participant and facilitator widely thought on the structure, content and output of creative and innovative strategic process" [50]. Wilson further identified four methods according to their complexity, including sensitivity/risk assessment, strategic assessment, planning focus scenario, and scenario planning for strategic development [51].

Scenario planning provides theoretical guidance and has practical significance for the climate change response, public participation, risk regulation, and other aspects of national parks [52]. In 2007, the U.S. National Park Service discussed the applicability of scenario planning for national park resource management and evaluated the utility of scenario planning in Joshua Tree National Park. Since then, Wind Cave National Park [53] and Alaska's National Park [54] have constructed scenario plans with different objectives and applied them in resource management planning and decision-making processes.

Scenario planning is of great help in the study of climate change, and many studies have used it to explore the potential socioeconomic and physical impacts of climate change [55]. The development of socioeconomic conditions and climate environmental change has a two-way impact. SSPs can show the future social and economic development of the region and provide the basis for scenario planning [56].

2.4.2. Defining the Focal Issue and Identifying Local Key Factors

A national park is a specific area with clear boundaries, which is established by a country and seeks to achieve scientific protection and rational use of natural resources. Its main goal is to protect a large area of natural ecosystems with national representation and promote harmonious coexistence between man and nature [57]. The uniqueness and importance of Sanjiangyuan National Park are mainly reflected in the following two aspects:

On the one hand, located in the ecologically fragile Qinghai–Tibet Plateau region, Sanjiangyuan National Park is the source of life and civilization and is known as the "Water Tower of China". Sanjiangyuan is also the most concentrated area of biodiversity on the plateau and is one of the 32 priority areas for biodiversity in China. It provides habitat for many endemic and rare and endangered species of the Qinghai–Tibet Plateau and is known as the germplasm pool of alpine organisms. At the same time, Sanjiangyuan is a typical area of Cenozoic tectonic movement in the world and a window for the study of geodynamics and the structure of the earth circle, with many geological relics. However, in recent years, global warming and intensified human activities have not been conducive to its long-term development [58].

On the other hand, Sanjiangyuan National Park is located in an underdeveloped ethnic region in western China, where ethnic minorities have distinctive cultural characteristics, and their economic development level is at a low level. Therefore, it is necessary to promote economic development and improve the well-being of residents [59,60]. In order to embed local residents into the background of ecological civilization construction, Sanjiangyuan National Park mainly promotes a rapid increase in resident income through public welfare posts, ecological compensation, industrial transformation, and other ways. At present, the salary income of ecological conservators and franchise income have become the new growth points of herdsmen's income in Sanjiangyuan National Park. But policy income has reached more than 80%, which reflects the great dependence on financial support. Unbalanced development is still the main contradiction. To sum up, the theme of this scenario is focused on ecological protection and economic development.

To put it simply, the key factors are important external driving forces for the realization of scenario themes. They and further indicator layer divisions are presented in Table 9.

Table 9. Local key factors.

Classification	First-Level Indicator Layer	Second-Level Indicator Layer
Nature conservation	Climate change	Changes in average annual temperature, precipitation, and sunshine hours
	Water resource protection	Surface and groundwater resources
	Soil and water conservation	Soil erosion intensity conservation
	Ecosystem quality	Vegetation coverage, desertification, environmental quality, etc.
Economic development	Human activities	Changes in settlements, roads, and infrastructure
	Policies and measures	Policies and management measures

Nature Conservation

According to the data of Sanjiangyuan National Park from 2017 to 2020, in terms of natural protection, three first-level indicator layers, including climate change, resource conservation, and water and soil conservation, have developed well in recent years. The temperature fluctuation in the area where Sanjiangyuan National Park is located is not significant, with an annual average temperature fluctuating around −1.5 °C. Annual average sunshine hours and precipitation are related, showing a slight fluctuation. The climatic conditions are stable overall. Water resource protection has achieved good results, with both surface and groundwater resources showing an increasing trend. The total erosion area has slightly decreased, and the main type of erosion is freeze–thaw erosion.

The performance of the vegetation quality index is not as good as other indicators, and further enhancement in vegetation protection is still needed. As shown in Table 10, from 2017 to 2020, the various indicators of grassland in the area where Sanjiangyuan National Park is located have slightly declined. The vegetation coverage, biomass, and other indicators of forests, desertified land, and wetlands have all achieved steady increases. The comprehensive Ecosystem Functional Quality Index is used to measure the vegetation status, which is expressed by the average values of leaf area index, vegetation coverage, and total primary productivity in the *i*-th year [61]. The specific method is as follows:

$$EQI_{ij} = \frac{LAI_{ij} + FVC_{ij} + GPP_{ij}}{3} * 100\% \tag{13}$$

where EQI_{ij} is the ecosystem quality of zone *j* in year *I*; FVC_{ij} is the relative density of the leaf area index in zone *j* in year *i*; GPP_{ij} is the total primary productivity in period j of year *i*; and FVC_{ij} is the vegetation coverage of period *j* in year *i*. Using the data from 2021, the ecological quality index of Sanjiangyuan National Park was 33.28, and the ecological quality index of the Yangtze River Zone, Yellow River Zone and Lancang River Zone was 30.86, 41.62 and 43.44, respectively. According to the "Technical specification for investigation and assessment of national ecological status—Ecosystem quality assessment" released in 2021, the ecological quality index of Sanjiangyuan National Park is low, which probably is related to the single vegetation type in the Sanjiangyuan area.

Table 10. Monitoring indicators of different categories.

Land Category	Indicators	2017	2018	2019	2020
Grassland	Grass height (cm)	6.2	7.2	4.89	4.89
	Average coverage of dominant species	32.93%	36.40%	30.05%	30.05%
	Average grass yield (kg/hectare)	2189.91	2389.91	2065.91	2065.91
Forest	Cypress plot canopy closure	0.41	0.43	0.43	0.44
	Standard wood stock of cypress plots (m^3)	0.0365	0.04	0.0367	0.0394
	Annual average growth of shrub height (cm)	3.68	3.7	3.71	0.22
Desertified Land	Average vegetation coverage	38%	38%	40%	41%
	Biomass (g/m^2)	94	94	94	96.4
	Average height of indicator species (cm)	19.79	19.79	20.06	20.26
Wetland	Average vegetation coverage	66%	66%	66%	67%
	Biomass (g/m^2)	128	128	130	137
	Average height of indicator species (cm)	13.68	13.68	13.68	13.7

Economic Development

In terms of human activities, according to the 2021 data, the settlements, the length of roads, and the area of other artificial facilities in each region are all increasing. This indicates that planned human activities are increasing.

In the management of Sanjiangyuan National Park, the allocation of management personnel faces the problem that full-time administrative personnel need to be increased and administrative capacity needs to be enhanced. The current management personnel and technical personnel of Sanjiangyuan National Park cannot meet the needs of the park construction. For example, the management committee of Lancang River Zone currently has 45 cadres, managing an area of 31,700 square kilometers, and each person is responsible for supervising an area of 704.44 square kilometers, as shown in Table 11.

Table 11. Personnel allocation of Sanjiangyuan National Park administration in 2023.

Zone	Administrative Staffing	Public Service Staffing	Total Staff
Sanjiangyuan National Park	99	203	302
Yellow River Zone	12	39	51
Yangtze River Zone	25	109	124
Lancang River Zone	12	33	45

In terms of policy implementation, the ecological compensation policy is one of the core projects in the planning of ecological construction in the Sanjiangyuan region. The "one post for one household" policy for ecological rangers in the park is an important measure to promote the combination of ecological protection and targeted poverty alleviation.

The ecological compensation policy mainly includes the following types: forbidding grazing and balancing grazing and livestock. According to statistics, the area of forbidden grazing grassland in Sanjiangyuan National Park is about 512,000 square kilometers, and the area of balanced grazing and livestock grassland is about 22,889 square kilometers. From 2016 to 2022, the government invested more than CNY 6 billion, as shown in Table 12. However, the following shortcomings still exist: on the one hand, a regular ecological compensation mechanism has not yet been formed. The existing ecological compensation is mostly project-based and phased policies. On the other hand, the ecological compensation mechanism is not perfect. At present, the conflicts between wild animals and domestic animals, and between wild animals and human beings, are increasing, and the relevant compensation measures are still in the development stage.

Table 12. Government investment in ecological compensation (billion yuan).

Year	2016	2017	2018	2019	2020	2021	2022	Total
Funds	0.18	0.96	1.25	1.04	1.20	1.03	0.81	6.45

In the process of implementing the "one post for one household" policy, there are also some problems. Firstly, there is an issue with the coverage of management and protection. While there are 27,956 herding households in Sanjiangyuan National Park, only 17,211 of them have been assigned as rangers, leaving 10,745 households uninvolved in the park's management. Moreover, because of the vast area of Sanjiangyuan National Park, covering 190,700 square kilometers, and the scattered residences of ecological rangers, their patrols cover a large area. The monthly income of CYN 1800 can only ensure the operation of their patrol vehicles and basic living expenses. Secondly, the age structure of the rangers needs to be optimized. Taking the Yellow River Zone as an example, nearly 20% of the rangers are over 50 years old, as shown in Table 13. Their physical conditions and ability to learn new knowledge are poorer, which may result in lower work quality compared with younger adults. At the same time, working for extended periods in high-altitude and cold areas can also have adverse effects on the health of the elderly. Additionally, the knowledge and skill levels of the rangers are not high enough. The level of education of ecological rangers in the Yellow River Zone is also shown in Table 13. In the Yellow River Zone, all the rangers in the park have only primary school education, and they are all ethnic minorities. They face challenges in reading, writing, speaking, and listening in the national common language, as well as in using equipment and organizing data.

Table 13. Situation of ecological rangers in Yellow River Zone in 2022.

Category	Education		Age					Gender	
	Primary School	Above	18~30	31~40	41~50	51~60	Above 60	Male	Female
Number of people	3142	0	564	1075	905	574	24	1943	1208
Percentage	100	0	17.95	34.21	28.80	18.27	0.76	61.84	38.45
Ethnicity	3142 (100%)								

3. Results

3.1. Future Population Change in Sanjiangyuan National Park

According to the SSPs, the PDE model was used to forecast the population of Haixi Prefecture, Yushu Prefecture, Guoluo Prefecture, and Naqu Prefecture, and the predicted results are shown in the following figure. The five SSPs all show that the future population of the area where Sanjiangyuan National Park is located will increase first and then decrease. In terms of the changing rate, SSP1 > SSP5 > SSP2 > SSP4 > SSP3, as shown in Figure 3. Under SSP1, the ecosystem stability and sustainability are good, and humans and nature coexist in harmony, with the highest expected population. Under SSP5, good levels of scientific, technological, and economic development, improved health care, and higher incomes lead to longer life spans when fertility changes are small, so the difference between the SSP5 population and the SSP1 population is small. SSP2 is in the medium development path, with a low birth rate and a moderate level of health conditions. Under SSP4, the fertility rate is low, and the mortality rate is moderate under unbalanced development. Under SSP3, the population number is lower than the other paths. Its social contradictions are prominent. By 2050, the maximum gap in the population number under the different paths will be nearly 100 thousand.

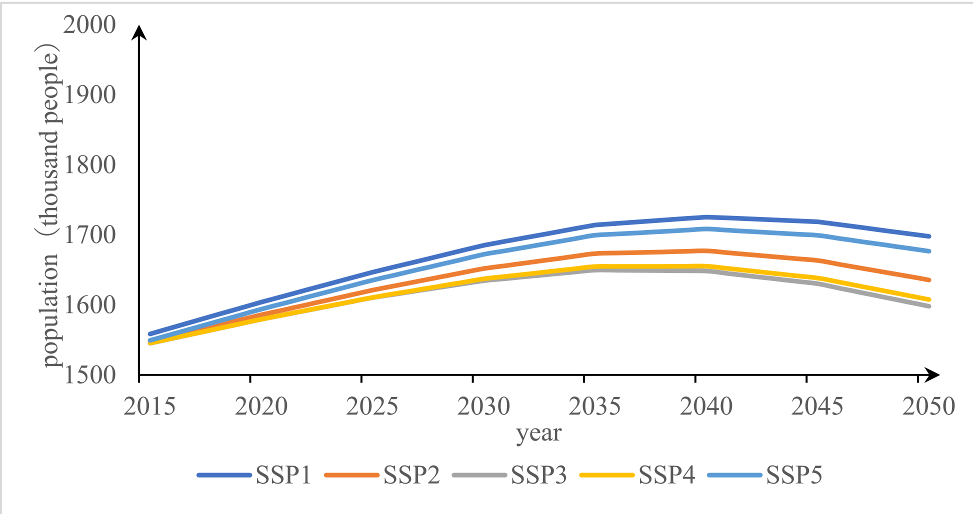

Figure 3. Forecast of population change from 2015 to 2050.

3.2. Changes in GDP

In general, the regional GDP of Sanjiangyuan National Park and its surrounding areas shows an increasing trend year by year (Figure 4). The SSP1 and SSP5 paths rise the fastest, and it is expected that the GDP of the SSP5 path will surpass that of SSP1 in 2047, indicating that the maintenance of the ecological environment and the development of technology are of great significance to the economic development of the region where Sanjiangyuan National Park is located. However, the SSP5 path needs to pay the price of the ecological environment. SSP2 and SSP4 are medium development paths. Social inequality and unbalanced economic growth have negative effects on regional economic development, so more attention should be paid to the efficiency and equity of economic development. On the contrary, the GDP growth level of the SSP3 path is significantly lower than that of the other paths, which represents serious environmental damage, social and economic imbalance, and political and social unrest. By 2050, the maximum GDP gap under different paths is nearly CNY 200 billion, and the GDP levels of the SSP1 and SSP5 paths are about twice that of the SSP3 path, which reflects the huge divergence in economic development under different development paths.

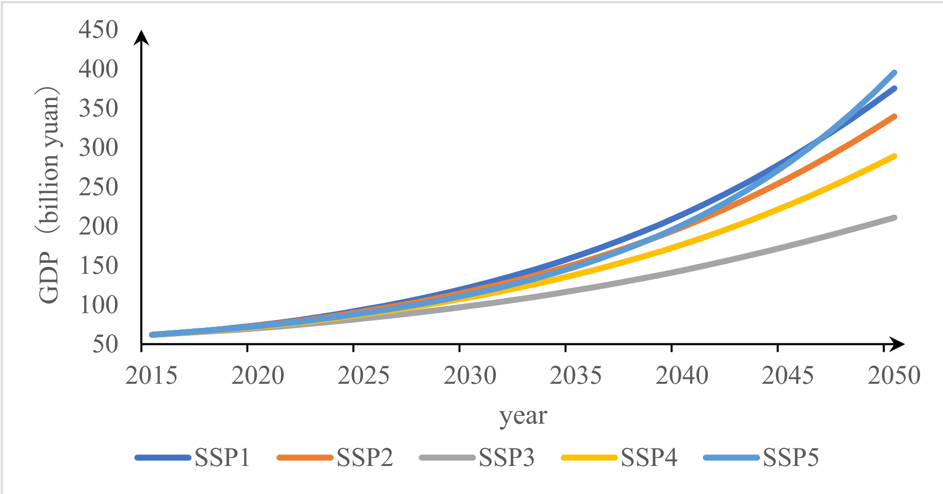

Figure 4. Forecast of GDP change from 2015 to 2050.

By region, the per capita GDP shows an increasing trend year by year, as shown in Figures 5–8. The horizontal comparison of the four regions shows that the per capita GDP of Haixi Prefecture of Qinghai Province is higher than that of the other three regions. The main reason is that compared with the other three regions, Haixi Prefecture has a lower altitude, more convenient transportation, and more residents, which is more suitable for people to live and engage in economic activities. For nature reserves located in high-altitude areas such as Sanjiangyuan National Park, more attention should be paid to feasibility and suitability when developing policies and implementing plans. In terms of development paths, SSP1 and SSP5 have the fastest growth, while SSP3 has the most obvious development difference with the other paths.

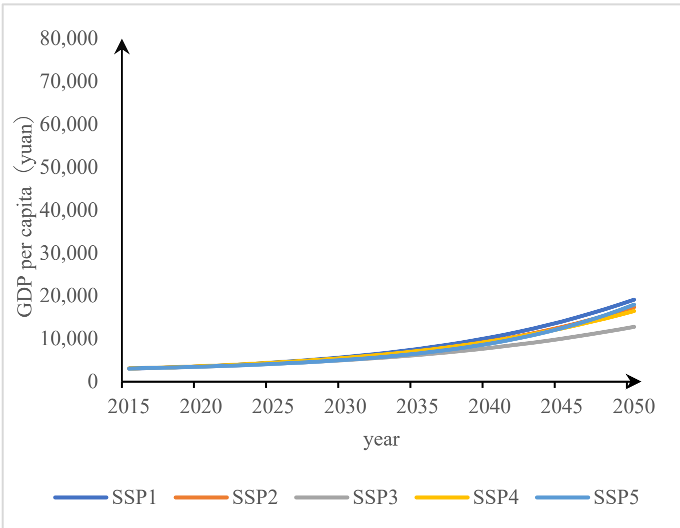

Figure 5. Forecast of per capita GDP in Guoluo.

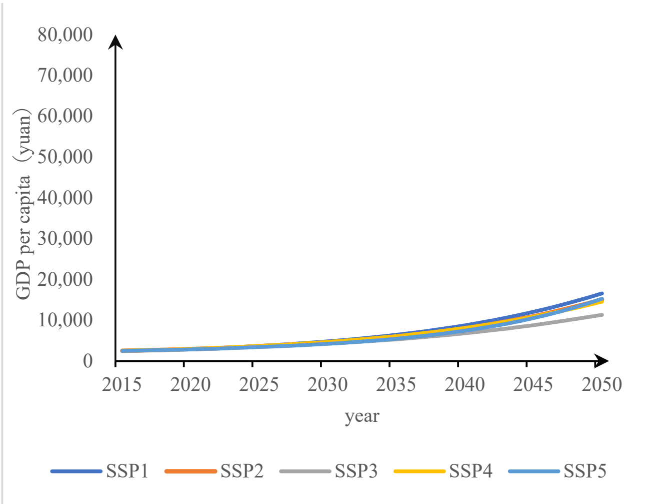

Figure 6. Forecast of per capita GDP in Yushu.

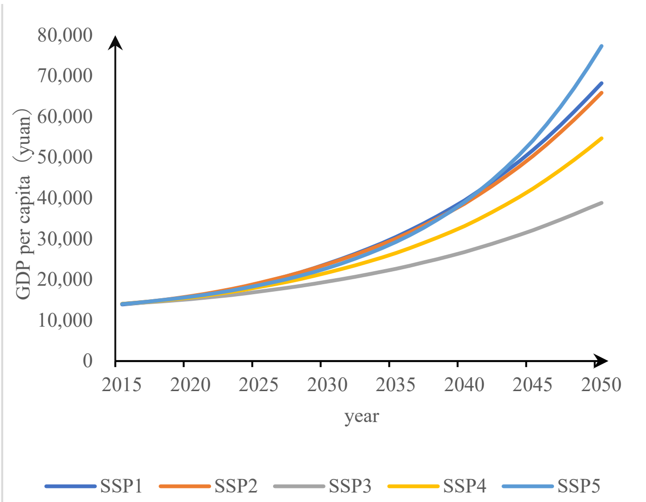

Figure 7. Forecast of per capita GDP in Haixi.

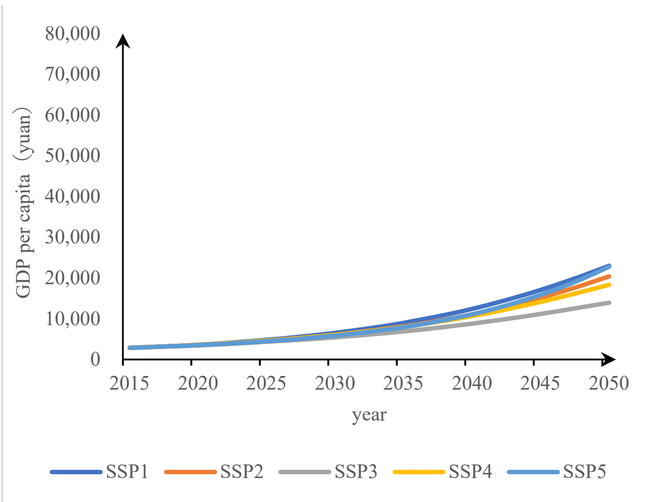

Figure 8. Forecast of per capita GDP in Naqu.

3.3. Develop Narratives of Scenario Planning

After analyzing the above key variables, planning can focus on the content with high importance and uncertainty, and these key variables are called scenario variables. In terms of nature protection, vegetation protection is identified as a scenario variable by comprehensively measuring the current status of various factors of nature protection and the future planning of Sanjiangyuan National Park. In terms of economic development, improving residents' economic levels is an important content of regional economic development in Sanjiangyuan, which is identified as a scenario variable.

In the forecast results of GDP based on the SSP path, the GDP growth level of the SSP3 path is lower than that of all other paths, which represents serious environmental damage, socioeconomic imbalance, and political and social unrest. It does not reflect the role of planning and does not meet the requirements of China for the positive development and planning of national parks, so this path is removed. SSP2 and SSP4 have a small gap in population and GDP development, which represents social inequality and unbalanced economic growth. These two paths can be classified as one scenario. Then, SSP1, which represents sustainable development and technological innovation, and SSP5, which represents rapid economic development and environmental damage, are classified into two scenarios. According to the scenario variables, the scenario scheme is set in Table 14:

Table 14. Scenario settings.

Scenario	Corresponding SSPs Path	Scenario Threshold	Planning Content
Plan A	SSP1	High requirements for vegetation protection; resident economic development	Development in accordance with local conditions and technological innovation
Plan B	SSP2, SSP4	Regional development; unbalanced resident economic development	Different regions develop separately
Plan C	SSP5	Low requirements for vegetation protection; rapidy resident economic development	Minimum ecological protection and attention paid to resident economic development; development fruits feedback

Plan A: Development in accordance with local conditions and technological innovation.

This scenario emphasizes the coordinated development of the economy and ecology, requiring that economic growth for residents must be achieved alongside ecological protection. Economic progress should not come at the expense of environmental integrity. It is essential to ensure that efforts to boost economic development are aligned with the goals of environmental conservation. By making full use of various technical means, the terrain and geomorphology are analyzed. Through the buffer analysis of data such as the land elevation gradient, river hydrology, and vegetation coverage, we can conduct an ecological sensitivity evaluation, classify areas with high sensitivity as key protection areas, and determine the available areas based on planned economic and ecological benefits. Also, the government should grant greater autonomy to each sub-park (Changjiang River Zone, Yellow River Zone, and Lancang River Zone), enabling them to participate in decision-making and rule-making related to vegetation protection and resource management according to their unique features.

Specifically, in terms of resident participation, the government should provide training and financial support and determine the natural endowment, comparative advantages, and characteristic industries of each region. Then, the government can clarify the development way, development path, and development measures, and develop the economy according to local conditions. For example, to improve the "one post for one household" system, different policy standards should be formulated according to the actual population of the family. The government should accelerate the establishment of a mechanism for increasing the labor remuneration of ecological conservators and providing individual care for families under special circumstances. Also, the government should rationally plan patrol routes, increase patrol infrastructure, and formulate clear group and regional patrol plans to reduce the frequency of patrols and better meet policy objectives. It is essential to provide targeted support to certain regions, such as NaQu Prefecture, which falls under the jurisdiction of the Lancang River Zone. Because of its high altitude and harsh climatic conditions, economic development in this area is hindered, and it is predicted that future per capita GDP growth will remain relatively low. Therefore, greater economic support should be directed towards the residents of this region.

In terms of technological development, efforts should be made to attract green technology companies to develop renewable energy sources and research and develop environmental protection equipment in order to reduce resource waste, lower production costs, and improve efficiency. The government should continue to promote the development of photovoltaic industrial parks, pumped-storage power stations, and wind power bases that have already been built and carry out rational layouts of the new energy industry. The government should also cooperate with research institutions to conduct field ecological studies that monitor the health status of vegetation and wildlife communities and conduct supplementary research through academic means.

In terms of external communication, ecological publicity should be emphasized so that tourists can better understand the ecosystem and culture of Sanjiangyuan. This can improve their awareness of environmental protection and reduce adverse impacts on vegetation.

In terms of coordinated regional development, numerous administrative divisions impact the overall ecological development. It is necessary to establish a unified ecological development plan and policy measures, clarify the boundaries and responsibilities of each administrative division, and ensure a clear delineation of rights and responsibilities in terms of ecological protection and economic development. Additionally, enhancing cross-departmental and cross-regional communication and collaboration, through the establishment of joint working mechanisms, information-sharing platforms, and other means, can facilitate resource sharing, complementary advantages, and the formation of a concerted effort. Ultimately, this will guarantee administrative coherence and the efficiency of policy implementation.

Plan B: Different regions develop separately.

In this scenario, the government should take some local environmental protection measures to cope with the pressure on vegetation and the ecosystem, but these measures may be inconsistent in different areas, resulting in local protection and local damage. The economic opportunities of residents may differ in different areas, and some areas may lose the opportunity for economic development because of environmental protection policies.

In key ecological protection areas (usually within Sanjiangyuan National Park), the government should aggressively promote policies such as the conversion of grazing land back to grassland and ecological restoration initiatives. Major biodiversity conservation projects should be actively pursued, alongside ecological initiatives such as wetland protection and restoration, as well as the rescue and protection of endangered wildlife and plant species. Large-scale vegetation restoration projects should be undertaken, including the reintroduction of native tree species and the rehabilitation of degraded grasslands and wetlands. The government should also establish ecological corridors between adjacent nature reserves to enhance the biodiversity protection network. Also, improving the regulatory system, supervising nature reserves, and strictly punishing all types of illegal acts are important. Moreover, the government should reduce the interference of human activities on the ecology of the region, reduce the number of tourists, and implement ecological migration for residents whose living locations affect ecological protection.

Economic development should be conducted in the areas surrounding the national park. In these areas, there may be a conflict between economic priority development and environmental sacrifice. Economic growth is treated as the primary task, with natural resources being fully utilized and resource development serving as a key driver for economic growth. However, economic growth in these regions often concentrates on a few wealthy enterprises and individuals, while most local residents may benefit limitedly from resource development, potentially exacerbating inequality issues. Because of geographical and historical reasons, the economic development of Haixi Prefecture has already surpassed that of the other three prefectures significantly, and the same trend is predicted for the future. Such development will further widen the gap between the rich and poor in the surrounding regions, exacerbating contradictions. Additionally, many residential areas may face environmental risks due to potential problems caused by land destruction and water pollution. In this scenario, balancing resource development and environmental protection becomes a critical challenge. The government should weigh economic growth and the health of vegetation while ensuring that resource development benefits not only a few wealthy individuals but also promotes social inclusiveness and sustainable development.

Plan C: Minimum ecological protection and development feedback.

This scenario focuses on the rapid development of residents' economic levels and, at the same time, carries out the minimum protection of ecology. After economic development, ecological construction is fed back. In this scenario, the plan takes economic growth as the primary task and environmental protection as the secondary goal. The government should encourage land development, resource collection, and industrialization to achieve short-term economic gains. But carrying out minimum protection and paying more attention to economic growth in the short term will lead to inappropriate development and destruction of vegetation in the nature reserve. Also, by vigorously introducing advanced resources and technologies, the development of local characteristic industries will be promoted, and the economy will be developed by taking advantage of the local abundant unique resources. At the same time, the government should actively promote the development of tourism, increase tourism publicity, and strengthen the construction of tourism projects and the development of supporting services. Furthermore, the government should focus on the construction of brands, build integrated tourism resorts, and make Sanjiangyuan National Park the name card of Qinghai Province. Then, the government should drive the development of the whole province through regional development.

However, the use of fossil energy may lead to a substantial increase in carbon emissions, which poses a great challenge to the environment. Carbon emissions are contributing to climate change, potentially leading to more frequent extreme weather events, higher temperatures, and threats to ecosystems. In the long run, economic growth may benefit from resource development, but environmental damage may lead to catastrophic losses and have a serious impact on the economy. The cost of environmental restoration cannot be reflected in the GDP forecast above, so actual economic development should be lower than the forecast level, and there may be inequalities in the coverage of the benefits of resource development. The benefits of resource development may not be equally beneficial to all regional residents, and the degree of social inequality will increase. With the deterioration of the environment, some communities may lose the economic foundation of relying on natural resources, which may lead to poverty, social unrest, and health problems.

4. Discussion

Based on the analysis of the SSP path, Plan A reflects the development idea of the SSP1 path. According to the forecast, the GDP growth in SSP1 is significant, the population growth initially rises and then declines, and the development effect is good. It ensures the protection of nature and fully develops the economy at the same time. Compared with the other plans, Plan B reflects the development ideas of SSP2 and SSP4, but the development paths are not balanced enough. Some areas may lose the opportunity for economic development because of environmental protection policies, and some areas completely focus on the environment, ignoring the importance of economic development. Plan C reflects the development idea of SSP5. Focusing only on economic development may achieve huge benefits in the short term, but in the long term, it cannot obtain the benefits brought by environmental advantages, let alone conform to the positioning of an ecological nature reserve. To sum up, the development idea of Plan A is more suitable for the development of Sanjiangyuan Nature Reserve, and the future development can be started from the following aspects:

The relevant policies, regulations, and management mechanisms should be enhanced by establishing a comprehensive and institutionalized law enforcement system. This system should facilitate seamless integration between administrative law enforcement and criminal justice processes. Additionally, there should be improved coordination in the construction and management of parks across different provinces to address and mitigate the issue of “one park with multiple systems”. This coordination will ensure a unified approach to park management and regulation, thereby reducing administrative fragmentation and promoting more effective governance.

The level of technical equipment should be improved, and relevant training should be carried out to ensure that the system of “one post for one household” can more effectively perform the duties of ecological monitoring and protection. In accordance with the principle of integrated management and protection of mountains, rivers, forests, grass, and lakes, the government should further expand the scale of public welfare posts of ecological management and protection in a scientific and reasonable way, clarify the responsibilities of ecological management personnel, strengthen the training and management of ecological management personnel, implement the assessment system, and explore the introduction of a professional-grade recognition system. The government should increase the benefits given to officials and workers in high-altitude areas and support the establishment of a system of subsidies and rewards for ecological protection.

The government should actively foster pilot franchising operations and properly relax the limits while implementing supervision. Based on the premise of ensuring ecological protection first, the government should follow the concept of classified protection and zoning control and formulate a strong and detailed regulatory framework to ensure that the franchising entities comply with environmental regulations, public interests, and the management plan of the national park. Also, the government should carry out in-depth research on village conditions, village appearances, and the implementation of the rural revitalization strategy, identify the natural endowments, comparative advantages, and characteristic industries of different regions, and clarify development methods, paths, and measures. This research should clarify the optimal carrying capacity of franchise projects, carry out knowledge popularization and environmental protection publicity, and raise the awareness of tourists and franchisees on the protection and sustainable use of national parks, so as to promote sustainable tourism and business practices.

The provision of basic livelihoods should be ensured and employment opportunities should be promoted by addressing critical issues such as power outages and inadequate network communication in designated poverty-relief villages. It is essential to advance and enhance the construction of infrastructure and public facilities. Focus should be placed on key projects such as ecological protection and restoration, franchising, and industrial upgrading. Broadening local employment channels will be crucial in fostering stable employment for impoverished populations. Efforts should also be made to improve the quality of the ecological environment and enhance livelihood security. Additionally, effectively utilizing rural public welfare positions can help to increase income and contribute to overall poverty alleviation.

The government should enhance measures for ecological compensation by establishing a systematic and regular mechanism for such compensation. This should include the development of diverse compensation frameworks. Gradually, the government should explore and implement various market-based compensation methods, such as emission rights trading, water rights trading, and carbon sink trading markets. Additionally, the implementation of preferential tax policies and specialized fiscal measures should be actively pursued to support these compensation mechanisms and incentivize environmental protection.

5. Conclusions

Based on the economic forecast of the Shared Socioeconomic Pathways of the IPCC, this paper forecasts the future population and GDP of the area where Sanjiangyuan National Park is located according to different paths. It is found that the future population will increase first and then decrease. In terms of change speed, SSP1 > SSP5 > SSP2 > SSP4 > SSP3. The GDP will show an increasing trend year by year. SSP1 and SSP5 will increase the fastest. SSP2 and SSP4 will be medium development paths. The GDP growth level of SSP3 will be significantly lower than that of the other paths. A series of key variables are identified to describe the future state of the system and its development path, and vegetation protection and resident economic development are identified as scenario variables. Combined with the SSP paths, the optimal management system scheme and mechanism path under different development modes is constructed. Plan A has high requirements for vegetation protection and the development of residents' economic levels. Plan B has regional development and unbalanced development of residents' economic levels. Plan C has low vegetation protection requirements and a high economic level of residents. In a nutshell, the development path of Plan A is the most suitable for the development needs of Sanjiangyuan National Park. Finally, development suggestions are put forward, such as continuing successful ecological protection through science and technology, focusing on natural endowments, comparative advantages, and characteristic industries to develop the economy according to local conditions, and promoting ecological industrialization and industrial ecology.

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Conflicts of Interest: Author Yang Liu was employed by the company China Three Gorges Corporation. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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