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Spatio-Temporal Variation of the Ecosystem Service Value in Qilian Mountain National Park (Gansu Area) Based on Land Use

Lili Pu [1], Chengpeng Lu [2,*], Xuedi Yang [1] and Xingpeng Chen [1,2]

[1] College of Earth and Environmental Sciences, Lanzhou University, Lanzhou 730000, China
[2] Institute of County Economic Development & Rural Revitalization Strategy, Lanzhou University, Lanzhou 730000, China
* Correspondence: lcp@lzu.edu.cn

Abstract: The value of ecosystem services and service capabilities continue to improve, and the way to form a path of resource industrialization development has become one of the important directions of sustainable development. This paper mainly takes the construction of national parks as a major opportunity and explores the temporal and spatial changes in the value of ecosystem services in Qilian Mountain National Park (Gansu area) and the construction path of the industrial system of national park construction. The total value of ecosystem services was calculated using a comprehensive index of the degree of land use, land contribution rate, ecological service value, equivalent factor of economic value, and the improved value coefficient of farmland ecological services, and then the Sensitivity index was used to reveal the dependence of the value of ecosystem services on the value index over time. The results showed the following: (1) Human disturbance factors in Qilian Mountain National Park (Gansu area) are weak, and the land use of Qilian Mountain National Park (Gansu Area) was mainly grassland, followed by unused land, forest land, and glacial snow, with the change in glacial snow cover being the largest. (2) The ecosystem of Qilian Mountain National Park (Gansu area) is strong, and the contribution rate of forest land, construction land, unused land, and glacial snow cover in Qilian Mountain National Park (Gansu Area) was positive, while cultivated land, grassland, and water area were negative. Among them, glacial snow cover contributed the most at 10.4723 the ecological barrier function plays a stable role. (3) The ecosystem service value (ESV) in Qilian Mountain National Park (Gansu Area) showed a fluctuating growth trend on the whole, showing the characteristics of high northwest and low southeast, among which the total value of grassland was the largest, the value of unused land was the smallest with the largest increase range, and the increase in water area was the smallest. (4) Qilian Mountain National Park (Gansu Area) is mainly based on regulated services, followed by support services, supply services, and cultural services, all showing a clear growth trend, increasing by 181.77%, 183.90%, 196.19%, and 170.38%, respectively. With the development of low-carbon economy and circular economy as the main idea, we aim to build a national park industrialization development path of direct product supply, indirect product supply, and basic guarantee.

Keywords: ecosystem services value; land use intensity; land use change; sensitivity analysis; Qilian Mountain National Park (Gansu Area)

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1. Introduction

The continuous satisfaction of economic and social service functions by ecosystem services is an important basic prerequisite for achieving their continued function [1]. In 2015, China promulgated and implemented the “Opinions of the Development and Reform Commission on the Key Work of Deepening Economic System Reform in 2015” to carry out a “pilot national park system” in nine provinces, including Sichuan, Hainan, and Guangdong, and in 2021, China officially established the first batch of national parks, which included

Sanjiangyuan, giant pandas, Northeast tigers and leopards, Hainan tropical rainforest, and Wuyi Mountain, covering an area of 230,000 square kilometers, covering nearly 30% of the terrestrial areas of the national key protected wild animal and plant species. Due to the coupling characteristics of the natural and cultural landscapes of China's natural resources themselves [2], more attention is being paid to the attributes of cultural characteristics and the needs for integrated development, such as ecosystem service functions, social functions, and premium functions, in the process of their development [3]. The proposal national park construction explores the shift from the ecological protection system dominated by nature reserves to the nature reserve system with national parks as the main body, providing a typical development model for the overall protection of the global natural system and paying attention to the important role of ecological assets [4]. As an important ecological barrier typical of western China [5], the Qilian Mountains play an important role in helping to maintain the balance of the oasis ecosystem in the Hexi Corridor [6] and cultural symbols [7,8], and the way to better highlight the service characteristics in the protection system dominated by national parks has become an urgent problem.

Ecosystem services refer to the environmental conditions and utilities formed and maintained by ecosystems for human survival and development, and all the benefits directly or indirectly obtained by human beings from the ecosystem, including four aspects of supply services, regulation services, support services, and cultural services [9]. The research on the value of China's ecosystem services has been carried out by Xie Gaodi [10] to develop the "China terrestrial ecosystem service value equivalent factor table". It provides a basis for calculating regional ecosystem values and is widely used, and the coordination between ecosystem services is constantly weighed [11]. The main types of ecosystems are farmland, forests, grasslands, wetlands, oceans, and cities [12], which can provide people with systematic service functions—that is, the various utilities that humans obtain from the ecosystem [13]. Similarly, they provide a variety of services to humans, directly or indirectly, and have been widely discussed in the academic community [14]. For example, Costanza first assessed global natural capital in 1997, mainly using ecosystem goods and services [15]. De Groot et al. defined ecosystem functioning as the ability of natural processes and their components to provide goods and services that meet direct or indirect human needs [16]. Since the United Nations Millennium Assessment (2005), which pointed out that ecosystem services refer to the benefits that people receive from ecosystems, ecosystem services science has made many advances in developing the core concepts and methods [17]. The research and development of ecosystems continue to deepen, and the importance of the development of economy [18], society [19], and urban ecosystem service value prediction continues to increase [20], which not only plays an important role in the construction of national parks [21] but also in human development, such as cultural development [22] and landscape value [23]. In 2021, the United Nations officially adopted the new framework of environmental–economic accounting–ecosystem accounting (SEEA-EA) to further promote sustainable economic and social development. In the study of ecosystem service value in China, it has been proposed that ecological equivalent factors [10] rely on continuous optimization and in-depth calculation of ecosystem value. In 2020, the Ministry of Ecology and Environment and the Research Center for Eco-Environmental Sciences of the Chinese Academy of Sciences jointly compiled a technical guide for accounting for the terrestrial ecosystem product (GEP) and then extending the function and value of recreation services to the ecosystem [24], which continues to enrich the research on the value system of ecosystem services with a focus on counties [25]. Similarly, with the transformation and development of China's economy and society, more attention should be paid to connotative development and cross-regional ecological economic linkage development [26], and the role of the vegetation index in ecosystems should be fully utilized [27].

Ecosystem service function and ecological sensitivity are important contents of ecological protection evaluation [28], and the process of national park construction not only pays attention to the supply capacity of the ecosystem itself but also divides national parks into strictly protected areas, ecological conservation areas, traditional use areas, and scientific and educational recreation areas [29], and also pays more attention to the reuse of other extended functions such as cultural aesthetics. Some scholars have made calculations based on GEP (gross ecosystem product), demonstrating that the ecological value is the most prominent [30]. The Qilian Mountains are ecologically fragile and sensitive areas, and ecological restoration is more difficult [31], but the way to further realize the service value of the ecosystem as a national park, better serve the local economy, and society to play a better role and form a benign interaction with the ecosystem has become an urgent problem to be solved. As such, the systematic protection of national parks as the main body has become a typical case demonstration.

This paper mainly relies on the importance and resource characteristics of ecological economic development, taking Qilian Mountain National Park (Gansu area) as an example. First, the ecosystem service value equivalent factor was used to analyze the changes in ecosystem service value from 2000 to 2019 and enrich the application research of ecosystem service value equivalent factor. Second, combined with the economic development of the Qilian Mountains and its surrounding areas, highlight the characteristics shared by the people of national park construction, build a national park industrialization development path of direct product supply, indirect product supply and basic guarantee, and put forward countermeasures and suggestions for national park construction. We also hoped to provide a typical case for the development of terrestrial ecosystems around the world.

2. Overview of the Study Area

Qilian Mountain National Park (Gansu Area) covers an area of 34,400 km^2, accounting for 68.5% of the total area, involving the seven counties (districts) of Subei Mongol Autonomous County, Aksai Kazakh Autonomous County, Sunan Yugur Autonomous County, Minle County, Yongchang County, Tianzhu Tibetan Autonomous County, and Liangzhou District, including Qilian Mountain National Nature Reserve, Yanchiwan National Nature Reserve, Tianzhu Three Gorges National Forest Park, Horseshoe Temple Provincial Forest Park, Binggou River Provincial Forest Park, and other protected areas. The terrain is basically high in the south and low in the north, located in a cold area with a plateau continental climate and rich natural environment. It consists mainly of Qinghai spruce forest, shrub forest, and a small number of Qilian cypress, birch, and aspen forests, grassland meadow steppe, desert steppe, and alpine grassland. The vegetation growth in the area is good, and the forest coverage rate reaches 28.8% [32] (Figure 1).

As of 2019, The 7 counties (districts) of Qilian Mountain National Park (Gansu Area) have a land area of 1232.2 square kilometers and a population of 1460.3 thousand, the GDP totaled 7.974 billion USD, the investment in fixed assets was 5.338 billion USD, and the added value of the primary, secondary, and tertiary output was 1.964, 1.641, and 4.369 billion USD, respectively (According to the information released by the National Bureau of Statistics of China, the conversion of US dollars and RMB is based on the average exchange rate of US dollars and RMB in 2020—that is, 1 US dollar to 6.8974 yuan) (Table 1).

Table 1. Statistics of major indicators of Qilian Mountain National Park (Gansu Area) in 2019.

County (District)	Major Indicators						
	Area [1]	Population [2]	GDP	Value of the Primary	Value of the Secondary	Value of the Tertiary Output	Fixed Investment
	sq. km.	tp	Billion USD	Billion USD	Billion USD	Billion USD	Billion USD
Subei mongolian prefecture	667	15.1	0.236	0.016	0.099	0.121	0.6
Akesai kazak autonomous county	314	11.0	0.149	0.012	0.046	0.091	0.416
Minle county	37	192.5	0.851	0.275	0.163	0.413	0.793
Yongchang county	74	177.6	1.13	0.263	0.303	0.564	0.451

Table 1. *Cont.*

County (District)	Major Indicators						
	Area [1]	Population [2]	GDP	Value of the Primary	Value of the Secondary	Value of the Tertiary Output	Fixed Investment
	sq. km.	tp	Billion USD	Billion USD	Billion USD	Billion USD	Billion USD
Tianzhu tibetan autonomous county	71	151	0.663	0.17	0.127	0.366	0.552
Liangzhou district	49	885.3	4.559	1.127	0.788	2.644	2.368
Sunan Yugur Autonomous County	202	27.8	0.386	0.101	0.115	0.17	0.158
Total	1232.2	1460.3	7.974	1.964	1.641	4.369	5.338

1. sq. km.: Square kilometer. The data are mainly from the official websites of seven county (district) governments.
2. Population data are the seventh national census. "tp" represents "thousand people".

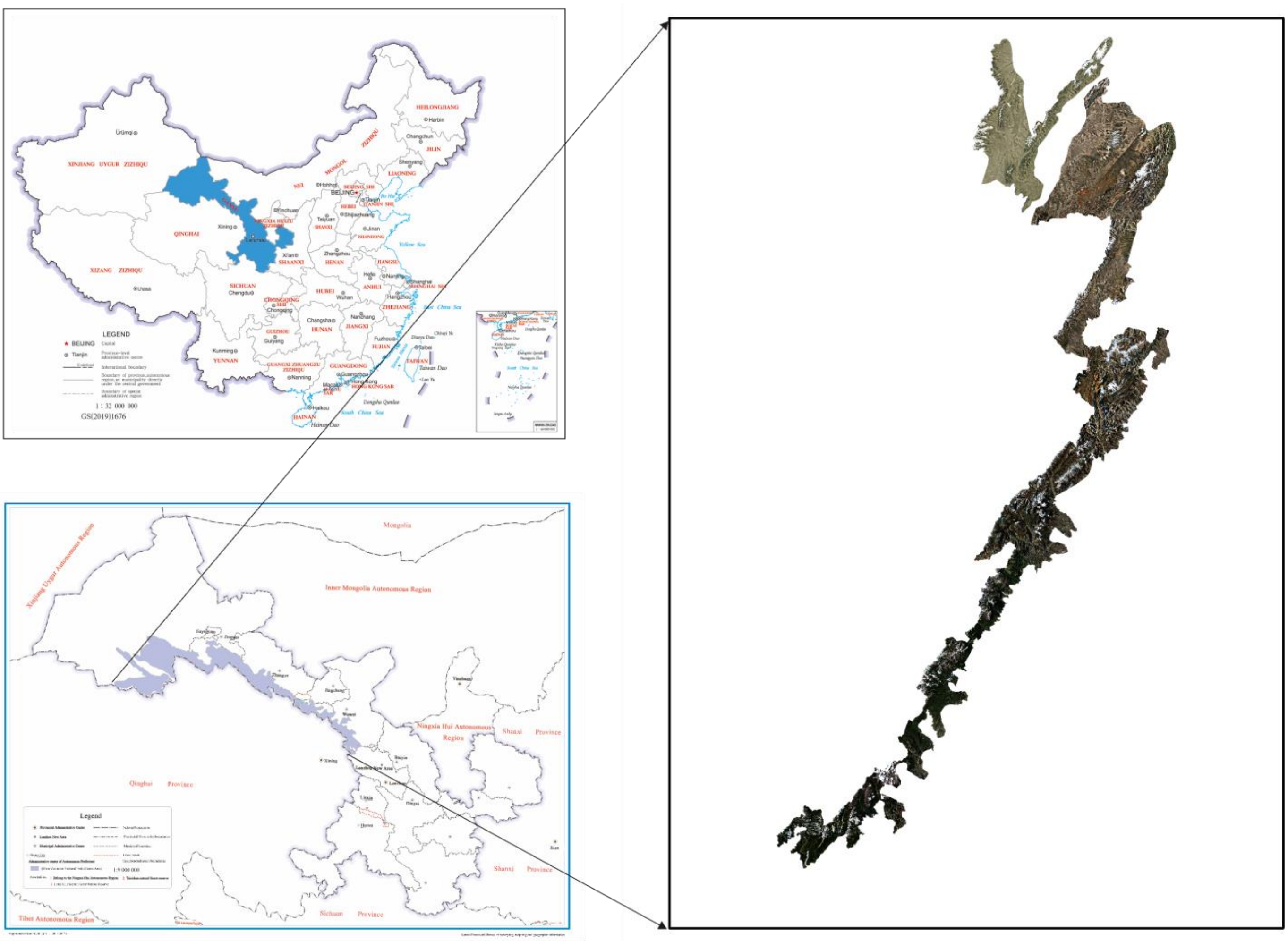

Figure 1. Location of the study area.

3. Materials and Methods

3.1. Data Sources and Processing

The remote sensing monitoring dataset of land cover change in China (CNLUCC) provided by the Data Center for Resources and Environmental Sciences of the Chinese Academy of Sciences from 2000 to 2019 was provided by the Data Center for Resources and Environment Science of the Chinese Academy of Sciences, and this paper analyzed the land use changes according to the first-level classification method of land use type of the system, namely, arable land, forest land, grassland, water, construction land, and unused land. The data on grain crop output and sown area came from the Gansu Development Yearbook, while the grain price data were from the Summary of National Agricultural Product Cost and Benefit Data. These data are widely used in the study of the value of ecosystem services in China [33,34] (Figure 2).

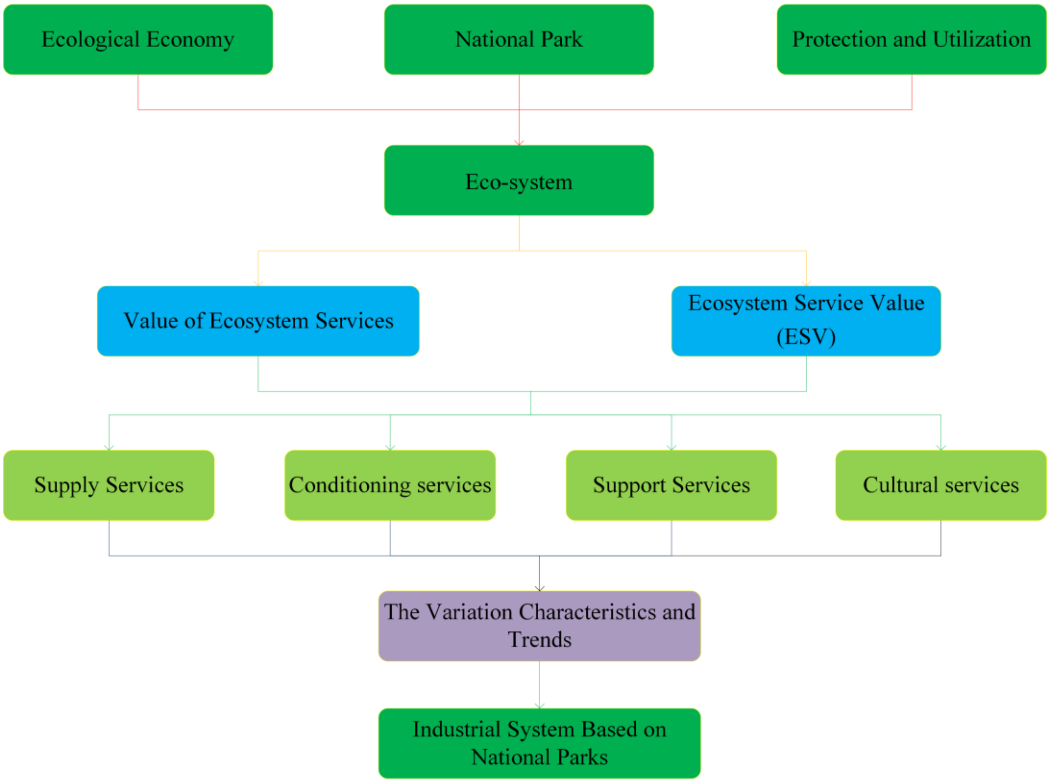

Figure 2. Flow chart. Based on the background of the construction of a community with a shared future for man and nature with Chinese characteristics, relying on the construction of the main body of national parks, highlighting the relationship between ecological economic development and ecosystem protection and utilization, calculating the value of ecosystem services through the equivalent factor of ecosystem services, maximizing the benefits of the four major ecosystem service functions of supply, regulation, support and culture, and analyzing the changing characteristics and trends of the four, and then putting forward countermeasures and suggestions for the construction of an industrial system dominated by national parks.

3.2. Research Methods

3.2.1. Analysis of Degree of Land Use and Change Characteristics

1. Composite Index of Land Use

The comprehensive index of the degree of land use (L) reflects the degree of human development and utilization of regional land and is an important indicator to measure the depth and breadth of regional land use. Its formula is expressed as [35]:

$$I = \sum_{n-1}^{n} (L_i \cdot P_i) \cdot 100\%, \quad (1)$$

where I represents the comprehensive index of land use intensity, L_i represents the land use intensity grade of the class I land use type, and P_i represents the proportion of class I land use type to the total land area.

In order to quantify the influence of each land use type on the change of the comprehensive index of land use intensity, the contribution rate of land type use intensity was introduced, and the calculation method is as follows [35]:

$$R_i = \frac{I_{ib} - I_{ia}}{I_{ia}} = \frac{L_i \cdot (P_{ib} - P_{ia})}{L_i \cdot P_{ia}}, \quad (2)$$

where I_{ib} and I_{ia} are the land use intensity index for the class I land use types b year and a year, respectively. P_{ib} and P_{ia} refer to ratio of the type I land use type to the total land area, respectively. L-i. denotes the land use intensity rating of the class I land use type. R_i is the contribution rate of the land use intensity composite index of class I land use type from a to b years, where a negative value means that its contribution makes the land use intensity composite index smaller, while a positive value indicates that its contribution makes the land use intensity composite index larger. The larger the absolute value of R_i, the greater the contribution of class I land use types to the change of the overall land use intensity composite index—that is, the greater the impact.

2. Analysis of land use change characteristics

The land use transfer matrix is the basis for analyzing the direction of regional land use change, which can reveal the structural characteristics and transfer direction of land use changes [36]. The rate of land use change can be expressed in terms of land use dynamics. A single land use dynamic degree can visually reflect the intensity of change in various land types [37].

$$K = \frac{U_b - U_a}{U_a} \times \frac{1}{T} \times 100\%, \quad (3)$$

where K is the dynamic degree of a certain land use type. Ua and U_b represent the area of a land use type at the beginning and end of the study period, respectively. T is the study period for a land type.

3.2.2. Approaches to Valuing Ecosystem Services

Referring to the research results of Xie Gaodi [38], Sutton and Costanza [39], and others, the economic value of the national ecosystem ecological service value equivalent factor was calculated, and the proposed equivalent factor table defines the economic value of the annual natural food yield of farmland, with a national average yield of 1 hm^2 being 1 [40] and the value equivalent factor of other ecosystem services being a relative quantity, which refers to the contribution of the ecological service relative to the farmland food production service.

The economic value of grain production can be calculated as [35]:

$$E_c = \frac{1}{7} T_a \cdot T_b, \quad (4)$$

where E_c is the economic value of grain production. T_a is the average grain benchmark yield (kg/hm^2) in the study area study area. T_b is the unit price of grain in the study area. 1/7 refers to the natural ecosystem without human input in the unit area, and the economic value provided by the natural ecosystem without human input is 1/7 provided by existing farmland [35]. According to the biomass factor table of farmland ecosystem in different provinces in China [10], the biomass factor of farmland ecosystem in Gansu was 0.42, and the value coefficient of farmland ecological service in Qilian Mountain area was 0.85 after adjustment according to the actual situation.

The service value coefficient of each ecological service function can be calculated as follows [41]:

$$VC_{ij} = E_c \cdot f_{ij}, \quad (5)$$

where VC_{ij} is the coefficient of the jth ecological service value of the ith land use type (dollar/hm^2·a), and f_{ij} represents the equivalent factor of the jth ecological service value of the *i*th land use type. From 2000 to 2019, the average grain output of Qilian Mountain National Park (Gansu Area) was 66,009.02 kg/hm^2, and in 2019, the average grain price of the seven counties (districts) of Qilian Mountain National Park (Gansu Area) was 4.26 USD/hm^2, while the value of ecosystem services in Qilianshan National Park (Gansu Area) was calculated as 38,587.18 USD/hm^2. Furthermore, the value of ecosystem services in the study area was calculated [41]:

$$ESV = \sum_{i=1}^{n}(A_k \times VC_k) \qquad ESV_f = \sum_{i=1}^{n}\left(A_k \times VC_{jk}\right), \tag{6}$$

where ESV and ESV_f are the total value of ecosystem services and the functional value of the *f*-service, respectively. A_k represents the area of land use type k (hm^2). VC_k and VC_{jk} are the ecosystem service value coefficient and the *f*-service function value coefficient for land use type k, respectively.

3.2.3. Sensitivity Analysis

This paper used the Coefficient of Sensitive (CS) index commonly used in economics to reveal the dependence of the value index on the change of ecosystem service value over time, so as to reduce the uncertainty of the results. According to CS, to better verify the stability of the change trend and characteristics of the total value of ecosystem services in Qilian Mountain National Park (Gansu area) from 2000 to 2019. In this paper, CS was calculated by increasing or decreasing the ecological service value coefficient VC by 50% for each land use type [42].

$$CS = \left|\frac{(ESV_j - ESV_i)/ESV_i}{\left(VC_{jk} - VC_{ik}\right)/VC_{ik}}\right|, \tag{7}$$

where VC_{ik} and VC_{jk} represent the value coefficient of ecological services per unit area of Category k ecosystems before and after adjustment. ESV_i and ESV_j represent the total value of ecological services before and after the adjustment, respectively. CS is the sensitivity of the value coefficient of each ecosystem service in the study area. If $CS > 1$, ESV is elastic to VC, the accuracy of the value coefficient is poor, and the confidence is low. If $CS < 1$, ESV is not elastic to VC and the results are credible.

4. Results

4.1. Change Characteristics of Land Use Degree

4.1.1. Land Use Change Characteristics

From 2000 to 2019, Qilian Mountain National Park (Gansu Area) was mainly divided into four phases of arable land, forest land, grassland, water, unused land, construction, and glacier five types of land use types. Specifically, there were mainly the following aspects:

In the study periods of 2000, 2005, 2010, 2015, and 2019, different land types in Qilian Mountain National Park (Gansu Area) changed to varying degrees according to the remote sensing monitoring dataset of land cover change in China, mainly as follows: The area of unused land continued to increase, and the area of forest land, glacial snow cover, and construction land fluctuated and increased. The fluctuation of cultivated land and grassland area decreased. Specifically, the proportion of unused land increased from 35.21% (1,075,888.26 hm^2) in 2000 to 36.43% (1,122,641.01 hm^2) in 2019. The proportion of forest land increased from 5.18% (158,374.26 hm^2) in 2000 to 11.37% (350,380.26 hm^2) in 2019, the proportion of glacial snow area increased from 0.29% (8892.72 hm^2) in 2000 to 3.34% (102,892.68 hm^2) in 2019, the proportion of construction land increased from 0.0015% in 2000 (46.08 hm^2) to 0.0048% (147.60 hm^2) in 2019, the proportion of cultivated land decreased from 0.31% (9324.27 hm^2) in 2000 to 0.28% (8717.04 hm^2) in 2019, and the proportion of grassland area decreased from 58.4668% (1,786,700.07 hm^2) in 2000 to 48.34% in 2019 (1,489,829.58 hm^2) (Table 2).

Table 2. Changes in land use area and proportion of Qilian Mountain National Park (Gansu Area) from 2000 to 2019 (units: hm^2, %).

Land Use Types	Area and Proportion					2000–2019 Rate of Change/%	Dynamics of Single Land Use/%
	2000	2005	2010	2015	2019		
Farmland	9324.27 0.31%	12,627.63 0.40%	9274.59 0.30%	9231.30 0.30%	8717.04 0.28%	−6.51	−0.02
Forestland	158,374.26 5.18%	457,176.42 14.66%	164,074.86 5.26%	319,009.05 10.2883%	350,380.26 11.37%	121.24	0.30
Grassland	1,786,700.07 58.47%	1,166,820.21 37.42%	1,613,574.54 51.72%	1,468,309.32 47.35%	1,489,829.58 48.34%	−16.62	−0.04
Water	16,695.90 0.55%	17,494.11 0.56%	6078.24 0.19%	113,096.97 3.65%	7452.81 0.24%	−55.36	−0.14
Built-up area	46.08 0.0015%	58.41 0.0019%	22.59 0.0007%	88.47 0.0029%	147.60 0.0048%	220.31	0.55
Unused land	1,075,888.26 35.21%	1,389,957.39 44.57%	1,219,935.60 39.11%	1,103,931.09 35.60%	1,122,641.01 36.43%	4.35	0.01
Glacial snow	8892.72 0.29%	74,350.26 2.38%	106,632.45 3.42%	87,024.51 2.81%	102,892.68 3.34%	1057.04	2.64

From the perspective of land use structure, grassland was the main one, followed by unused land, forest land, and glacial snow cover, with annual average area ratios of 48.66%, 38.18%, 9.35%, and 2.45%, respectively, while the annual average area ratios of cultivated land and construction land were 0.32% and 0.0023%, respectively. In terms of change rate and up, the change range was 1057.04%, 220.31%, and 121.24%, and the dynamic degree of single land use was 2.64%, 0.55%, and 0.30%, respectively (Figure 3).

4.1.2. Land Use Change Characteristics

In this paper, with reference to the land use intensity grading method [35,43], the use intensity of the land use type in the study area was divided into five levels and assigned the corresponding index in Formula (1), with the specific land use degree detailed in Table 3.

Table 3. Assignment table for land use intensity ratings.

	Unused Land (Glacial Snow)	Water	Forestland (Grassland)	Farmland	Built-Up Area
Degree of land use	1	2	3	4	5

According to the actual situation of the study area and the division of land use intensity grades in existing studies, this paper divided them into five levels, assigned them to the grades, and obtained the land use intensity index and its changes in the four phases of Qilian Mountain National Park (Gansu Area) in 2000, 2005, 2010, 2015, and 2019 (Table 4).

Table 4. Land use intensity and rate of change in Qilian Mountain National Park (Gansu Area).

	Land Use Intensity Index	Amount of Change in the Land Use Intensity Index	Rate of Change in Land Use Intensity
2000	2.2877	—	—
2005	2.0594	−0.2283	−9.98%
2010	2.1506	0.0912	4.43%
2015	2.1984	0.0478	2.22%
2019	2.2052	0.0069	0.31%

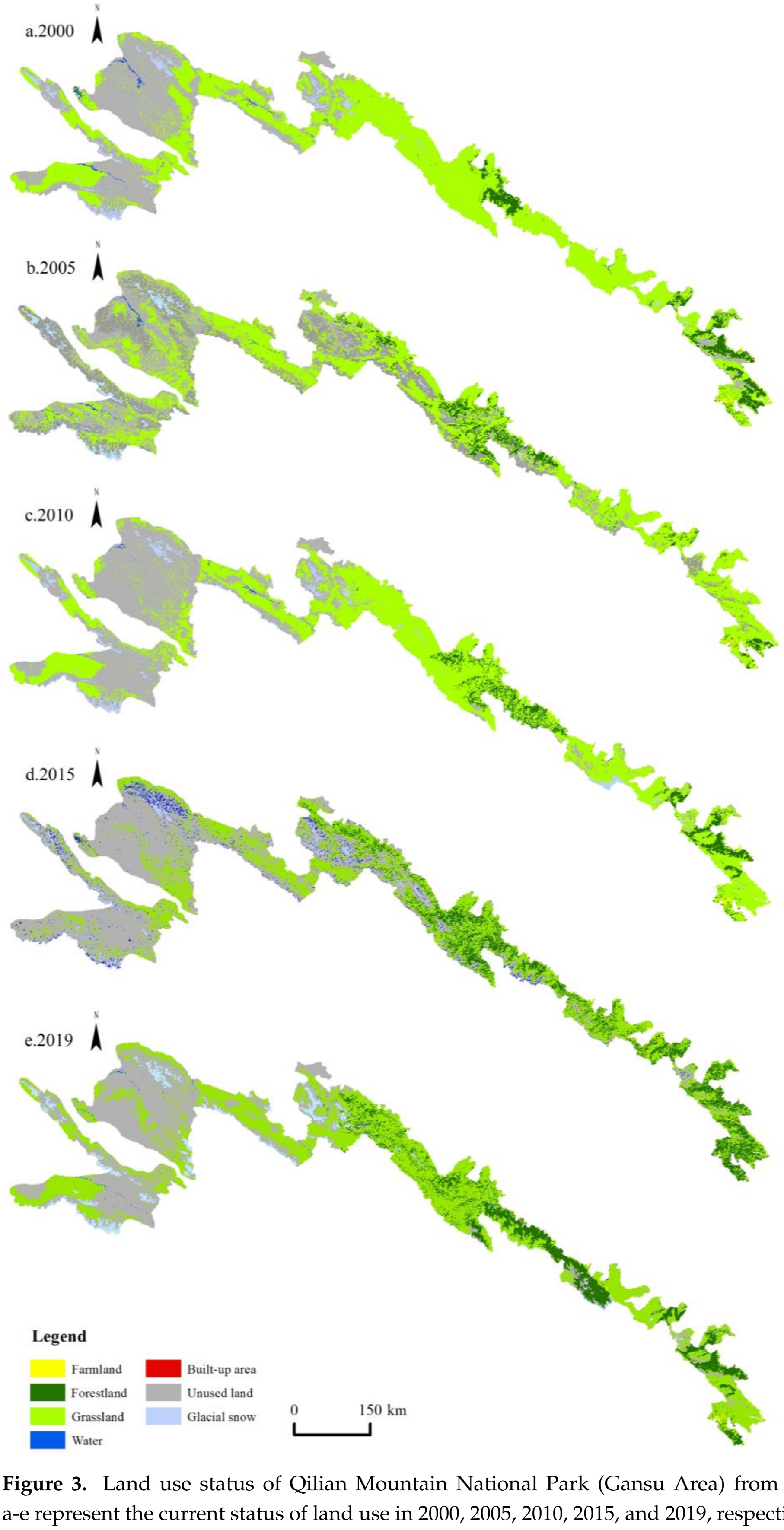

Figure 3. Land use status of Qilian Mountain National Park (Gansu Area) from 2000 to 2019. a-e represent the current status of land use in 2000, 2005, 2010, 2015, and 2019, respectively.

The variation range of Qilian Mountain National Park (Gansu Area) was large during the study period, and the change range of each study period was very different, but the land use intensity index was very low. Analysis of the results calculated according to Formulas (2) and (3), The land use intensity indices and their changes for the five periods 2000, 2005, 2010, 2015, and 2019 are shown in Table 5.

Table 5. Contribution rate of land use intensity by land type in Qilian Mountain National Park (Gansu Area).

	Farmland	Forestland	Grassland	Water	Built-Up Area	Unused Land	Glacial Snow
2000–2005	0.3271	1.8288	−0.3600	0.0268	0.2421	0.2660	7.1931
2005–2010	−0.2658	−0.6412	0.3824	−0.6527	−0.6134	−0.1226	0.4337
2010–2015	0.0014	0.9561	−0.0845	17.7203	2.9402	−0.0896	−0.1789
2015–2019	−0.0500	0.1050	0.0208	−0.9337	0.6784	0.0231	0.1895
2000–2019	−0.0731	1.1936	−0.1732	−0.5574	2.1760	0.0346	10.4723

From the study period from 2000 to 2019, the contribution rate of forest land, construction land, unused land, and glacial snow cover was positive, while for cultivated land, grassland, and water area, it was negative. The contribution rate of glacial snow cover was 10.4723, and the contribution rate of construction land and forest land was also relatively large and positive, indicating that during the study period, a very small portion of arable land, grassland, and water areas in Qilian Mountain National Park (Gansu Area) was developed or developed into glacial snow, construction land, or woodland. Specifically:

First, from 2000 to 2005, the contribution rate of arable land, forest land, water area, construction land, unused land, and glacial snow cover was positive, only grassland contributed negatively. The contribution rate of glacial snow cover was the largest at 7.1931, and the contribution rate of forest land and cultivated land was 1.8288 and 0.3271, respectively. This shows that from 2000 to 2005, grassland was developed or developed into arable land, forest land, water, construction land, unused land, or glacial snow.

Second, from 2005 to 2010, the contribution rate of grassland and glacial snow cover was positive, while the contribution rate of cultivated land, forest land, water area, construction land, and unused land was negative, and the contribution rate of water area was the largest and negative. This indicates that from 2000 to 2005, arable land, forest land, water areas, construction land, and unused land were developed or developed into grassland or glacier snow.

Third, from 2010 to 2015, the contribution rate of arable land, forest land, water area, and construction land was positive, while the contribution rate of grassland, unused land, and glacial snow cover was negative, and the contribution rate of water area was the largest and positive. This illustrates that grassland, unused land, and glacial snow cover were developed or developed into arable land, forest land, water area, or construction land.

Fourth, from 2015 to 2019, the contribution rate of forest land, grassland, construction land, unused land, and glacial snow cover was positive, while the contribution rate of cultivated land and water area was negative, and the contribution rate of construction land was the largest and positive. This shows that, from 2015 to 2019, cultivated land and water areas were developed or developed into forest land, grassland, construction land, unused land, or glacier snow.

4.2. The Value of Ecosystem Services

4.2.1. The Temporal Variation Characteristics of the Total Value of the Service

From the perspective of the total value of ecosystem services of land types, the total value of ecosystem services in Qilian Mountain National Park (Gansu Area) from 2000 to 2019 showed a trend of fluctuation with an increase, with an overall increase of 990.2085 billion USD according to Formulas (4)–(6).

First, the total value of services increased from 542.1147 billion USD in 2000 to 3521.2048 billion USD in 2015, an increase of 182.66%, and then dropped to 1532.3232 billion USD in 2019, a decrease of 54.68%, showing a clear inverted "U" growth trend (Table 6).

Table 6. The total value and proportion of ecosystem services of each land type in Qilian Mountain National Park (Gansu Area) and the corresponding changes.

	Total Value of the Service and Percentage									
	2000		**2005**		**2010**		**2015**		**2019**	
Farmland	0.4844	0.09%	1.2263	0.14%	1.9925	0.10%	2.2898	0.06%	1.3488	0.09%
Forestland	46.7240	8.62%	252.0863	27.94%	200.1601	9.91%	449.3289	12.76%	307.8546	20.08%
Grassland	455.8161	84.08%	556.3551	61.65%	1702.1868	84.26%	1788.3872	50.79%	1131.9449	73.87%
Water	37.9062	6.99%	74.2339	8.22%	57.0635	2.82%	1225.9076	34.81%	50.3932	3.29%
Unused land	0.0007	0.01%	0.0016	0.01%	0.0013	0.01%	0.0061	0.01%	0.0062	0.01%
Glacial snow	1.1833	0.21%	18.4907	2.04%	58.6723	2.90%	55.2853	1.57%	40.7754	2.66%
Total	542.1147	100%	902.3941	100%	2020.0764	100%	3521.2048	100%	1532.3232	100%

	Amount of Change				
	2000–2005	2005–2010	2010–2015	2015–2019	2000–2019
Farmland	0.7417	0.7664	0.2972	−0.9411	0.8644
Forestland	205.3623	−51.9262	249.1688	−141.4742	261.1306
Grassland	100.5390	1145.8315	86.2005	−656.4423	676.1288
Water	36.3277	−17.1704	1168.8439	−1175.5144	12.4869
Unused land	0.0009	−0.0003	0.0046	0.0003	0.0057
Glacial snow	17.3075	40.1814	−3.3868	−14.5100	39.5920
Total	360.2794	1117.6823	1501.1284	−1988.8816	990.2085

Second, from the perspective of the total value, the total value of all types of land types showed an increasing trend, with the largest total value for grassland, the smallest and largest increase for unused land, and the smallest increase for water areas. First, the total value of grassland was the largest and showed an increasing trend, increasing from 455.8161 to 1131.9449 billion USD, an increase of 148.33%, with the average proportion being 70.9316%. Second, the total amount of unused land was the smallest, but its increase was the largest—that is, from 0.0007 billion USD in 2000 to 0.0062 billion USD in 2019, an increase of 853.95%. Third, the total value of water areas increased the least, from 37.9062 billion USD in 2000 to 50.3932 billion USD in 2019, an increase of 32.94% (Table 6).

4.2.2. Spatial Variation Characteristics of the Total Service Value

From the perspective of the spatial total ecosystem service value of land type, the total ecosystem service value of Qilian Mountain National Park (Gansu Area) from 2000 to 2019 showed the characteristics of high northwest and low southeast values. In 2000, it was mainly high in the Western Arctic, while other regions were mainly moderately distributed. In 2005, it was mainly high in the west and arctic, while other regions were low and very low. In 2010, it was dominated by extremely high in the northwest, and in 2015, it was basically the same as in 2010. In 2019, the northwest was dominated by extremely high, the middle region was dominated by very low, and the southeast region was dominated by medium and low values (Figure 4).

4.2.3. The Function of the Service and the Changing Characteristics of the Value of the Individual Service

The service functions of Qilian Mountain National Park (Gansu Area) were analyzed from the perspective of supply, regulation, support, and cultural services, mainly based on regulation services, followed by support, supply, and cultural services, all showing obvious growth trends, increasing by 181.77%, 183.90%, 196.19%, and 170.38%, respectively (Table 7).

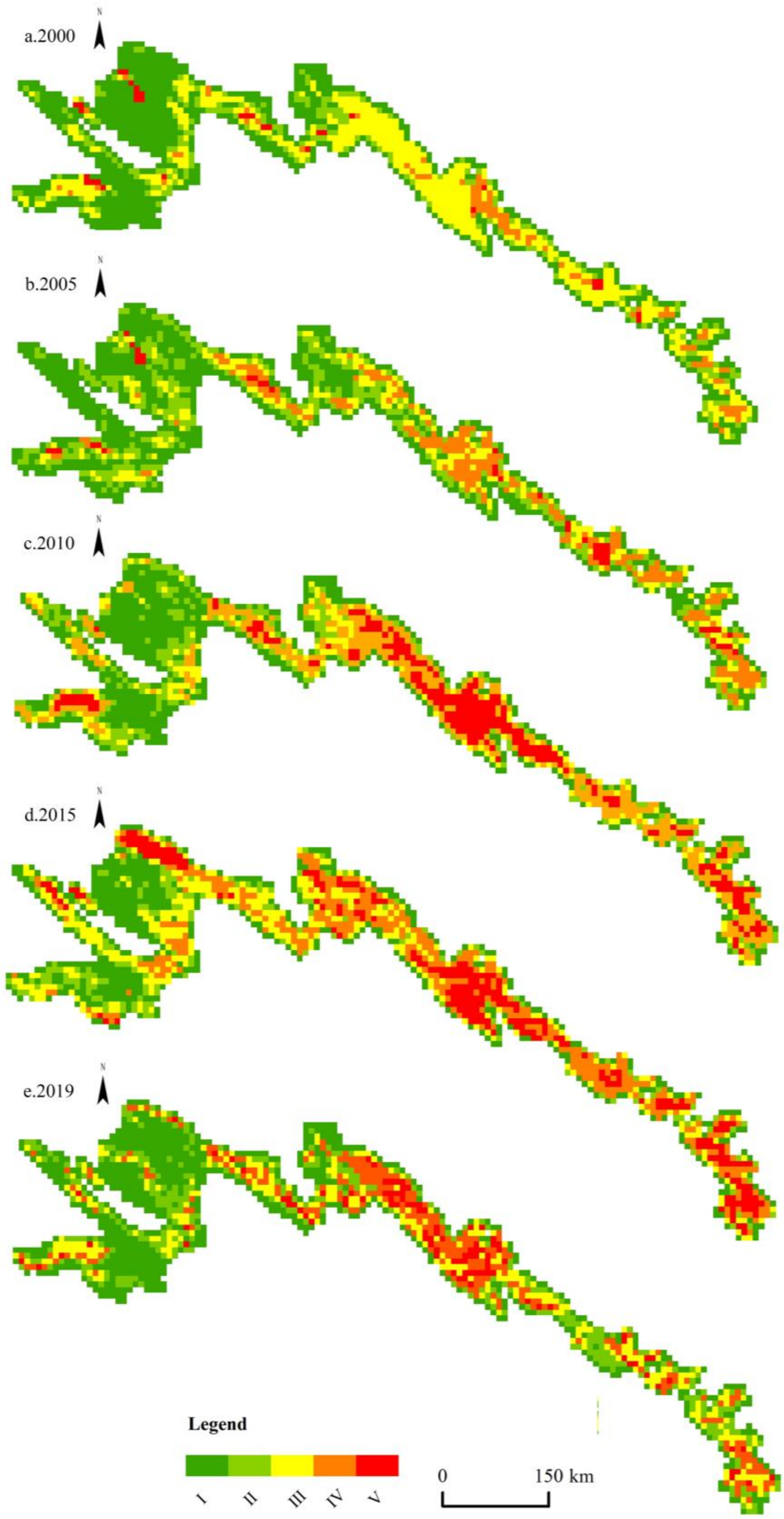

Figure 4. Value characteristics of land ecosystem services in Qilian Mountain National Park (Gansu area), 2000–2019. (**a**–**e**) represent the value characteristics of land ecosystem services in 2000, 2005, 2010, 2015, and 2019, respectively. I–V mainly represent the intensity ranking of the total value of ecosystem services from low to high, classified according to the five-level natural fracture method in ArcGIS software.

Table 7. Total value and proportion of ecosystem services by land type in Qilian Mountain National Park (Gansu Area) and the corresponding changes (billion USD %).

Service Features	Supply Services	Conditioning Services	Support Services	Cultural Services
2000	34.8308	356.9154	125.0125	25.3560
	6.42	65.84	23.06	4.68
2005	60.1541	599.3683	203.6830	39.1886
	6.67	66.42	22.57	4.34
2010	137.2245	1323.3005	466.6521	92.8994
	6.79	65.51	23.1	4.6
2015	238.6677	2489.8058	642.5233	150.2079
	6.78	70.71	18.25	4.27
2019	103.1654	1005.6898	354.9110	68.5569
	6.73	65.63	23.16	4.47
2000–2019 Amount/rate of change	68.3346	68.3346	68.3346	68.3346
	196.19%	181.77%	183.90%	170.38%

From 2000 to 2019, the single service functions of Qilian Mountain National Park (Gansu Area) were mainly based on climate, water, and soil regulation and remained basically stable, accounting for an average of 24.04% and 25.63%. Meanwhile, soil conservation, diversity, gas regulation, environmental purification, aesthetic landscape, raw material production, water supply, food production, and nutrient cycling accounted for 10.87%, 10.34%, 8.95%, 8.20%, 4.47%, 2.57%, 2.47%, 1.64%, and 0.82%, respectively. In terms of the proportion of total ecological service value, the proportion of total ecological service value basically maintained a growth trend, except for air purification, water and soil regulation, soil conservation, diversity, and aesthetic landscape, while the proportion of other individual service functions showed a growth trend (Table 8).

Table 8. Total value of ecosystem services by land type in Qilian Mountain National Park (Gansu Area) and the corresponding proportion (billion USD %).

Service Features	Individual Service Features	2000	2005	2010	2015	2019	Amount of Change (2000–2019)	Rate of Change (2000–2019)
Supply services	Food production	9.6633	14.6791	36.1903	45.2447	26.4925	16.8292	174.16%
		1.78%	1.63%	1.79%	1.28%	1.73%		
	Raw material production	14.6270	24.1152	55.0894	70.2096	42.1374	27.5105	188.08%
		2.70%	2.67%	2.73%	1.99%	2.75%		
	Water supply	10.5405	21.3599	45.9448	123.2134	34.5355	23.9950	227.65%
		1.94%	2.37%	2.27%	3.50%	2.25%		
	Subtotal	34.8308	60.1541	137.2245	238.6677	103.1654	68.3346	196.19%
Conditioning services	Gas conditioning	51.1063	83.3408	193.1937	245.3344	146.7329	95.6266	187.11%
		9.43%	9.24%	9.56%	6.97%	9.58%		
	Climate comfort	136.0364	227.8777	516.8104	644.0117	398.0173	261.9808	192.58%
		25.09%	25.25%	25.58%	18.29%	25.97%		
	Clean-up operation	45.9109	74.8265	170.1298	260.4256	129.0871	83.1762	181.17%
		8.47%	8.29%	8.42%	7.40%	8.42%		
	Soil–water regulation	123.8618	14,713.76	30,566.97	92,427.52	22,889.19	14,345.9491	167.92%
		22.85%	23.64%	21.94%	38.06%	21.66%		
	Subtotal	356.9154	599.3683	1323.30	2489.806	1005.69	648.7744	181.77%

Table 8. *Cont.*

Service Features	Individual Service Features	2000	2005	2010	2015	2019	Amount of Change (2000–2019)	Rate of Change (2000–2019)
Support services	Soil conservation	62.2532	101.1645	234.1863	297.6786	177.9187	115.6654	185.80%
		22.85%	23.64%	21.94%	38.06%	21.66%		
	Nutrient cycling	4.6870	7.6643	17.6358	22.5078	13.4347	8.7477	186.64%
		0.86%	0.85%	0.87%	0.64%	0.88%		
	Diversity	58.0724	94.8543	214.8300	322.3370	163.5577	105.4854	181.64%
		10.71%	10.51%	10.63%	9.15%	10.67%		
	Subtotal	125.0125	203.6830	466.6521	642.5233	354.9110	229.8985	1.8390
Cultural services	Aesthetic landscape	25.3560	39.1886	92.8994	150.2079	68.5569	43.2010	170.38%
		4.68%	4.34%	4.60%	4.27%	4.47%		
	Subtotal	25.3560	39.1886	92.8994	150.2079	68.5569	43.2010	170.38%

4.3. Sensitivity Analysis

According to the sensitivity analysis in Formula (7) of the 50% increase in the value coefficient of ecological services, the sensitivity index of different land use types was very different, but there was little difference between different years of the same type, and the sensitivity index was less than 1. Among them, grassland had the largest sensitivity index, while arable land had the lowest sensitivity index. The total value of ecosystem services in the study area was not elastic to the value coefficient, so the value coefficient used in this calculation was suitable for Qilian Mountain National Park (Gansu Area), and the results are credible (Table 9).

Table 9. Ecosystem service value sensitivity index by land type in Qilian Mountain National Park (Gansu Area).

	Amount of Change				
	2000	2005	2010	2015	2019
Farmland (VC ± 50%)	0.00089	0.00136	0.00099	0.00065	0.00088
Forestland (VC ± 50%)	0.08619	0.27935	0.09909	0.12761	0.20091
Grassland (VC ± 50%)	0.84081	0.61653	0.84263	0.50789	0.73871
Water (VC ± 50%)	0.06992	0.08226	0.02825	0.34815	0.03289
Unused land (VC ± 50%)	0.00000	0.00000	0.00000	0.00000	0.00000
Glacial snow (VC ± 50%)	0.00000	0.00000	0.00000	0.00000	0.00000

5. Discussion

(1) First, the land use of Qilian Mountain National Park (Gansu Area) was mainly grassland from 2000 to 2019, followed by unused land, forest land, and glacial snow, with an annual average area ratio of 48.66%, 38.18%, 9.35%, and 2.45%, respectively, during which the largest variation of glacial snow cover occurred. From 2000 to 2020, the area of water bodies increased significantly, and the desert area decreased significantly in Sanjiangyuan National Park [44], while the changes in Qilian Mountain National Park (Gansu Area) were mainly glacial snow, construction land, and forest land, reflecting that Qilian Mountain National Park (Gansu Area) has low human interference factors and obvious originality and integrity characteristics. It shows that the construction and self-repair ability of the ecosystem of Qilian Mountain National Park (Gansu Area) continue to improve, provide high-quality system service resources for the construction of the national park, provide original natural landscape, provide a more intuitive landscape system for further exerting its ecosystem service value, which is conducive to the development of a green industrial

system based on sightseeing and tourism, and lay the foundation for the optimization of the ecosystem for the construction of the national park.

(2) Second, the contribution rate of forest land, construction land, unused land, and glacial snow cover in Qilian Mountain National Park (Gansu Area) from 2000 to 2019 was positive, while that of cultivated land, grassland, and water area was negative. Among them, the contribution rate of glacial snow cover was 10.4723, and the contribution rate of construction land and forest land was relatively large and positive. Conversely, the grassland and water bodies of Sanjiangyuan National Park contributed greatly to the ecological environment of the park [45], and the evolution of land use types was related to the value of ecosystem services. This shows that a very small portion of arable land, grassland, and water areas in Qilian Mountain National Park (Gansu Area) has been developed or developed into glacial snow, construction land, or woodland, which reflects the integrity of the system. This poses a new challenge to how to realize the protection of ecosystem integrity in the construction of national parks, not only focusing on strengthening the authenticity and integrity protection of natural ecosystems in the process of national park construction but also putting forward a more severe test for the path of utilization.

(3) Third, the ESV in Qilian Mountain National Park (Gansu Area) from 2000 to 2019 showed a fluctuating growth trend on the whole, demonstrating the characteristics of high northwest and low southeast values, and showed opposite spatial characteristics with the characteristics of a high value in the northeast and a low value in the northwest of the ecosystem service value of the Yangtze River Source Park and Lancang River Source Park, The Yellow River Source Park presented the characteristics of a high value in the west and a low value in the east. [46]. Qilian Mountain National Park (Gansu Area) had the largest total grassland value, the smallest unused land value, and the smallest increase in water area. Regulating services, followed by support services, supply services, and cultural services, all showed a clear growth trend, increasing by 181.77%, 183.90%, 196.19%, and 170.38%, respectively. It shows that as an important ecological barrier in the western region of China, the Qilian Mountains play an important role in the regulation of the overall environment, and at the same time, with the opportunity of developing eco-tourism in the western region, the cultural service function of the Qilian Mountains ecosystem is well played, and the construction results of the national park are shared by the whole people.

(4) Fourth, this article took the comprehensive services of Qilian Mountain National Park (Gansu Area) as the mainstay, giving full play to the four major service functions of supply, regulation, support, and cultural services, maintaining ecological security, ensuring ecological regulation functions, providing products for a good living environment, establishing a sound long-term ecological compensation mechanism to help provide financial guarantee for the park [47], taking the development of low-carbon economy and circular economy as the main idea, and building direct product supply. The industrialization development path of national parks with indirect product supply and basic guarantee appropriately develops the construction of direct market and life-oriented product systems for agricultural production, forestry services, animal husbandry production, and fishery production according to the characteristics of the region. Agricultural production mainly relies on the natural conditions of the region to develop the production of wheat, corn, vegetables, fruits, and other green agriculture, meet the basic needs of the region, and the most suitable development of large-scale agricultural seed production and production base. Develop a forestry service system focusing on forestry breeding and renewal and better realize the breeding and renewal of forest land. In turn, high-quality natural ecosystems are used to develop circular pastoral production and suitable fishery production. In addition, it extends and cultivates business systems such as accommodation and catering, leisure vacation, culture and art, and fitness and leisure activities, such as the development of campsite products, ecological catering services, and other green and ecological tertiary industry service systems. Similarly, effective conversion mechanisms for ecosystem goods and markets should be combined and considers the use of carbon sink compensation mechanisms and ecological banks in the process of consumption or marketization of these

products. Through the systematic and intelligent sustainable use of the ecosystem of Qilian Mountain National Park (Gansu Area), we can better help the construction of national parks and become an area jointly built and shared by the people. In particular, the construction of national parks is more prominent in the construction of the people's sharing mechanism for construction results, paying attention to the integrity of the ecosystem and paying more attention to the realization of its added value and maximizing its benefits. Build a mechanism for mutual coordination and unification of direct product supply, indirect product supply and basic security system, and explore the construction of a sustainable industrial system with the goal of human and natural communities. Combined with the actual situation and industrial characteristics of China's national park construction, fully tap the cultural supply capacity of ecosystem services, provide direct product supply, such as agriculture, forestry, animal husbandry, and fishery, explore diversified indirect product supply, such as accommodation and catering, leisure vacation, culture and art, fitness and leisure activities, and more direct, systematic, and intelligent protection and supervision systems, so as to realize the effective docking of product supply and sustainable utilization (Figure 5).

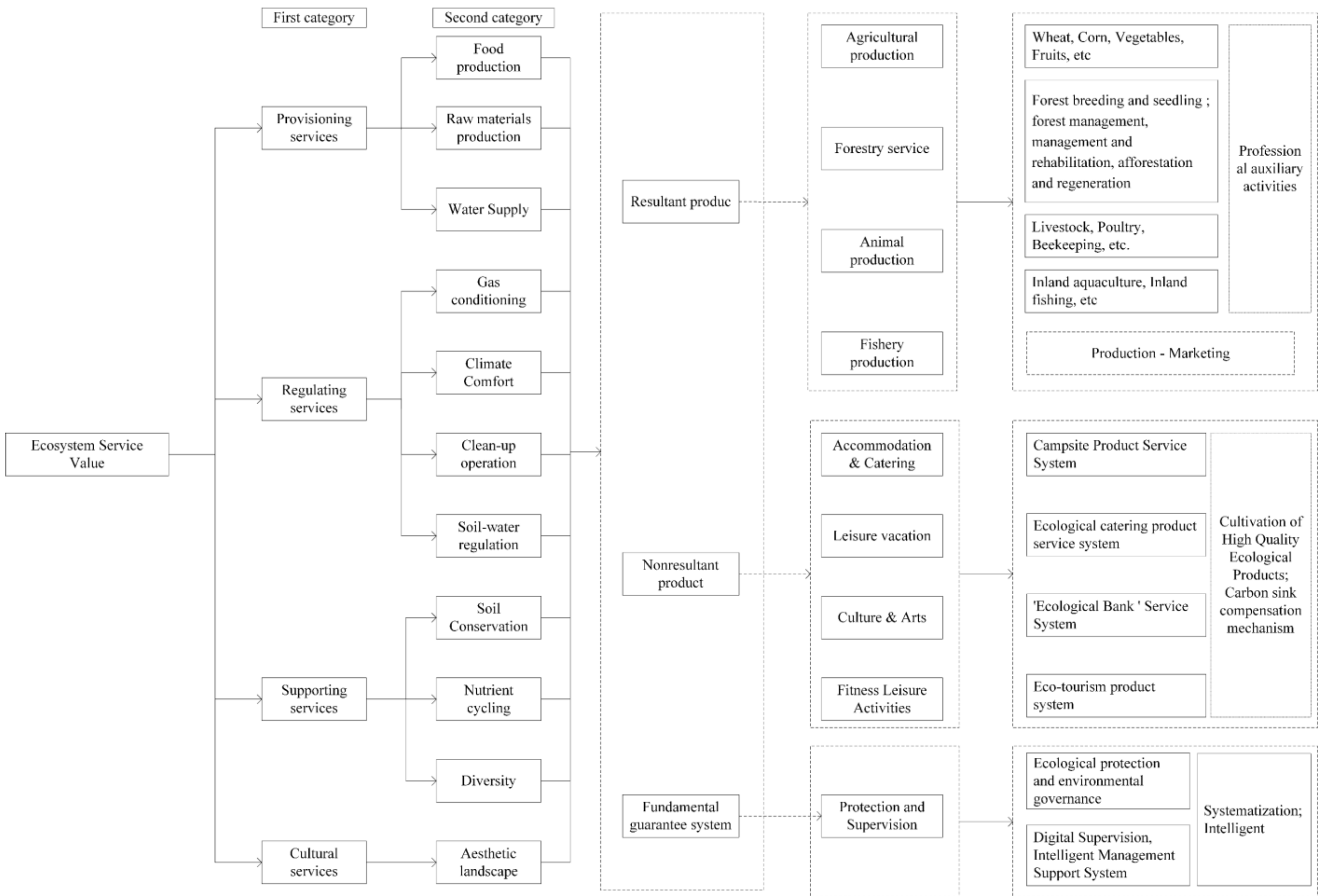

Figure 5. Industrial system construction diagram.

6. Conclusions

Based on the equivalent factor of ecosystem services, this paper calculated the ecosystem value of Qilian Mountain National Park (Gansu Area) by assetization, which provides theoretical support for its market-oriented development. From 2000 to 2019, the land use of Qilian Mountain National Park (Gansu Area) was mainly grassland, during which the largest change in glacial snow cover occurred. The value of ecosystem services in 2019 was 1532.32 billion USD, showing a clear inverted "U" growth trend, taking the development of the low-carbon and circular economies as the main idea, and putting forward the path of marketization or industrialization development of national parks. However, it is mainly based on the analysis of economic equivalent factors, and more GEP and other methods should be used in the process of method selection for in-depth research and exploration, and the research area is mainly selected for the study of Qilian Mountain National Park (Gansu Area), and the comparative study with Qinghai Area and Qilian Mountain National Park should be considered, and the actual development of the industry in the region should be explored in depth.

This paper studied the calculation of the total value of ecosystem services in Qilian Mountain National Park (Gansu Area) from 2000 to 2019, which needs to be combined with the new framework of the environmental–economic accounting–ecosystem accounting (SEEA EA) officially adopted by the United Nations in 2021 and China 2020. The annual compilation of the gross ecosystem product (GEP) calculation guide further deepens the value research of ecosystems, and the value comparison of different internal regions should also be studied in depth.

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