

# Study on the Spatial Characteristics of Landscape Services in Nature Reserve Based on Participatory Geographic Information System ——A Case Study of Jiuzhaigou Nature Reserve

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**Abstract.** This paper comprehensively adopted the Geographic Information System (GIS) and Participatory Geographical Information System (PGIS) technologies to construct the Jiuzhaigou Nature Reserve's landscape services index system and analyzed the landscape services spatial characteristics. The results show that the perception of landscape services of the Jiuzhaigou Nature Reserve varies greatly among the respondents. The number of landscape services points for rare animals habitat, forest recreation, and returning farmland exceed half of the total number, accounting for 53.78%. At the same time, the spatial distribution of landscape services points has a strong agglomeration, with the most concentrated distribution around residential areas. It can be seen that residents' perception of landscape services mainly comes from the vicinity of residential areas. With the increase in distance from residential areas, the density of landscape services points gradually decreases. The areas with the greatest intensity of landscape services are concentrated around Zharugou, Shuzhenggou and Nuorilang Tourist Service Center. The landscape services categories are unevenly distributed in different regions, and the landscape services in Shuzhenggou and Zharugou are most densely distributed.

## Introduction

Ecosystem services are already a comprehensive and mature concept. Most of them are assessed through economic and monetary values[1-5]. However, this method only assesses the content of land and resources that can be monetized and ignores social culture[6-9]. At the same time, the problem of spatial heterogeneity has not been answered in the existing assessment methods.

The provision of landscape services depends not only on the ability of the landscape to provide services, but also on the demand of the community for its services. Termoschuizen and Opdam proposed "Landscape Services", which considers landscape services as an additional ecological, social and economic value brought about by human activities that promote landscape change and multi-functionality [10]. According to Willemsen et al. (2005), "Landscape Services" is the mobile service provided by landscapes from the ecosystem to human society[11]. Ralf-Uwe Syrbe and Ulrich Walz also proposed that landscape services can be a new auxiliary item for assessing ecosystem services from spatial indicators, and highlights the perfection of ecological service evaluation by landscape services on spatial indicators [12].

Therefore, building a landscape services index system based on the relationship between supply and demand of landscape ecosystems, and adopting public participation in geographic information system technology to digitize landscape service indicators will be one of the ways to evaluate landscape services.

## Research Methods and Statistics

### Landscape Service Index Classification

The landscape service indicators need to emphasize all the tangible services and intangible services provided by the landscape ecosystem. As Jiuzhaigou Nature Reserve is a living area for local communities, it is also a famous tourist destination. Therefore, the surveyed groups assessed by the landscape service include residents, tourists and staff of the Jiuzhaigou District Administration.

Based on the research results of Fagerholm [13], this paper combines the remote sensing image data of Jiuzhaigou in 2012 and the landscape classification related data for index selection, and adopts the method of research meeting to revise the unserviceability index and missing indicators of landscape services. According to statistics, there are 18 landscape service indicators, which are five categories of supply services, recreation services, support services, cultural services, and ecological services( Table 1).

### Public Participation Mapping and Data Collection

The data of landscape services was statistically analyzed through a combination of interviews by visitors, residents and staff, and GPS positioning. For each landscape service indicator, when more than three respondents considered that the landscape with the same geographic coordinates (error within 300 meters) has a certain service or function, this indicator was included in the statistics.

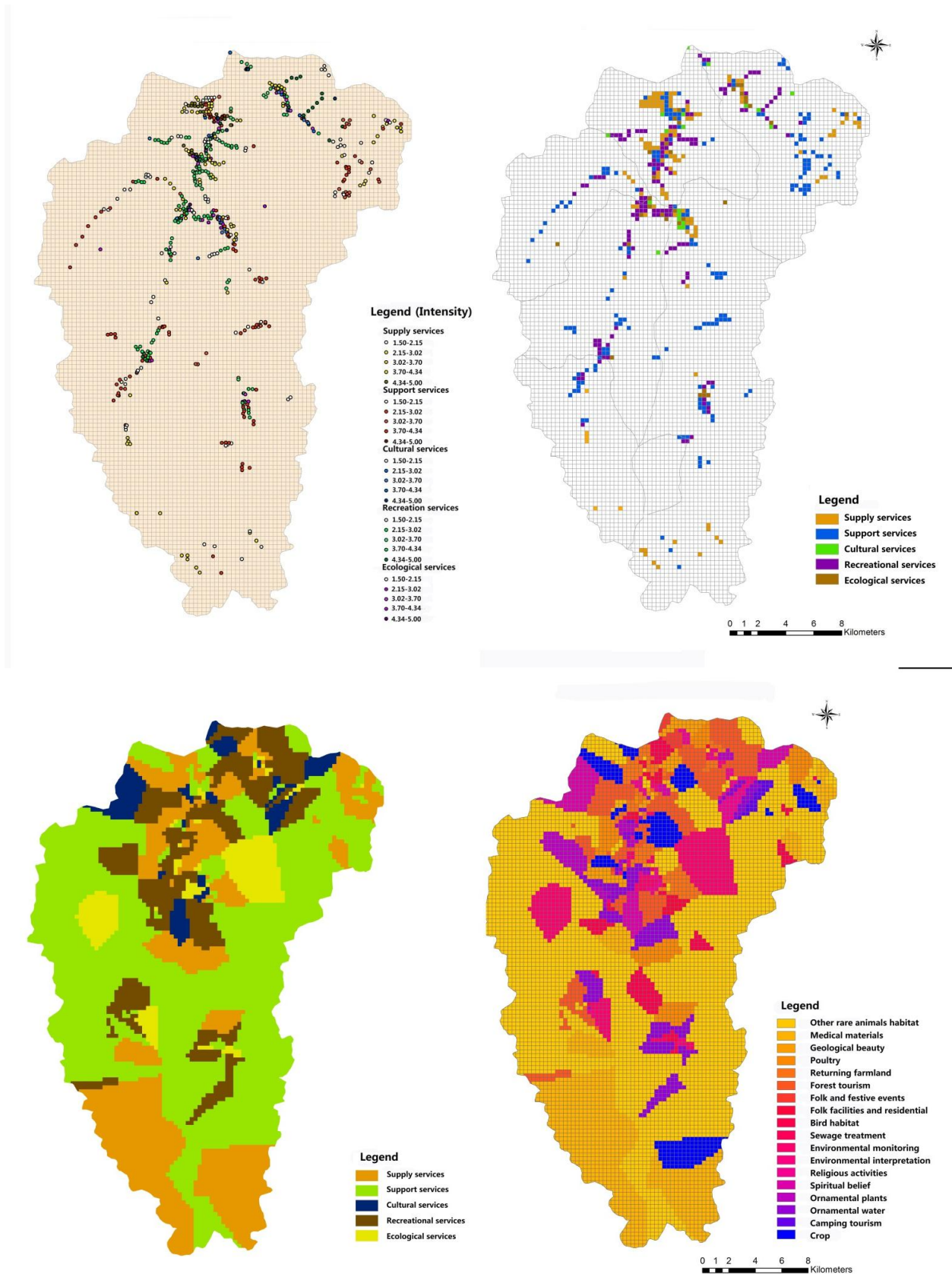
At the same time, in order to study the spatial differentiation of the density and intensity of different landscape services, each survey question has a scale and intensity of 1-5 points. Only if the average of the attribute options is greater than 1.5 (not equal to 1.5), it was included in the statistics.

**Table1** Landscape Service Index Classification & Data Collection

Landscape service indicator	Category	Remote sensing image data	Scenic real-time data	Field collection	
				Observation	Interview research
Returning farmland	ecological service	×		×	×
Folk facilities and residential buildings	support service	×		×	
Poultry	supply service		×		×
Medical materials	supply service		×		×
Crop	supply service		×		×
Bird habitat	support service		×	×	×
Other rare animals habitat	support service		×	×	×
Forest recreation	recreation service			×	×
Ornamental plants	recreation service		×	×	×
Geological beauty	recreation service		×	×	×
Ornamental water	recreation service		×	×	×
Camping tourism	recreation service			×	×
Spiritual belief	cultural service				×
Sacrifice activities	cultural service				×
Folk and festive events	cultural service				×
Environmental interpretation	ecological service		×	×	×
Environmental monitoring	ecological service			×	×
Sewage treatment	ecological service		×	×	

### Landscape Service Digitalization

This study uses Arcgis10.0 software for digitization. First, it overlays points data and geolocation into landscape service points distribution maps. Secondly, the landscape service indicators summary map vector is converted to a grid. An area data attribute association tool is used to form the landscape service map with the most adjacent landscape service points as a polygon.

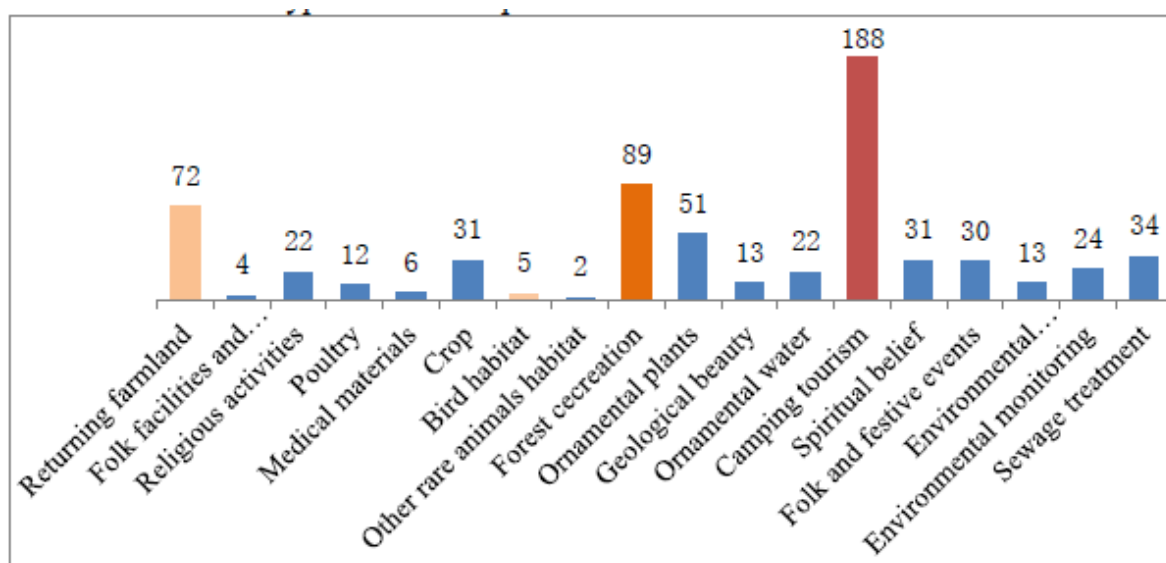


**Fig. 1** Landscape Service Points - Grid -Landscape Service Classification - Landscape Service Indicators

## Results

### Data Analysis

Among the 649 landscape service metrics obtained from the statistics, the most highly perceived objects were rare animals habitat, and residents and staff had very high awareness of rare animals habitat. A total of 188 landscape service sites were surveyed, accounting for 28.97% of the total number of landscape service points. Followed by forest recreation services, this perception of landscape services mainly comes from tourists and residents. A total of 89 landscape service sites were surveyed, accounting for 13.71% of the total; 72 landscape service sites of the returning farmland accounted for 11.09% of the total. The number of landscape service points for rare animals habitat, forest recreation, and farmland reclamation exceeded half of the total number, accounting for 53.78%. It can be seen that the surveyed objects have higher awareness and concentration of the above types of landscape services.



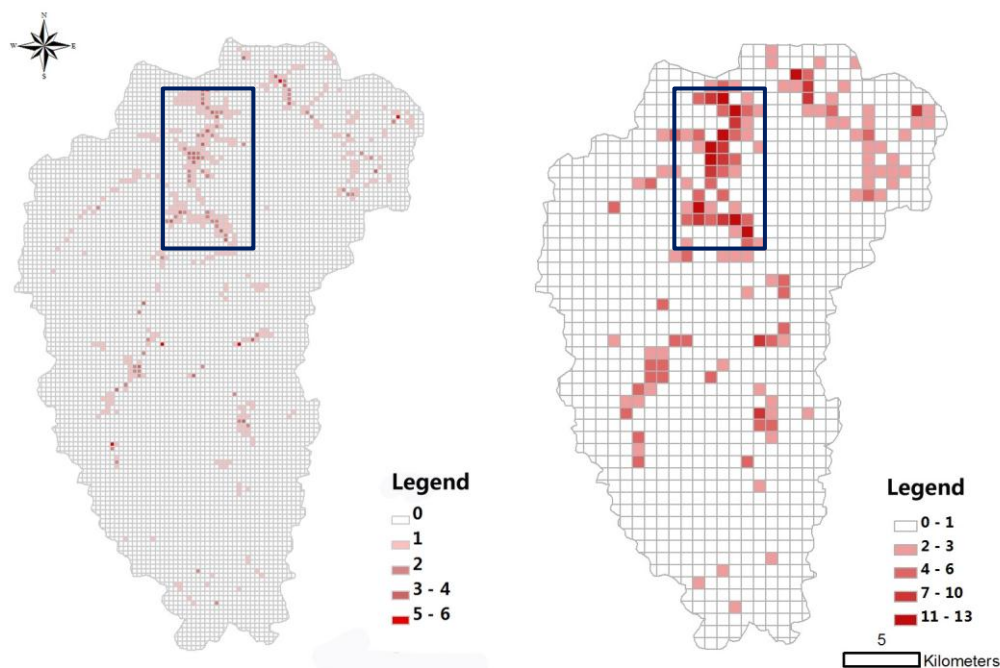
**Fig. 2** Distribution of Landscape Service Points

### Density and Intensity of Landscape Service Points

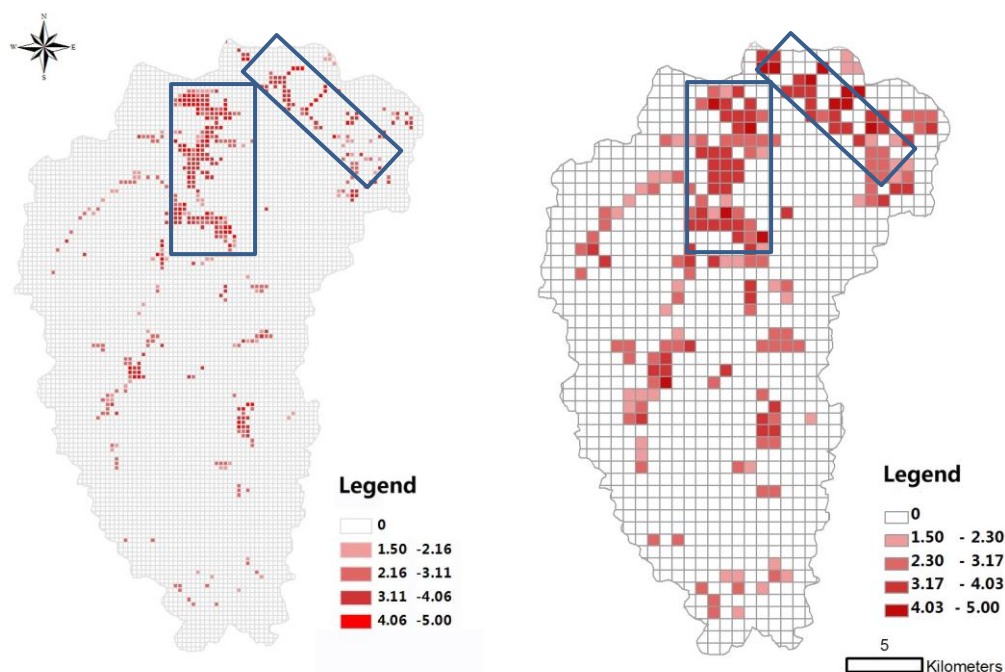
In this paper, spatial density and intensity of landscape service points are analyzed with 300m\*300m cells and 800m\*800m cells respectively.

The largest density in the 300m unit is 6 landscape service points, and the highest density in the 800m unit is 13 landscape service points. The areas with higher density of landscape services are concentrated in the surrounding areas of Shuzheng Village, Heye Village, Zharu Village and Chazhe Village. It can be seen that the perception of landscape services of the surveyed objects, especially residents, mainly comes from the vicinity of the residential area. With the increase of the distance from the residential area, the density of landscape service points gradually decreases.





**Fig. 3** 300m and 800m cell landscape service index density distribution



**Fig. 4** 300m and 800m cell landscape service index intensity distribution

The areas with the greatest intensity of landscape services are concentrated in Zharugou, Shuzhenggou and Nuorilang tourist service centers. Although Zharugou is not open to the general public, residents and ecotourists have a higher overall assessment of their landscape services. The highest scores were for landscape services such as forest recreation, camping tourism and spiritual beliefs.

The conclusion shows that public demand for landscape services has a certain degree of spatial agglomeration in the survey. The regular results have a good indication of the spatial distribution characteristics of landscape services.

### Spatial Distribution Characteristics of Landscape Service Area

This study divides landscape services into support services, supply services, cultural services, ecological services, and recreation services. Among them, the largest number of support service categories was 90 service points, followed by recreational services and provision services, with 63 and 58, respectively. The number of landscape service points for cultural services was the least. Different landscape service categories are unevenly distributed within nature reserves. Taking the number of plaques as an example, landscape services are mainly concentrated in Shuzhenggou, followed by Zharugou.

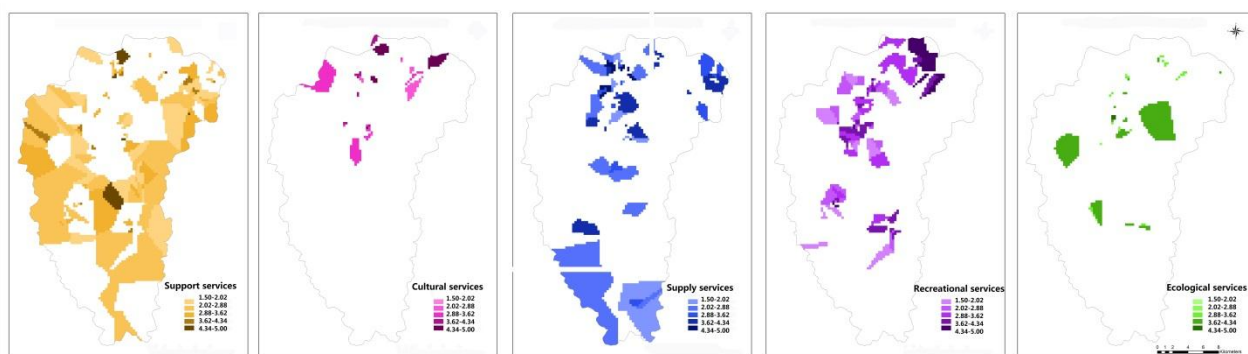


Fig. 5 Jiuzhaigou Nature Reserve Landscape service partition (Intensity)

### Conclusions and Discussions

Based on relevant overseas empirical studies and the resource classification of Jiuzhaigou Nature Reserve, the indicator system for landscape services was divided into five categories and 19 indicators such as rare animals. The results of the study showed that the perception of the landscape services of the Jiuzhaigou Nature Reserve varies greatly among the respondents. The highest density of landscape service points was other rare animals habitat, forest recreation, and returning farmland. The number of three landscape service points accounted for more than half of the total.

At the same time, the spatial distribution of landscape service points has strong agglomeration, with the most concentrated distribution around residential areas. The area with a higher density of landscape services is concentrated in the surrounding areas of Shuzheng Village, Heye Village, Zharu Village and Chazha Village, and other tourist attractions are also geographical units with dense landscape services. The areas with the greatest intensity of landscape services are concentrated around Zharugou, Shuzhenggou and Nuorilang Tourist Service Center.

It can be seen that the perception of residents' landscape services mainly comes from the vicinity of residential areas. With the increase in distance from residential areas, the density of landscape service points gradually decreases.

In the management of nature reserves in China, the core area, buffer zone and experimental area have always been the main basis for district management. This article attempts to spatially correlate landscape architecture with landscape services. From comparative analysis of different ditch and circle in Jiuzhaigou Nature Reserve, we can see that the spatial distribution of landscape structure and service is uneven, and the function and service of nature reserve are not completely spread from the center of the experimental zone to the surrounding. Therefore, the spatial distribution of landscape services and value can provide a new perspective for the protection and management of nature reserves, and promote the protection and sustainable development of nature reserves.

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