RESEARCH ARTICLE

Influences of land use change on ecosystem service value: a case study in Jiangxi province, China

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Land use and cover change play an important role in research on soil and water conservation, food security, and biodiversity. Studying land changes can provide an explanation for changes in the value of ecosystem services. This study used matrix of land use transfer to analyze the spatial and temporal changes of land use types in Jiangxi province, China from 2010 to 2020. The equivalent factor method, net primary productivity (NPP), and precipitation taken as regulating factors were applied to study corresponding changes of ecosystem service value (ESV). The results showed that (1) the major land use types in Jiangxi province, China were forest land and cultivated land, accounting for 92.7% in the whole region in 2020. Meanwhile, cultivated and construction land expanded significantly, while forest land decreased significantly, and unused land and water area increased slightly; (2) the ESV in Jiangxi province was ¥960,532 million (CNY) in 2020, which showed a net increase of ¥3,226 million comparing to that in 2010. Among all the regulating services, specific ecosystem services including climate regulation, air regulation, and hydrological regulation played the leading roles in the ESV, and forest land took an important part in the increased ESV; (3) amid the total amount of ESV in Jiangxi province, Ganzhou city accounted for 32.39%, and the ESVs per unit area in cities of various scales, from large to small, reached ¥74,716.67/ha, ¥69,965.75/ha, ¥56,042.02/ha, ¥55,778.45/ha, ¥54,838.02/ha, ¥50,809.19/ha, ¥50,358.72/ha, ¥50,100.94/ha, ¥49,165.86/ha, ¥43,978.23/ha, and ¥27,647.07/ha in the cities of Ganzhou, Fuzhou, Yingtan, Jiujiang, Yichun, Xinyu, Pingxiang, Shangrao, Jingdezhen, Ji'an, and Nanchang, respectively. With lush mountain forests, southern Jiangxi was a high concentration area of ESV, while northern Jiangxi was a low concentration area of ESV because it covers a large area of plain cultivated land. Thus, the cities were sorted into three groups to propose more accurate policy implementations and more sustainable land exploitation and utilization.

Keywords: ecosystem services value; equivalence factor; land use type; transfer matrix; Jiangxi province.

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Introduction

Ecological products including natural factors that maintain ecological security, ensure ecological regulation functions, and provide a good living environment should have value attributes and transaction attributes [1-3]. Also, their values can be incorporated into the current economic system through some realization paths and can be embodied in the form of currencies and assets [1, 4-6]. However, in China, only some ecological products are considered to have economic value, while most ecological products and services cannot be effectively monetized as there is no method to transform them into assets [7]. Environmental costs are often deemed as internalized costs, while the value created by ecological products and services is regarded as an external economy, which is independent from the current economic system. It has gradually formed a national consensus that the unpriced ecological resources in rural areas are the key to the revitalization of rural areas [8]. Thus, the key to the ecological civilization lies in the study and solution to the connotation, evaluation method, and realization path of ecological products and services.

To evaluate the value of ecological products, researchers should establish a scientific and reasonable value evaluation indicator system in the first place. This indicator system should be based on appropriate framework structure. Under this context, evaluation on ecosystem services values (ESV) is a necessary means to assign products and services provided by ecosystems with value attributes and transaction attributes [1, 3, 9-12]. With the development of geographic information system (GIS), remote sensing (RS), and other technologies and their widely application in the analysis of ecosystem services value, the dynamic change of ecosystem services value has become one of the current research trends. Therefore, understanding the influences of land use on ESV can provide dependable consults and basis for policy makers to draw up ecological protection design and management system from the perspective of land use planning.

The biennially updated statistics of Land-Use and Land-Cover Change (LUCC) in Jiangxi province, China was used in this study to determine the transfer of local land use types from 2010 to 2020 by using remote sensing images. On this basis, the change of the ecosystem services was analyzed in count of money. This study could provide references for decision makers to analyze the agricultural land consolidation projects in Jiangxi and formulate ecological security management and control policies. On the other hand, this study could also provide theoretical support for promoting rational development of regional land resources and ecological environment protection.

Materials and methods

The geographic information of Jiangxi province

Jiangxi province, China locates on the middle and lower reaches of the Yangtze River between 113°34′36″ to 118°28′58″ E and 24°29′14″ to 30°04′41″ N, which is mainly featured with mountainous and hilly terrains with widely distributed basins and valleys. It has a remarkable monsoon climate due to its location in the mid-subtropical zone. Due to the large differences in hydrothermal conditions in Jiangxi, the multi-year average temperature increases from north to south, and the temperature difference between south and north is about 3℃. The whole province covers a region of 166,900 square kilometers and is composed of 11 cities. Jiangxi is one of the provinces with vast area of red soil distribution in southern China. Also, it is famous for numerous rivers and lakes, and a centripetal water system based on Poyang Lake. Covered mainly by evergreen broad-leaved forest, Jiangxi is a typical subtropical forest plant community and belongs to Jiangnan hills in landform. The province is embraced by mountains in the east, west, and south, hills and river valley as well as terraces distributed in transposition in the middle, and lakes and alluvial plains in the north.

Data resources

The data of land use/cover types in 2010, 2012, 2014, 2016, 2018 and 2020 with spatial resolution of 30 meters were downloaded from the Resource and Environment Science and Data Center of Chinese Academy of Sciences (https://www.resdc.cn). The data were interpreted based on the Landsat thematic mapper/enhanced thematic mapper (TM/ETM) remote sensing image data of each period in an interactive manner in the ArcMap software (ESRI Inc, Redlands, California, USA), and were verified by regional auxiliary data such as topographic map, vegetation map, and field investigation.

After strictly quality control, the accuracy of farmland and urban polygons reached 95%, and that of other land types reached 90% according to remote sensing image interpretation. The required data for estimating vegetation net primary productivity (NPP) by using Carnegie-Ames-Stanford approach (CASA) model in ENVI 5.5 (Exelis Visual Information Solutions, Melbourne, FL, USA) included normalized digital vegetation index (NDVI) time series data, land type data of land consolidation project, radiation data, maximum light energy utilization rate of each type under ideal condition, temperature data, and moisture data, *etc*. The temperature, precipitation, and sunshine hours were generated by sorting, calculating, and spatial interpolation based on the daily observation data of meteorological stations in Jiangxi province, China and the surrounding provinces. The data of grain price, yield, and planting area were obtained from relevant statistical yearbook data (http://tjj.jiangxi.gov.cn/col/col38595/index.html).

Dynamics of land use

Dynamics of land use (single) (*Lu*) refers to the area change of a certain land use type in a certain period and is commonly expressed as:

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

where U_a was the area of a certain land use type at the beginning of the study in various cities of Jiangxi province. U_b was the area of land use type at the end of the study. T was the length of the study period in years.

Evaluation of ESV

At present, there are many methods to evaluate the ESV. In this study, the equivalent factor method based on value per unit area was adopted [9-11], and the spatial-temporal adjustment factor was introduced. The equivalent factor of a standard ESV was equal to 1/7 of the economic value of food crops produced on 1 hm^2 farmland. Rice paddy accounted for 91% of the grain crop output in Jiangxi province, China. Referring to previous research results, in this study, the standard ESV equivalent factors of the years 2010, 2012, 2014, 2016, 2018, and 2020 in all cities of Jiangxi province were calculated based on the grain output value data in the statistical yearbooks over the years, the sowing area of grain crops in different periods, and the grain crop output value data as follow:

$$L_u = \frac{1}{7} \times p/M \quad (2)$$

where P was the output value of grain crops in various cities of Jiangxi province in Chinese yuan (¥). M was the total sown area of grain crops in various cities in Jiangxi province (hm^2).

The ESV of Jiangxi province in each period was calculated according to formula (3) and in combination with the equivalent factors of each period in the study area and the data of land use types. According to the equivalent factor method, the value equivalent of the construction land type was 0 and was not included in the ESV calculation.

$$ESV = \sum_{i=1}^{n} A_i \times VC_i \quad (3)$$

where ESV indicated the ESV in the study area. A_i was the area of land use type i (hm^2). VC_i was the ESV coefficient of the land use type i.

As the internal structure and external form of ecosystems in different regions were constantly changing at different time periods within the same year, the according ecosystem service function and value were also constantly changing. Ecosystem food production, raw material production, air regulation, climate regulation, hydrological regulation, nutrient cycling, biodiversity, and aesthetic landscape functions were positively correlated with biomass in general, while waste disposal and soil conservation were correlated with precipitation changes. Based on the above understanding, the spatial-temporal dynamic factors of NPP and precipitation were further analyzed and

Table 1. Ecosystem service equivalent value of Jiangxi province, China per unit area.

Primary types of ecosystem service	Secondary types of ecosystem service	Forest land	Grass land	Farm land	Wet land	Rivers /lakes	Deserts	Regulatory factor
Supply services	Food production	0.33	0.43	1.00	0.36	0.53	0.02	NPP
	Raw material production	2.98	0.36	0.39	0.24	0.35	0.04	NPP
Regulation services	Gas regulation	4.32	1.5	0.72	2.41	0.51	0.06	NPP
	Climate regulation	4.07	1.56	0.97	13.55	2.06	0.13	NPP
	Hydrological regulation	4.09	1.52	0.77	13.44	18.77	0.07	NPP
	Waste treatment	1.72	1.32	1.39	14.4	14.85	0.26	precipitation
Support services	Soil conservancy	4.02	2.24	1.47	1.99	0.41	0.17	precipitation
	Maintenance of biodiversity	4.51	1.87	1.02	3.69	3.43	0.4	NPP
Cultural services	Providing aesthetic landscape	2.08	0.87	0.17	4.69	4.44	0.24	NPP

determined. The spatial-temporal dynamic change value scale of ecosystem services was constructed based on the basic value scale of ecosystem services according to the following formula and table 1:

$$F_{nij} = \begin{cases} P_{ij} \times F_{n1} \ or \\ R_{ij} \times F_{n2} \end{cases} \quad (4)$$

where F_{nij} was the value equivalent factor per unit area of the *n*-th type ecosystem service function of an ecosystem in the year *j* of the region *i*. F_n was the *n*-th equivalent factor of ecosystem service value of this kind of ecosystem. P_{ij} was the spatial-temporal regulatory factor of NPP in the year *j* of the region *i* of this kind of ecosystem. R_{ij} was the spatial-temporal regulatory factor of precipitation in the year *j* of the region *i* of this kind of ecosystem. *n1* was service functions such as food production, raw material production, gas regulation, climate regulation, hydrological regulation, maintenance of nutrient cycle, biodiversity, and aesthetic landscape function. *n2* was ecosystem service function including waste treatment and soil conservation service function.

The NPP spatial-temporal regulatory factor (P_{ij}) was calculated as follows:

$$P_{ij} = B_{ij}/\overline{BJ} \quad (5)$$

where B_{ij} was the NPP in the year *j* of the region *i* (g C/m^2·a). B_J was the annual average NPP in the year *J* of the whole province (g C/m^2·a).

The precipitation time-space regulatory factor (R_{ij}) was specifically calculated as follow:

$$R_{ij} = W_{ij}/\overline{WJ} \quad (6)$$

where W_{ij} was the average precipitation in the year *j* of the region *i* (mm). W_J was the average annual precipitation in the year *J* of the whole province (mm).

The ecosystem service value of per unit area (*aESV*) was specifically calculated as follow:

$$aESV_{ij} = ESV_{ij}/S_{ij} \quad (7)$$

where ESV_{ij} was the ecosystem service value in the year *j* of the region *i* (¥) and S_{ij} was the total land area in the year *j* of the region *i* (hectare).

City cluster analysis of ESV

The SPSS 16.0 (IBM, Armonk, New York, USA) clustering analysis was used to study the classification structure of ESV in 11 cities in Jiangxi province, China. The data were standardized and classified into similarity samples. Then, ecosystem service function areas were divided according to the degree of similarity between the sample data.

Results

Characteristics of land use structure

The land use types in Jiangxi province, China from 2010 to 2020 were mainly forest land and cultivated land accounting for over 92.7% of the regional area. The forest land was mainly distributed in the hilly areas of central and southern Jiangxi. The forest land in Ganzhou accounted for 29.32% of the total forest land area in the whole province. The cultivated land was mainly distributed in the northern Jiangxi plain, among which the cultivated land in Nanchang, Jiujiang, Yichun, and Shangrao accounted for 50.87% of the total cultivated land area in the whole province. The water area was mainly distributed in the north of Jiangxi province. With an area of nearly 20,000 square kilometers, Poyang Lake Plain is a depressed lowland narrow in the north and wide in the south in the middle and lower reaches of the Yangtze River, which was formed by sediment deposition of the Yangtze River and five major rivers in the province. The surface was mainly covered with laterite and river alluvium, and the laterite had been cut with slight undulations. Farms were also widely developed in lakeside areas. Distributed with dense water networks, interwoven river bays and branches, and scattered lakes, the water area of Jiujiang city, Shangrao city, and Nanchang city accounted for 72.39% of the total water area of the whole province. The construction land was mainly distributed in the northern Jiangxi plain because this place could be developed much more easily. The construction land in Nanchang, Jiujiang, Yichun, and Shangrao accounted for 48.37% of the total construction land area in the province.

Characteristics of land use change

From 2010 to 2020, the cultivated land increased from 46,177.26 km^2 to 48,866.73 km^2, the construction land increased from 4,757.71 km^2 to 6,404.08 km^2, the forest land decreased from 110,268.07 km^2 to 105,885.97 km^2, and the water area increased from 5,496.85 km^2 to 5,675.33 km^2 in Jiangxi province, respectively. The dynamic changes of construction land were increased from 2.76 to 5.66% in all cities and reached 3.46% in the whole province. Except for Nanchang, the cultivated lands in all cities were increased with the dynamic change of cultivated land reached 0.15 - 1.68%, and that of the whole province reached 0.58%. Except for Nanchang, the woodlands in all the cities were decreased with the dynamic change of woodland ranged from -0.74% to -0.14%, and that of the whole province was -0.40%.

Land use transfer

From 2000 to 2020, the cultivated land, forest land, and construction land in Jiangxi province changed frequently. To be specific, the cultivated land increased by 2,687.60 km^2, while 5,949.8 km^2 of cultivated land was converted to the other land use types including 3,373.99 km^2 to forest land and 1,928.67 km^2 to construction land, accounting to 56.71% and 32.42% of the total, respectively. On the other hand, 8,637.40 km^2 lands were transformed into cultivated lands with 7,481.07 km^2 from forest land, accounting to 86.61% of the total. Forest land decreased by 4,396.28 km^2 with 7,990.42 km^2 was converted to other land use types including 7,481.07 km^2 was converted to cultivated land accounting to 93.63% of the total. A total of 3,605.53 km^2 were converted to forest land, of which 3,373.99 km^2 was converted from cultivated land accounting to 93.58% of the total land transferred in. Construction land increased by 1,647.19 km^2, while 800.18 km^2 of construction land was converted to other land use types including 554.66 km^2 was transformed to cultivated lands accounting to 69.32% of the total. A total of 2,447.37 km^2 was converted to construction land, of which 1,928.67 km^2 was from cultivated land accounting to 78.81% of the total.

Precipitation distribution

The precipitation in Jiangxi province, China was unevenly distributed in terms of both times and locations. On the time scale, the precipitation of the whole province was above 2,000 mm in 2010, 2012, and 2020 with the highest precipitation of 2,149.3 mm in 2020. On the other hand, the precipitations were below 2,000 mm in 2014,

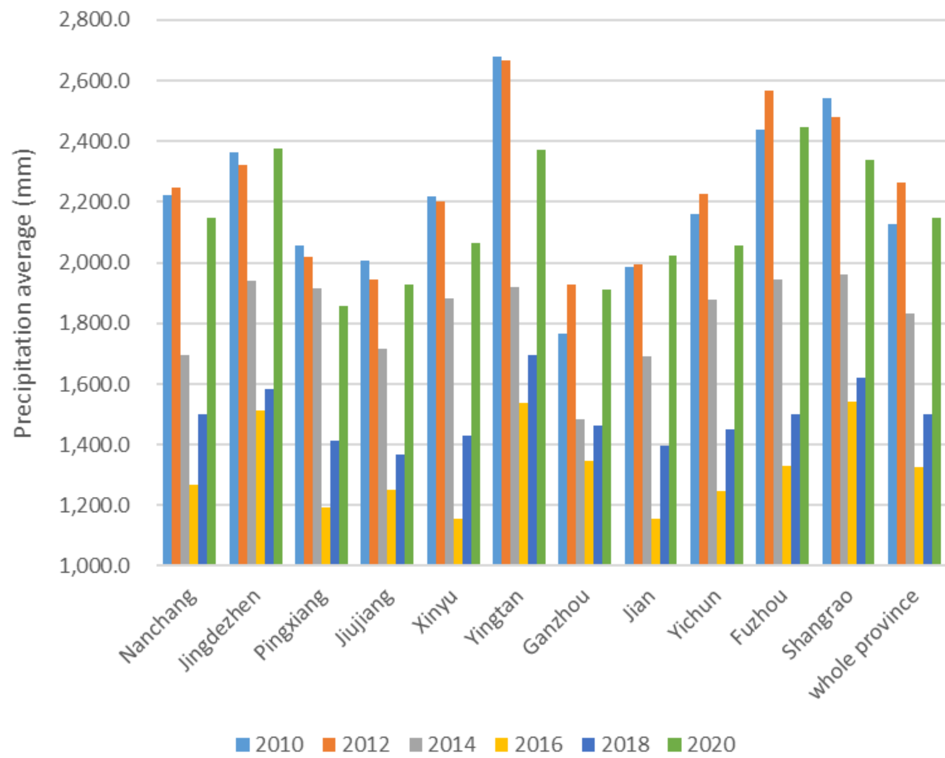

Figure 1. Precipitation average (mm) in cities in Jiangxi province, China from 2010 to 2020.

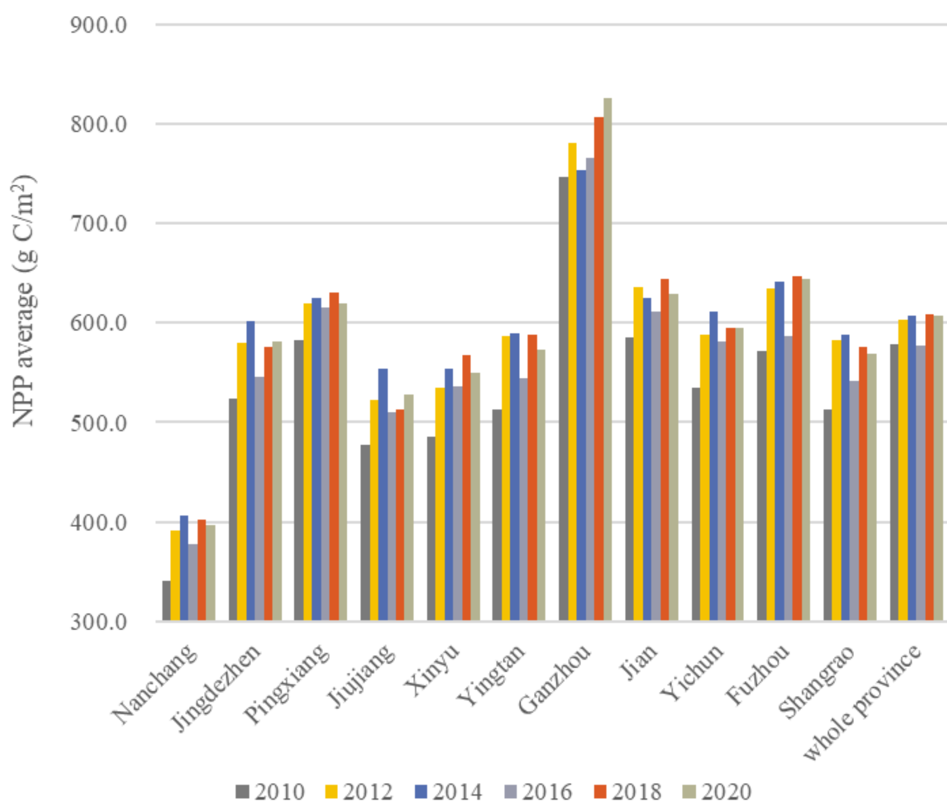

Figure 2. NPP average (g C/m^2) of cities in Jiangxi province, China from 2010 to 2020.

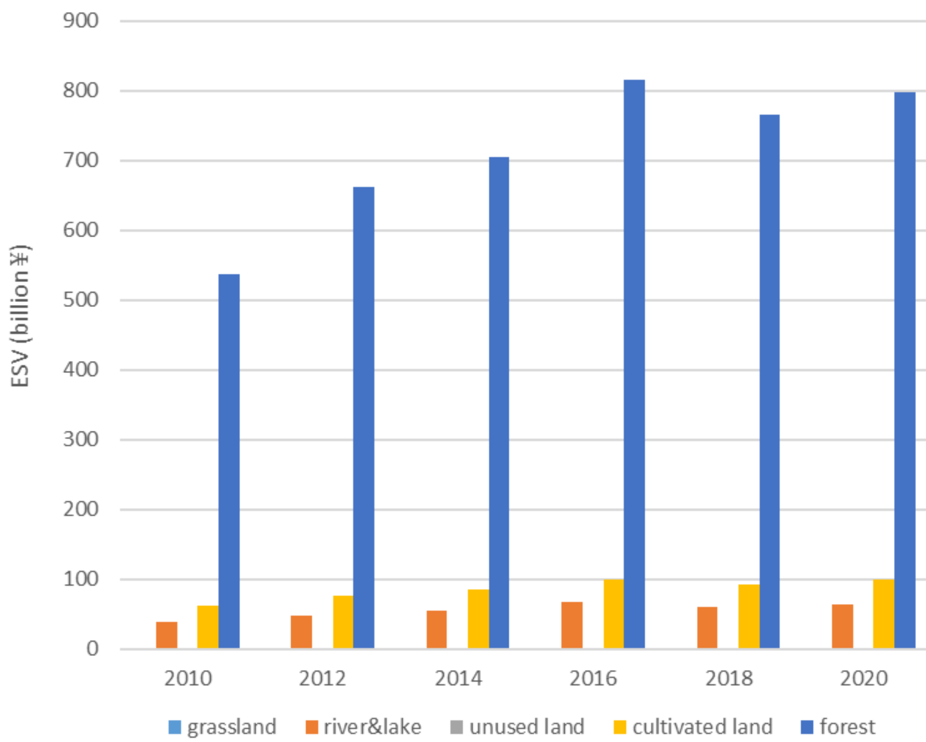

Figure 3. ESV (billion ¥) contribution of individual land use type in Jiangxi province, China from 2010 to 2020.

2016, and 2018 with the lowest level of 1,325.2 mm in 2016. Geographically, from 2010 to 2020, the average annual precipitations in Yingtan, Shangrao, Fuzhou, and Jingdezhen were more than 2,000 mm, of which Yingtan reached the highest number of 2,144.8 mm. The average annual precipitations in Pingxiang, Jiujiang, Ganzhou, and Ji'an were below 1,800 mm. Ganzhou was the lowest one with only 1,650.2 mm (Figure 1).

Distribution of NPP

The NPP in Jiangxi province was also unevenly distributed in terms of both times and locations. On the time scale, the NPP of the whole province was below 600 g C/m^2 in 2010 and 2016 with 578.1 and 576.6 g C/m^2, respectively. Furthermore, the NPP increased above 600 g C/m^2 in 2012, 2014, 2018, and 2020 ranging from 602.4 to 609.3 g C/m^2. However, there was no significant difference observed. Geographically, from 2010 to 2020, Ganzhou city had the highest annual NPP of 747.3 – 826.6 g C/m^2, while Nanchang city had the lowest annual NPP of 340.5 - 406.3 g C/m^2. The other cities demonstrated the annual NPP of 476.9 - 646.5 g C/m^2 (Figure 2).

Changes in ecosystem services value (ESV)

Comparing to 2010, the net appreciation of ESV in Jiangxi province in 2020 was ¥322.646 billion (Figure 3), of which that of regulation services and support services reached ¥171.884 billion and ¥87.477 billion, respectively, accounting to 53.27% and 27.11% of the net appreciation of ESV (Figure 4). The contribution of individual ecosystem services such as climate regulation, air regulation, hydrological regulation in regulation services, soil conservation in support services, and biodiversity maintenance were greater than 10% (Figure 4). To be specific, the net appreciations of ESV of forests, farmland, and rivers were ¥260.964, ¥37.457, and ¥24.353 billion, accounting to 80.88%, 11.61%, and 7.55% of the net appreciation of ESV, respectively (Figure 3).

Comparison of regional distribution of ESV

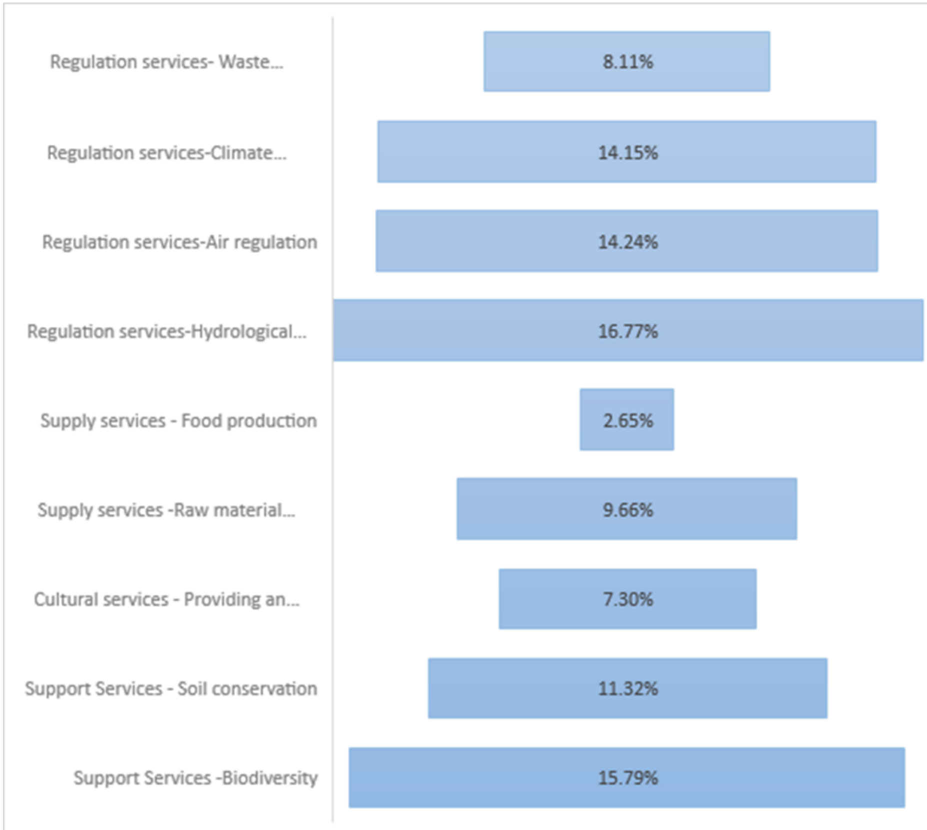

Figure 4. The contribution of individual ecosystem services to the net appreciation of ESV in Jiangxi province, China from 2010 to 2020.

From 2010 to 2020, the total ESV of cities across Jiangxi province showed an upward trend. The average annual growth rate of ESV per unit area in Jiujiang, Yingtan, Ganzhou, and Fuzhou was more than ¥2,000/ha. In 2018, the total ESV in cities across Jiangxi province decreased comparing to that in 2016. In terms of the total ESV in Jiangxi province, Ganzhou city accounted to 32.39%. The ESVs per unit area in various cities, from large to small, were ¥74,716.67/ha, ¥69,965.75/ha, ¥56,042.02/ha, ¥55,778.45/ha, ¥54,838.02/ha, ¥50,809.19/ha, ¥50,358.72/ha, ¥50,100.94/ha, ¥49,165.86/ha, ¥43,978.23/ha, ¥27,647,07/ha in Ganzhou, Fuzhou, Yingtan, Jiujiang, Yichun, Xinyu, Pingxiang, Shangrao, Jingdezhen, Ji'an, and Nanchang, respectively. Southern Jiangxi province was a high concentration area of ESV because it owns lush mountain forests, while northern Jiangxi province was a low concentration area of ESV because it is a plain area with a lot of cultivated and constructed land (Figure 5).

Regional cluster analysis of ESV

According to the clustering analysis results of the land classification of ESV, 11 cities in Jiangxi province, China were divided into three types of functional areas. The first type cities were the control type including Nanchang, Jingdezhen, Pingxiang, Xinyu, and Yingtan. These cities had higher intensity of land development, and the river and lake ESV was not realized. The second type cities were the balance type including Jiujiang, Ji'an, Yichun, Fuzhou, and Shangrao. In these 5 cities, forest land was developed and protected in a balanced manner, and the local farmland ESV was improved. The third type city was the protection type. With high ESV and rich forest resources, Ganzhou, which is located at the junction of Jiangxi, Fujian, and Guangdong

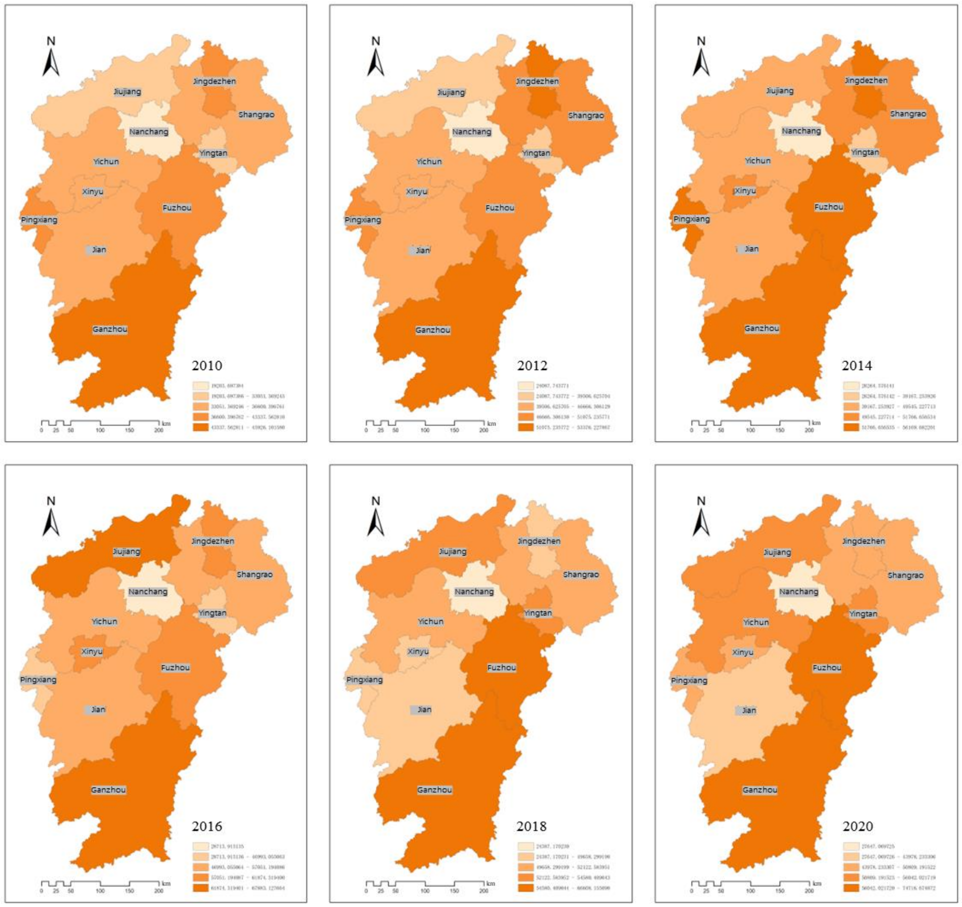

Figure 5. Value of ecosystem services per unit area in Jiangxi province, China from 2010 to 2020.

Table 2. Cluster analysis result of regional ESV in Jiangxi province, China.

Cities	City No.	ESV (¥100 million)					Cluster analysis group number
		Grassland	Rivers/Lakes	Deserts	Farmland	Forest land	
Nanchang	1	0.05	87.07	0.01	67.97	43.73	1
Jingdezhen	2	0.01	6.80	0.00	24.76	226.51	1
Pingxiang	3	0.02	1.14	0.00	20.28	171.06	1
Jiujiang	4	0.16	221.62	0.02	110.34	733.36	2
Xinyu	5	0.01	10.36	0.00	30.96	119.47	1
Yingtan	6	0.01	10.73	0.00	34.29	153.56	1
Ganzhou	7	1.13	40.05	0.00	161.45	2,737.86	3
Ji'an	8	0.13	36.40	0.00	110.45	964.77	2
Yichun	9	0.12	47.87	0.00	166.06	809.29	2
Fuzhou	10	0.25	32.74	0.01	104.46	1,002.69	2
Shangrao	11	0.16	134.84	0.00	156.73	1,023.54	2

provinces, contributed nearly 1/3 to the ESV of the whole province. Thus, different ecological development strategies should be formulated for these three different types of functional areas (Table 2).

Discussion

From 2010 to 2020, the ESV in Jiangxi province, China increased by ¥322,646 million, which was mainly arisen from the increase in forest ESV. Regulation services and support services contributed 80.39% to the net appreciation. Therefore, more efforts should be made to strengthen the protection of forest land in the regional ecological environment in future. The mountainous regions in southern Jiangxi are rich in forest resources, but the local communities and economy have not been fully developed. Therefore, the local superior natural resources can be utilized to develop the regional tourism industry based on the abundant oxygen emitted by the natural forests. Also, the awareness of farmers should be aroused to plant and cultivate high-efficiency ecological economic forests, and to appropriately convert the grassland into forest land with dense grassland, so as to create more abundant ecological value and increase people's well-being. At present, there are many rivers and lakes and a large area of cultivated land in the north of Jiangxi province, and the ESV of rivers and lakes has not been fully tapped. So, it is required to further strengthen hydrological protection.

From 2000 to 2020, a large number of forest land in Jiangxi province was converted into cultivated land and construction land with total increases of 2,687.60 km^2 of cultivated land and 1,647.19 km^2 of construction land, while a total decrease of 4,396.28 km^2 of forest land. The major driver behind was the increase of NPP of forest land and stronger ecosystem service capacity. However, the NPP of forest land was not stable and reached a historical low in 2016, resulting in an adverse effect on plant production and ecological environment protection. Hence, regional forest land and river protection should be strengthened to enhance land use efficiency. In areas where cities are densely distributed such as the plain in the north of Jiangxi province, the orientation and rate of urbanization should be rationally planned with a promotion in the urban space utilization. Also, the unused land in mountainous and basin areas in Jiangxi province should be reasonably developed. In addition, the land use structure should be continuously optimized to promote the sustainability of regional ecosystems and to tap the ESV potential of land use.

In this study, land use transfer matrix was used to explore the spatial and temporal characteristics of land use and study the according impact on regional ESV in 11 cities of Jiangxi province from 2010 to 2020. Based on the ESV brought by land use, 11 cities were divided into three groups according to the results of clustering analysis so as to provide a reference for accurate policy implementation, land resource management, and ecological environment protection. The results showed that land use types in Jiangxi province were diverse with significant differences in the spatial distribution. The spatial distribution of the regional ESV was high in the south and low in the north of the province. For the cities of Nanchang, Jingdezhen, Pingxiang, Xinyu, and Yingtan with high level of economic development and land development intensity close to the critical level, more attentions should be paid to rational planning, increasing utilization rate of urban space, protection of rivers and lakes with high ecological value to avoid further large-scale development into cultivated land and construction land. For the cities of Jiujiang, Ji'an, Yichun, Fuzhou, and Shangrao, more attentions should be paid to both protection and development, and extensive development should be avoided while rationally developing and improving the level of economic development. The ESV per unit area should be moderately increased to reserve more development spaces. For Ganzhou city where the total area and ESV account to a relatively high proportion in the whole province, emphasis should be focused on the green lung function of its forest resources in the ecosystem, giving play to its role as an ecological highland at the junction of Jiangxi, Fujian, and Guangdong provinces, establishing an ecological compensation mechanism, avoiding destructive development, and giving better play to its ecological benefits of green hills and clear waters.

Conclusion

Jiangxi province, China has various types of land use. From 2000 to 2020, the conversion between different land types was significant, mainly manifested as a large decrease in forest land and a significant increase in cultivated land and construction land. With the increase of NPP value of forest land, the overall ESV of Jiangxi province showed an increasing trend with the net appreciation of ¥322.646 billion. The increase in value of regulation services and support services took a major part in the regional ESV appreciation. The spatial distribution of the regional ESV was high in the south and low in the north of Jiangxi province. Since realization paths of ESV in different cities varied, the 11 cities were divided into three types of functional areas including control type, balance type, and protection type. Classified policies and protection were formulated to achieve a win-win situation for ESV and economic development.

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