Research on Regional Ecological Compensation Mechanism Based on Improved Footprint Model and Ecosystem Service Value

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Abstract. In order to solve the problem that the compensation and environment in the ecological compensation are separated from each other and the theoretical compensation amount is excessively high, it is of great significance to study the establishment of a reasonable and feasible ecological compensation mechanism. From the perspective of ecosystem service value, this paper substitutes and replaces the sustainable ecological profit and loss index calculated by the "consumption-output" ecological footprint model and compensation correction coefficient on the calculation idea based on the unit area value equivalent factor. The new ecological compensation standard and the accounting method of compensation priority are obtained, and the empirical analysis is carried out in Linxiang City as an example. Results are as follows: (1) The total value of ecosystem services in Linxiang City is higher, but the regional distribution is different, and the supply and demand are not balanced in space. (2) The regional ecological compensation standard model of Linxiang City has certain rationality. The ecological compensation standards of all regions are smaller than the upper limit of ecosystem service value. (3) Chengfeng Township first obtained ecological compensation, Chang'an town paid compensation first, and Taolin Town finally received compensation. The ecological compensation standard revised by the "consumption-output" model is economically reasonable within the regional GDP tolerance. The compensation is based on the "high non-market value output and low GDP output" area as the priority to obtain compensation logic. And the logic is in line with the concept of reality.

1. Introduction

In view of the current ecological civilization construction, the contradiction between economy and ecology and the imbalance of regional development, it is of great significance to construct regional ecological compensation mechanism to alleviate regional pressure and coordinate and promote...
sustainable development. As a key means of coordinating the balance of regional eco-economic development, ecological compensation can promote regional harmonious and stable development by paying fees to regions or groups that provide support and protection of ecological services [1]. At present, the research on ecological compensation standards at domestic and foreign mainly uses the opportunity cost method, the value theory method, the willingness to pay method and the ecological footprint method. Kosoy and other scholars have calculated the ecological compensation standard by quantifying the opportunity cost [3], and Pham et al. have compared the ecological compensation efficiency problem of the opportunity cost method [4]. Domestic scholars Jing Duan [5] and Ming Dai [6] have applied and improved the opportunity cost accounting method in ecological compensation, and carried out regional empirical research. However, the opportunity cost method is used to calculate the ecological compensation standard, in which the economic loss of the ecosystem service provider is calculated, rather than the service value of the ecosystem loss. It will weaken people's attention to ecological security [7]. The Willingness to Pay ("WTP" for short) method is to investigate the payment or compensation willingness of the ecosystem service provider and the buyer through inquiry, questionnaire, etc. to determine the compensation level acceptable to both parties [8-11]. Although it can reflect the willingness of the compensator to pay and the development level of the region, it is difficult to adjust the contradiction between the willingness to pay and the willingness to accept. At the same time, WTP has problems such as long investigation period and difficulty in collecting data. On the basis of value theory, Gaodi Xie constructed and gradually updated the unit area value equivalent factor system suitable for China's terrestrial ecosystems [12-13], which laid the foundation for exploring the compensation model from the perspective of ecosystem service value and enriched the ecological compensation research [14-18]. But the lack of differentiation of public goods attributes and non-public goods for the types of ecosystem services, the compensation standards far exceed the social and economic development level of the study area and the government's financial capacity.

Jianwu Xiao [19], Jie Liang [20], Jian Zhou [21], etc., based on the value of ecosystem services, combined with the ecological footprint model to carry out research on ecological compensation mechanism, and carried out empirical analysis. However, the traditional ecological footprint model neglects the relationship between the regions, and fails to fully consider the output of the ecological footprint, which leads to the deviation of the regional sustainable state from the reality, which has limitations in some aspects [24].

In order to overcome the problems of Opportunity Cost Approach in counting ecological compensation, strengthen the interrelationship between compensation and environment, and enhance the ecological security awareness of various social subjects, this paper is based on the basic point of ecosystem service value, and considered the actual ecological security sustainability of the study area and the rationality of the ecological compensation calculation results, and combined with the "consumption-output" ecological footprint model to calculate the ecological compensation standard. This paper innovatively uses the sustainable carrying ecological profit and loss in the "consumption-output" footprint model to replace the land area in the traditional value calculation, so as to rationalize the calculation results, and to give the ecological compensation a connotation of balance of regional resources circulation. Finally, through the ecological compensation calculation of 19 towns and towns in Linxiang City, an empirical study was conducted.

2. Methods and Data

2.1. Study Area
The study takes Linxiang City as an example. The research area is located in the middle reaches of the Yangtze River, with a suitable environment, and the enrichment of water resources and various natural resources, which contains enormous ecological and economic value. Secondly, thanks to the appropriate geographical conditions such as geography and climate, the forest coverage rate of Linxiang City is as high as 51.11%, and it contains a wide variety of forest resources. In 2017, the forest stock volume reached 2.613 million m³, and bamboo and wood processing products exist a higher export volume.
Linxiang City is rich in mineral resources, including various metals, non-metals and energy minerals, which contain extremely high economic value.

In order to improve economic development, various areas in Linxiang City are competing to promote economic activities such as industry and mining, and there are problems such as water pollution and declining land quality. Unreasonable discharge of sewage and dust, high-strength mining activities of mines, etc. have a negligible negative impact on the supply and support of regional ecosystem services. At the same time, because the relevant regions attach importance to the protection and construction activities of the ecological environment, they have given up opportunities for economic development, and development has lagged behind. Therefore, the implementation of a reasonable ecological compensation mechanism in Linxiang City can balance the interests of the developers of resource consumption and the environmental protection parties, thus achieving the stability of the ecological environment and economic development. The reasonable compensation mechanism can also indirectly guide the regional population to carry out production activities suitable for the current ecosystem conditions, and avoid inefficient and inefficient use and destruction of the ecological environment.

2.2. Method
Compensation payments for ecosystem loss services (also known as "payment for ecosystem services") are the essence of ecological compensation and a basis for quantifying the contribution of ecosystems to human society. The ecological compensation standard determined according to the increase or decrease of the value of regional ecosystem services is often because the value is too high and the payer cannot complete the payment [20], but it can be set as the upper limit of the ecological compensation standard, and the reasonable range of control compensation and proportion. This paper attempts to construct an ecological compensation standard model using the "consumption-output" ecological footprint model.

2.2.1. Estimation of Ecosystem Service Value. Based on the equivalent factor method proposed by Xie scholars, this paper considers the similarity of ecological service functions and the differences in ecological characteristics of different ecosystems, then subdivides the Linxiang ecosystem with existing research. With reference to relevant research, the ecosystem service value equivalent factor of Linxiang City was partially revised, and the value of ecosystem services in Linxiang City was finally calculated. The formula is as follows:

$$ESV = \sum (A_k \times VC_k)$$  (1)

Where $ESV$ is the total value of the annual ecosystem services in the study area, $A_k$ is land use area of k-type land and $VC_k$ is value of ecosystem services per unit area of k-type land.

2.2.2. "Consumption-output" footprint model. The "consumption-output" footprint model describes the consumption and production of the regional population by subdividing the footprint account as "consumption ecological footprint and output ecological footprint", and the ecological carrying capacity is calculated by the traditional footprint method. According to the traditional ecological profit and loss, the definition of consumption profit and loss and output profit and loss is defined. The relationship [16] is as follows:

$$EF_c = N \times \eta \sum_{i=1}^{n} (c_i/p_i)$$  (2)
$$EF_o = N \times \eta \sum_{i=1}^{n} (o_i/p_i)$$  (3)
$$EC = 0.88 \sum_{j=1}^{m} (A_j \eta_j y_j)$$  (4)
$$ER_c(ED_c) = EC - EF_c$$  (5)
$$ER_o(ED_o) = EF_o - EC$$  (6)
Where $EF_c$ is consumption ecological footprint, $EF_o$ is output ecological footprint, $ER_c$ is consumer ecological footprint surplus, $ED_c$ is consumer ecological footprint deficit, $ER_o$ is output ecological surplus, $ED_o$ is output ecological deficit, $EC$ is available ecological capacity, $c_i$ is per capita consumption of project $i$, $o_i$ is per capita production of project $i$, $p_i$ is global average production capacity of project $i$, $A_j$ is area of $j$-type land, $r_j$ equilibrium factor of $j$-type land, $y_j$ yield factor of $j$-type land.

According to the above formula, construct a sustainable ecological carrying loss index (EL) (Table 1) to quantify the area of ecologically productive land that can be depleted in the region.

| State one | $EF_o < EC$ | $EL = EC - EF_c$ | The regional production capacity is lower than the regional ecological load, and there is a surplus of ecological production land area. |
| State two | $EF_c < EF_o$ | $EL = ER_o + (EC - EF_c)$ | Production potential is released, regional production meets consumption, and is in an ecological surplus state |
|           | $EF_c = EF_o$ | $EL = ER_o + ED_c$ | Production potential release, regional consumption and production balance, ecological balance |
|           | $EF_c > EF_o$ | $EL = ER_o + ED_c$ | Production potential is released, regional consumption extends beyond the domain, and is at an ecological loss |

2.2.3. Ecological compensation method based on sustainable ecological loss. Combined with the calculation results of ecosystem service value, this paper uses the "consumption-output" ecological footprint model to calculate the ecological footprint and ecological carrying capacity of the study area, and based on this, determine the sustainable ecological loss amount, combined with the compensation coefficient, and finally calculate The ecological compensation that the area should pay or obtain, the quantitative model of the ecological compensation standard is shown in Table 2. The specific calculation formula is:

$$E = I_{et_i} \times N_i \times \overline{ESV_i} \times r_i$$  \hspace{1cm} (7)

Where $E$ is ecological compensation standard value, $\overline{ESV_i}$ is Ecosystem service value per unit area of region $i$, $I_{et_i}$ is per capita sustainable ecological loss in region $i$, $N_i$ is population in region $i$, $r_i$ is the ecological compensation coefficient of region $i$.

| Table 2. Connotation of quantitative model of ecological compensation standard. |
|-----------------------------------|-----------------|---------------------------------|
| Equivalent factor method | Ecological compensation standard |
| formula | $ESV = \text{Ecosystem service value per unit area} \times \text{Land area} \times \text{correction factor}$ | $E = \text{Ecosystem service value per unit area} \times \text{Sustainable ecological loss amount} \times \text{Correction factor}$ |
| Indicator 1 | Ecosystem service value per unit area | Ecosystem service value per unit area |
| Indicator 2 | Land area | Sustainable ecological loss amount |
| Indicator 3 | Equivalent factor correction factor | Compensation correction factor |

This paper refers to the relevant research on ecological compensation coefficient, combined with sustainable ecological carrying profit and loss calculation, the expression is as follows:
\[ r_i = \frac{L_i}{1 + e^{-e t}} \]  
\[ L_i = \left( \frac{I_{el}}{I_{et}} \right) \times \left( \frac{GDP_i}{GDP} \right) \]

Where \( L_i \) is compensation ability, \( e \) is the base of natural logarithm, \( t \) is reciprocal of Engel's coefficient, \( I_{el} \) is per capita sustainable ecological loss in whole research area, \( GDP_i \) is GDP of region i.

2.2.4. Ecological compensation priority assessment method. In order to balance the relationship between development and protection, this paper refers to existing research [25-26] to calculate the priority of ecological compensation. The specific expression is as follows [25]:

\[ ECPS = \frac{VAL_N}{GDP_N} \]

Where \( ECPS \) is ecological compensation priority, \( VAL_N \) is ecosystem non-market value or area, \( GDP_N \) is Gross Regional Product or area.

The smaller the \( ECPS \) value, the smaller the impact on the payer's compensation payment, and the first to pay for ecological compensation. For the party that receives the ecological compensation, the larger the \( ECPS \) value, the greater the need for compensation and compensation. It has a strong role in promoting its economy and needs to be the first to obtain ecological compensation.

2.3. Data Sources
In this study, the "consumption-output" raw data of the ecological footprint is derived from the "Linxiang Statistical Yearbook (2005-2017)", and the various land area data involved in ecological carrying capacity are derived from the land use change survey database (2005-2017), the equivalent factor in the ecosystem service value accounting is selected from the national scale "basic equivalent table" published by Xie, and the value coefficient is calculated to take an average of 1/7 of the market value per hectare of food per year. Other data refer to the statistics of Linxiang City Land and Resources Bureau, "Linxiang City Land Use Master Plan (2006-2020)", "Linxiang City Mineral Resources Development and Land Use Research Report", "Yueyang City Mineral Resources Overall Planning (2008-2017)", "The 2017 China Water Resources Bulletin", and the statistical bulletins of the counties and districts issued by the Hunan Provincial Bureau of Statistics.

3. Results
3.1. Ecological compensation standard based on "consumption-output" model

3.1.1. Ecosystem service value assessment. By accounting for the value of ecosystem services in various areas of Linxiang City in 2017, as shown in Figure 1, it can be found that the value of ecosystem services in Linxiang City has a large regional imbalance. Judging from the total value of ecosystem services in different towns of Linxiang City, Jiangnan, Yanglou, Yuantan, Chengfeng, Zhanqiao and Nieshi Town exceeded the average level of Linxiang City 629.2 million yuan. Among the 19 townships and towns, there are significant differences between the highest and lowest regions of ecosystem services, namely Jiangnan Town and Baiyun Town. The former ecosystem service value is 1.56 billion yuan, accounting for 13.08% of the total value, the latter is 0.17 billion yuan, accounting for 1.42% of the total value, the difference between the two is nearly 10 times.

From the perspective of the spatial distribution of ecosystem services in various regions, it generally presents a higher value in the north, a lower value in the south, and the weakest distribution in the middle. Jiangnan Town is located in the northernmost part of Linxiang City, adjacent to the Yangtze River. It has a very rich hydrological regulation service value of 1.08 billion yuan, accounting for 78% of the total value of Jiangnan Town. In addition, there are also townships with high value of ecosystem services
such as Chengfeng, Yuantan and Nieshi Town in the north. Although Yanglou Town is located in the central part of Linxiang City, it also has a high value of ecosystem services. This is mainly because its administrative area is large, reaching 27790.82hm², and its ecosystem service value per unit area is not protruding. Chang'an is located in the central part of Linxiang City. Due to its geographical location and regional characteristics, ecological resources are scarce compared with other regions. It is often necessary to input resources into the region, and the value of various ecosystem service functions is at a low level. Chang'an is typical low ecological output area.

3.1.2. Sustainable ecological losses and ecological compensation. The calculation of the sustainable ecological loss of the 19 townships under the jurisdiction of Linxiang City and the ecological compensation amount paid/acquired are shown in Table 3. It can be seen that among the 19 townships under the jurisdiction of Linxiang City, only the sustainable ecological burden of Chang'an is negative. The development status is not sustainable, and the ecological compensation value is 167.75 million yuan. 18 townships such as Hengpu, Chengnan and Huanggai Town receive ecological compensation, and the total ecological compensation value is 4.94 billion yuan. Among them, Jiangnan, Huanggai and Yuantan Town ranked the top three. The ecological compensation value of Jiangnan Town should be the highest, which was 2.00 billion yuan. The ecological compensation that obtained by Zhongfang, Zhanqiao and Hengpu Township was lower than Jiangnan, that Zhongfang Town should obtain is the lowest, which is 64.76 thousand yuan. From the perspective of geographical location, the distribution of compensation in Linxiang City in 2017 generally showed a trend of decreasing from the northern region to the southwest region, then to the central region, and then to the southeast region. The distribution of sustainable ecological loss and the distribution of regional ecosystem services are roughly the same during the same period (Figure 2, Figure 3 and Figure 4).

Jiangnan and Huanggai Town, located in the north of Linxiang City, are the crucial economic towns and towns in the Jianghu Plain, which are dominated by natural resources processing industries, including special aquatic products processing and vegetable production and processing. Yuantan Town is a typical lake township and is a production of aquatic products. The base not only has a high sustainable ecological loss, but also has sufficient ecosystem services for the leading industries. It
provides some help for the regional ecological environment protection and ecosystem stability, and should receive ecological compensation. The central and southeastern regions are main mining areas in Linxiang City. Baiyun Town, Wuli Township and Yanglousi Town are the main producing areas of dolomite and cement limestone. Zhongfang Town and Taolin Town mainly mine lead-zinc mines. Changtang Town and Zhanqiao is the main producer of clay and kaolin for bricks.

Higher natural resource production enables these towns to maintain above the critical point of sustainability. These areas receive less ecological compensation due to less substantial protection for ecosystems. As the downtown area of Linxiang, Chang’an town mainly develops secondary and tertiary industries, mainly tourism and light industry. The occupation of ecological services far exceeds regional output, and the output of resources is less, and the demand for population exceeds regional output capacity, resulting in consumption shifts. Therefore, Chang’an town needs to pay for ecological compensation.

In the target year, Linxiang City received a total ecological compensation of 47.70 billion yuan. Among them, the total amount of ecological compensation to be paid by Chang’an is 167.75 million yuan, and the total amount of ecological compensation received by another 18 towns, such as Hengpu, Chengnan and Huanggai Town is 4.94 billion yuan. The total amount indicates that the supply of ecosystem services in Linxiang City is greater than its demand in 2017, and the ecosystem of the study area is in a state of surplus health, which is consistent with the characteristics of resource-based cities that are flourishing at maturity.

**Figure 2.** Eco_deficit of townships in 2017.

**Figure 3.** Eco_value of townships in 2017.
Figure 4. Eco_compensation of Townships in 2017.

Table 3. Ecological Compensation Standards Based on Ecological Footprint.

| Township     | EL (ghm²) | Iel | Li   | ri   | ESV (*10⁴ yuan/hm²) | E (*10⁶ yuan) |
|--------------|-----------|-----|------|------|---------------------|--------------|
| Chang'an     | -49324.53 | -0.51 | 0.0747 | 0.072 | 4.7234 | -167.7458 |
| Henpu        | 3622.43   | 0.19 | 0.0107 | 0.0105 | 5.3802 | 2.053687 |
| Chengnan     | 7608.06   | 0.52 | 0.009  | 0.0089 | 5.2045 | 3.525608 |
| Tandu        | 27621.85  | 1.54 | 0.0397 | 0.039  | 5.5336 | 59.55616 |
| Chengfeng    | 37472.87  | 3.27 | 0.0508 | 0.0498 | 12.3485 | 230.594431 |
| Wulipai      | 16569.79  | 0.63 | 0.0429 | 0.0427 | 5.8709 | 41.495288 |
| Huanggai     | 76242.59  | 7.01 | 0.2333 | 0.1274 | 13.5794 | 1318.49814 |
| Dinghu       | 49945.59  | 2.81 | 0.0737 | 0.0723 | 8.1801 | 295.296531 |
| Ruxi         | 31432.71  | 2.49 | 0.0493 | 0.0485 | 8.9436 | 136.432397 |
| Zhanqiao     | 1606.07   | 0.04 | 0.0058 | 0.0057 | 5.1386 | 0.468849 |
| Baiyangtian  | 11015.98  | 0.47 | 0.0338 | 0.0334 | 5.5772 | 20.523774 |
| Changtang    | 9232.74   | 0.32 | 0.0083 | 0.0081 | 5.1558 | 3.868859 |
| Taolin       | 21308.69  | 0.55 | 0.0844 | 0.0833 | 5.2203 | 92.713418 |
| Yanglousi    | 5501.52   | 0.11 | 0.0168 | 0.0162 | 5.4581 | 4.872411 |
| Jiangnan     | 90483.71  | 3.1 | 0.3446 | 0.1653 | 13.3495 | 1996.306599 |
| Yuantian     | 40878.68  | 2.42 | 0.1259 | 0.1245 | 11.8388 | 602.613446 |
| Nieshi       | 27723.09  | 1.06 | 0.0736 | 0.0724 | 5.6715 | 113.762045 |
| Baiyun       | 12563.76  | 0.76 | 0.028  | 0.0274 | 4.5262 | 15.581294 |
| Zhongfang    | 1078.95   | 0.03 | 0.0012 | 0.0012 | 5.214  | 0.064757 |
Analysis of areas where ecological compensation is paid can be found. For example, comparing the ecological compensation and production value paid by Chang’an town in 2017, it can be concluded that the ecological compensation of Chang’an town is within the scope of its affordability, and the results can be accepted.

According to the analysis of the total amount of ecological compensation and the proportion of acquisition in 19 towns and towns in Linxiang City in 2017, it can be concluded that Jiangnan Town has the highest proportion of ecological compensation, with a ratio of 40.42%. Then Huanggai Town followed by 26.70%. Then Yuantan Town followed by 12.20%. The lowest proportion of ecological compensation is Zhongfang Town, with a ratio of 0.00001%, followed by 0.00009% of Zhanqiao Town. In terms of proportion, the ecological compensation obtained by Jiangnan Town and Huanggai Town accounted for more than half of the total. According to the analysis, Jiangnan Town and Huanggai Town both have relatively high output ecological footprint and low consumption ecological footprint. And there is a high sustainable ecological loss area in this place, which means that it has high ecosystem service provision and low ecological service occupation. According to the basic logic of ecological compensation, such areas should obtain higher ecological compensation value. Analysis of townships that have lower compensation such as Zhongfang Town and Yuantan Town etc., the change trend of regional ecological annual output and annual consumption is gradually decreasing. It means that the sustainable ecological loss of sustainable carrying capacity is declining year by year, and local ecosystem services are less occupied outside the region, so the ecological compensation values obtained in the region are lower.

3.2. Ecological compensation priority
According to the ecological compensation standard, the ecological compensation priority of 19 towns in Linxiang City is calculated. As shown in Table 4. The judgment result of the ecological compensation payment or acquisition obtained based on the calculation result of the sustainable ecological loss amount shows that Chang’an is the payer of ecological compensation, and other towns are the recipients of ecological compensation.

| Township   | EL$_2$ (ghm$^2$) | Regional development status | Ecological compensation payment/acquisition | Non-market value($10^4$ yuan) | ECPS |
|------------|------------------|-----------------------------|--------------------------------------------|-----------------------------|------|
| Chang'an   | -49324.53        | EL<0, Unsustainable         | Payer                                      | 21151.18068                 | 0.101|
| Henpu      | 3622.43          | EL>0, Sustainable           | Obtaining party                            | 45160.8051                  | 0.549|
| Chengnan   | 7608.06          | EL>0, Sustainable           | Obtaining party                            | 26641.14081                 | 1.068|
| Tandu      | 27621.85         | EL>0, Sustainable           | Obtaining party                            | 41892.12656                 | 1.135|
| Chengfeng  | 37472.87         | EL>0, Sustainable           | Obtaining party                            | 95849.92785                 | 4.287|
| Wulipai    | 16569.79         | EL>0, Sustainable           | Obtaining party                            | 53950.88905                 | 0.551|
| Huanggai   | 76242.59         | EL>0, Sustainable           | Obtaining party                            | 49430.06081                 | 1.034|
| Dinghu     | 49945.59         | EL>0, Sustainable           | Obtaining party                            | 59262.15742                 | 1.575|
| Ruxi       | 31432.71         | EL>0, Sustainable           | Obtaining party                            | 43161.05488                 | 1.519|
| Zhanqiao   | 1606.07          | EL>0, Sustainable           | Obtaining party                            | 67811.22248                 | 0.322|
| Baiyantian | 11015.98         | EL>0, Sustainable           | Obtaining party                            | 44944.86668                 | 0.437|
| Changtang  | 9232.74          | EL>0, Sustainable           | Obtaining party                            | 29838.43388                 | 0.809|
| Taolin     | 21308.69         | EL>0, Sustainable           | Obtaining party                            | 37843.22756                 | 0.171|
| Yanglousi  | 5501.52          | EL>0, Sustainable           | Obtaining party                            | 145478.8034                 | 0.666|
| Jiangnan   | 90483.71         | EL>0, Sustainable           | Obtaining party                            | 153228.4058                 | 0.959|
| Yuantan    | 40878.68         | EL>0, Sustainable           | Obtaining party                            | 98496.71973                 | 1.319|
| Nieshi     | 27723.09         | EL>0, Sustainable           | Obtaining party                            | 67368.02848                 | 0.676|
| Baiyun     | 12563.76         | EL>0, Sustainable           | Obtaining party                            | 16162.74224                 | 0.304|
| Zhongfang  | 1078.95          | EL>0, Sustainable           | Obtaining party                            | 56748.70418                 | 0.903|
Combining ECPS calculation value and ecological compensation payment or acquisition judgment analysis, the ecological compensation party has the highest priority, which is 4.28, so it should be the first to obtain ecological compensation, followed by Ruxi Town, Dinghu Town and Yuantan Town, etc. The ecological compensation priority of Chengfeng Township is much higher than other areas. The reason is that the non-market value of the regional ecosystem in Chengfeng Township is 958.49 million yuan per square kilometer, while the regional GDP is only 207.88 million yuan per square kilometer. Chengfeng town plays a role in providing high non-market value ecological services and its own market economy development is lagging behind in the market development. Therefore, in the process of ecological compensation for the redistribution of market interests, it is preferred to obtain ecological compensation.

4. Conclusion and Discussion

First of all, we considered the rationality of the regional ecological compensation standard model. In the regional ecological compensation mechanism, only knowing the value of ecosystem services in a certain area can't balance the ecological economic benefits between different regions. A method must be found to measure ecosystem services imbalance between value supply and demand. The calculation method of the "consumption-output" footprint model adopted in this paper comprehensively reflects the imbalance between supply and demand of services in the two levels of regional resource consumption and supply, and calculates the value of sustainable ecological carrying losses. Then, the results are combined with the calculation value of ecosystem service value to provide a calculation reference for regional ecological compensation. In 2017, Linxiang City has a sustainable ecological carrying surplus of 422,584.54 ghm², which is the provider of ecosystem services and should obtain compensation as a whole. Combining with the calculation of the value of ecosystem services, it is concluded that Linxiang City should receive 4.77 billion yuan, which is less than the ecological service value provided by ecosystem. Therefore, we have found that it is feasible to combine the "consumption-output" ecological footprint model with value theory as the basis for ecological compensation analysis.

In view of the operability of the regional ecological compensation mechanism, the regional ecological compensation subject of Linxiang City should be the township government of the lower jurisdiction, and the object should be the ecosystem providing the ecosystem service function within the administrative region. The Chang'an town needs to pay ecological compensation, with a total amount of 126 million yuan, the remaining 18 areas have received ecological compensation, with a total amount of 4.94 billion yuan, of which the ecological compensation values obtained by Jiangnan Town, Huanggai Town and Yuantan Town are among the top three. The ecological compensation of Linxiang City should consider the supply of the liquidity of its resources, give full play to the macroscopic role of the regional governments in compensation, and cooperate with the market compensation mechanism to balance the interests of the ecological service supply and the consumers, and achieve the optimization of regional development and positioning select.

Taking Linxiang City as an example, we verified the rationality and scientific nature of the ecological compensation standard quantitative model method based on the "consumption-output" ecological footprint model at a small regional scale. The results can provide a certain reference value for the quantitative study of regional ecological compensation standards at the provincial and national scales. Subsequent research can explore the differences and commonalities of quantitative methods for ecological compensation standards at different scales based on this study.

Through empirical research, it is found that the ecological compensation standard calculated by combining the "consumption-output" model is theoretically reasonable and feasible. Because it does not consider human factors, the amount of compensation funds is too large in some extent. Subsequent research can supplement the sample survey of willingness to compensate and gain on the basis of this study, and correct the compensation factor to adjust the ecological compensation standard. The ecological compensation quantitative model needs to be scientifically perfected and quantitatively researched and implemented. For example, the detailed data of time series needs to be further collected and supplemented, and the accuracy of the results will be affected. In the future research,
more in-depth research can be carried out to provide a more accurate basis for the quantitative standards of regional ecological compensation.

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