

Evolution of Community Income Structure around Nature Reserves and its Influence on Farmers' Income

-- Take Jinping Watershed National Nature Reserve as an Example

Xiaocheng Yin, Qingkui Lai*, Rui Yan

School of Economics and Management, Southwest Forestry University, Kunming, 650224, China

*1029931952@qq.com

Abstract

Taking Ma 'andi Township around Jinping Watershed National Nature Reserve as the research object, the evolution of community income structure and its influence on farmers' income in Ma'andi Township from 2010 to 2018 were analyzed, and the correlation between per capita income and operational income was analyzed by grey correlation degree. The results show that the income level of communities around Jinping Watershed National Nature Reserve is lower than the average level of Yunnan Province and the whole country. Community income structure mainly consists of operational income, wage income and transfer income; The change of income structure is characterized by the largest proportion of operational income, the fastest growth rate of wage income and the most unstable transfer income. The grey correlation degree of per capita income is as follows: operational income > wage income > transfer income. The dependence of community farmers on wage income is increasing, while the dependence on operational income and transfer income is decreasing. The grey correlation degree of operational income is as follows: animal husbandry income > agricultural income > forestry income > non-agricultural operational income. Although the proportion of animal husbandry income and forestry income is low, the correlation with operational income is constantly strengthening, and the non-agricultural business income has a limited effect on increasing operating income. Based on the above research, it is proposed to adjust the industrial structure and broaden the income channels; Expand investment and change the way of production and life; Three suggestions on establishing a long-term compensation mechanism for nature reserves.

Keywords

Grey Correlation Degree; Nature Reserve; Surrounding Communities; Income Structure; Farmers' Income.

1. Introduction

Nature reserve is an important carrier of ecological civilization construction and the core area of biodiversity protection. As of 2018, China has established 2750 nature reserves, including 474 national nature reserves, with a total area of 1.47 million Km², accounting for 15% of the land area (Duang et al., 2021). From the spatial distribution of nature reserves, it is not difficult to find that nature reserves are often highly coincident with economically underdeveloped areas. Neighboring farmers' dependence on natural resources is manifested in two aspects: income and non-income (Miller-Rushing et al., 2017), and the ways of utilization are diversified. The income from natural resources also accounts for a relatively high level in the total

household income(Thondhlana et al.,2017). Especially in remote ethnic mountainous areas, communities are more dependent on nature reserves, and the contradiction between protection and development is more acute(Nie et al.,2020, Zhao et al.,2016, Song et al.,2016). On the one hand, in order to realize the sustainable development of nature reserves and communities, the government has invested a lot of money to improve and expand their infrastructure and activities, and supported the nature reserves to develop tourism and other activities under the premise of protection(Qing et al.,2020, Sun et al.,2017). However, with the deepening of the construction of nature reserves, the natural capital and social capital of surrounding farmers decreased significantly, the physical capital and financial capital increased significantly, and the human capital did not change significantly(Wang et al.,2017). Compared with other areas, the surrounding community economy shows a lower income level, and the development of eco-tourism intensifies the income gap of farmers(Xu et al.,2022). On the other hand, because the interests of community farmers and managers of nature reserves are inconsistent, there is a conflict between them in the management of nature reserve(Duang et al.,2022, Angwenyi et al.,2020). Therefore, to coordinate the relationship between nature reserves and communities, it is necessary to understand the development characteristics and wishes of community farmers and establish a communication and coordination mechanism between the two managers(Ma et al.,2019). As the main body of the protection and development of nature reserves, residents are not only builders, but also the biggest beneficiaries. How to realize the effective management of nature reserves, guide community participation and achieve a win-win situation between community development and nature reserve construction has always been the focus of domestic and foreign scholars(Reng et al.,2016, Ji et al.,2016,). As a hot spot for biodiversity protection, Yunnan has 166 nature reserves by August 2020, which has made great contributions to the national ecological civilization construction. However, because most nature reserves are located in remote ethnic mountainous areas, the income structure of farmers in the surrounding communities is single, and the economic development is slow. In order to support the construction and development of nature reserves, the income structure has changed, the vulnerability of livelihood has become increasingly prominent, and the conflict between traditional production and life style and the construction of nature reserves has become more intense. In view of this, it is of great practical significance and theoretical value to analyze the impact of the evolution of community income structure on farmers' income from the perspective of farmers' income structure around nature reserves, so as to promote the construction and development of nature reserves and alleviate the contradiction between community farmers and nature reserves.

2. Research Objects and Methods

2.1. Overview of the Research Object

Jinping Watershed National Nature Reserve, located in Jinping County, southeast Yunnan Province, was established in 1986, and was promoted to a national nature reserve in 2001. The nature reserve is a forest ecological conservation zone. Jinping Watershed Nature Reserve is divided into two unconnected areas: Watershed-Wutai Mountain Area and Xilong Mountain Area. There are no villages in the watershed nature reserve, but there are 8 townships, 29 village committees and 186 village groups(Sheng et al.,2020)that have direct influence on the reserve. There are six ethnic groups living around the reserve, including Han, Yi, Yao, Hani, Miao and Lahu, and ethnic minorities account for 95.55% of the population of the reserve, which is a typical frontier ethnic area(Lai et al.,2014). Ma 'andi Township is located near Wutaishan area of watershed protection area, which belongs to the main area around the protection area. According to the statistical yearbook analysis of Maandi Township in 2010-2018, the per capita income of farmers in Maandi Township is not only lower than the average level of Jinping

County, but also lower than the average level of Yunnan Province and the whole country. It is a typical economically underdeveloped area. (See Figure 1) In addition, as can be seen from Figure 2, from 2010 to 2018, the income of farmers in Ma 'andi Township consisted of operational income, wage income and transfer income, among which operational income accounted for the largest proportion, followed by wage income and transfer income at the least. In addition, operational income and wage income show a trade-off trend. The proportion of operational income is declining, while wage income is rising, while transfer income fluctuates greatly. (see figure 2)

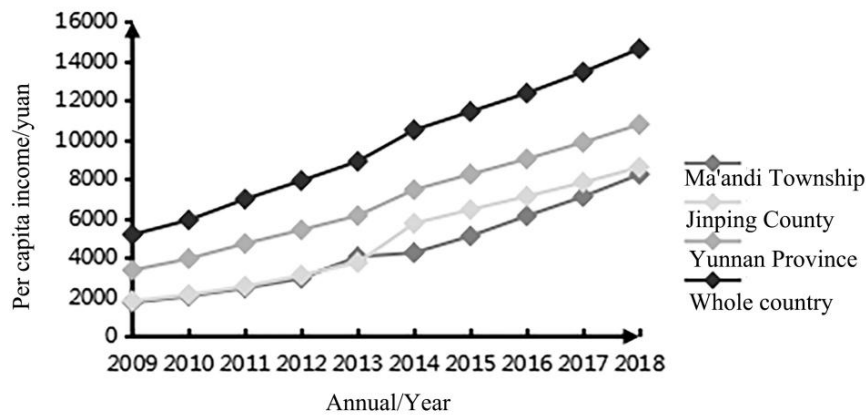


Figure 1. Comparison of Per Capita Income Differences of Farmers in Different Regions and Maandi Township from 2009 to 2018

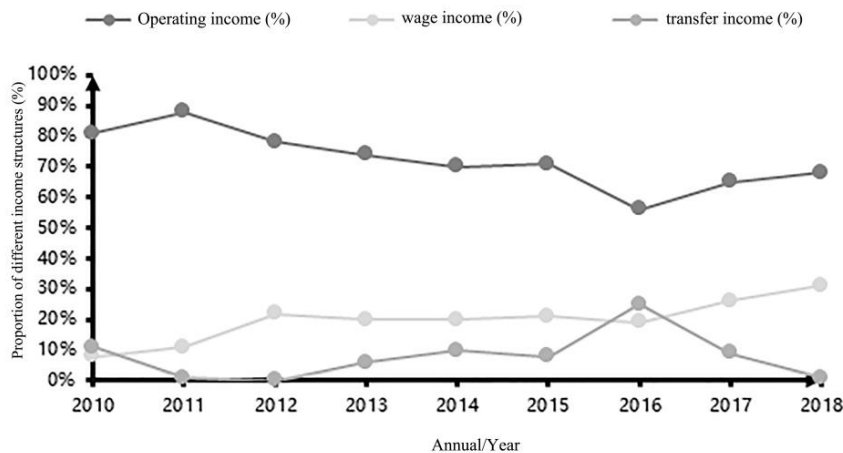


Figure 2. Trend chart of farmers' different income structure proportion in Maandi Township from 2010 to 2018

2.2. Research Methods

To explore the correlation between the income structure of communities around nature reserves and per capita income, as well as the correlation between agriculture, forestry, animal husbandry, non-agricultural operational income and operational income, based on comprehensive consideration of the number of samples, the grey correlation method (Yang et al., 2016) is adopted as the main research method of this study, and its main research steps are as follows (Zhang et al., 2014):

2.2.1. Determination of Reference Sequence and Behavior Sequence

The data series reflecting the characteristics of system behavior, called reference series, is set as: $X_0 = (x_0(1), x_0(2), \dots, x_0(n))$, the data sequence composed of factors that affect the system

behavior, called comparison sequence, is set as: $X_i = (x_i(1), x_i(2), \dots, x_i(n)) (i = 1, 2, \dots, m)$ Where m and n are the number of comparison sequences.

2.2.2. Dimensionless Raw Data

Because the dimensions of various factors in the system are often different, it is inconvenient to compare, or it is difficult to get a correct conclusion after comparison, so the change trend of existing data is comprehensively considered. In this paper, the data is dimensionless by averaging method, namely:

$$X'_i(t) = \frac{x_i(t)}{\bar{x}_i}, \bar{x}_i = \frac{1}{m} \sum_{t=1}^m x_i(t), t = 1, 2, \dots, m \tag{1}$$

2.2.3. Find the Absolute Value of the Dimensionless Reference Sequence and Comparison Sequence and the Minimum and Maximum Difference of Two Levels, Namely:

$$\Delta_i(t) = |X'_0(t) - X'_i(t)| \tag{2}$$

$$\Delta_{\min} = \min_i \min_t \Delta_i(t) \quad i = 1, 2, \dots, n, t = 1, 2, \dots, m, \tag{3}$$

$$\Delta_{\max} = \max_i \max_t \Delta_i(t) \tag{4}$$

2.2.4. Calculate the Corresponding Correlation Coefficient and Grey Correlation Degree

The calculation formula of correlation coefficient is as follows:

$$r_i(t) = \frac{\Delta_{\min} + \rho \Delta_{\max}}{\Delta_i(t) + \rho \Delta_{\max}}, (i=1, 2, \dots, n, t=2010, \dots, 2018) \tag{5}$$

ρ As the resolution coefficient, $0 < \rho < 1$, Generally take 0.5.

The calculation formula of correlation degree is as follows:

$$\xi_i = \frac{1}{m} \sum_{t=1}^m r_i(t), i = 1, 2, \dots, n (i=1, 2, \dots, n, t=2010, \dots, 2018 \quad n=9) \tag{6}$$

2.2.5. Order of Correlation Degree

The correlation degree of all comparison sequences to the same reference sequence is arranged in order of size, which constitutes the correlation order. The higher the correlation coefficient, the greater the influence of the comparison sequence on the reference sequence; otherwise, the smaller the influence.

3. Results and Analysis

3.1. Analysis of Grey Correlation Results of Per Capita Income in Maandi Township

First of all, the per capita income of farmers in Ma 'andi Township is taken as the research target, as the reference sequence, marked X_0 , and operational income, wage income and transfer income are taken as the research objects, marked X_i as the comparison sequence. After dimensionless processing of the data by the mean method, the calculation formula introduced above is used, and the results are shown in Table 1. as can be seen from Table 1, among various types of income, operational income > wage income > transfer income. The ranking of different income sources and farmers' per capita income reflects the consistency between the changing trend of various types of income and the changing trend of per capita income. Among all kinds of income sources of farmers in Maandi Township, the correlation between operational income and farmers' per capita income is the best, followed by wage income and transfer income. From Figure 3, we can easily see that from 2010 to 2012, the correlation between wage income and per capita income increased significantly, while the correlation between transfer income and per capita income decreased significantly, and the correlation between operational income and per capita income did not change obviously. From 2012 to 2015, the correlation between wage income and per capita income changed slowly, the correlation between transfer income and per capita income increased substantially, and the correlation between operational income and

per capita income decreased. In 2015-2018, the correlation between wage income and per capita income was declining, and the correlation between transfer income and per capita income fluctuated greatly. Except for the increase in 2016, the correlation between operational income and per capita income was plummeting. To sum up, from 2010 to 2018, except the correlation between wage income and per capita income is increasing, the correlation between the other two and per capita income is decreasing. This shows that with the passage of time, the dependence of farmers in Maandi Township on traditional production and operation income and transfer income is decreasing, while the dependence on migrant workers is increasing.

Table 1. Grey correlation degree between per capita income and income source of rural households in maandi Township

particular year	Operational income (X1)	Wage income (X2)	Transfer income (X3)
2010	0.984	0.842	0.976
2011	0.992	0.833	0.766
2012	0.986	0.986	0.705
2013	0.946	0.980	0.856
2014	0.943	0.999	0.925
2015	0.931	0.987	0.982
2016	1.000	0.950	0.336
2017	0.926	0.877	0.931
2018	0.851	0.829	0.482
degree of association	0.938	0.902	0.761
Correlation order	1	2	3

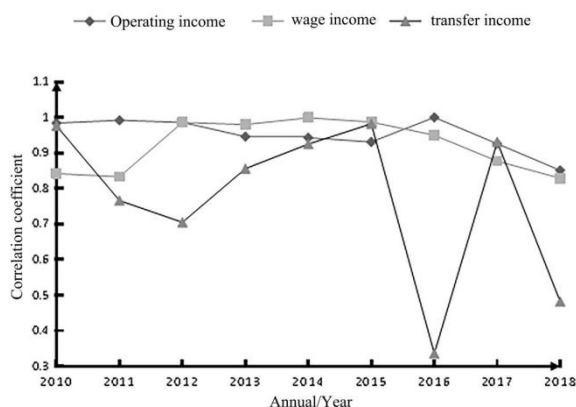


Figure 3. Grey correlation coefficient diagram of per capita income and income sources of farmers in Maandi Township.

3.2. Analysis of Grey Correlation Results of Operational Income in Maandi Township

According to the research needs, as mentioned above, operational income, a farmer in Ma 'andi Township, is taken as the research target, as a reference sequence, and marked as X_0 , while agricultural income, forestry income, animal husbandry income and non-agricultural operational income are taken as the research objects, marked as X_i , as a comparison sequence. After dimensionless processing of the data by the mean method, the calculation formula introduced above is used, and the results are shown in Table 2.

Table 2. Grey correlation degree between farmers' operating income and different industries in maandi Township

particular year	Agricultural income (X1)	Forestry income (X2)	Income from animal husbandry (X3)	Non-agricultural operational income (X4)
2010	0.938	0.543	0.781	0.647
2011	0.935	0.518	0.782	0.631
2012	0.919	0.902	1.000	0.919
2013	0.860	0.952	1.000	0.792
2014	0.911	0.372	0.995	0.492
2015	0.831	0.949	0.988	0.746
2016	0.726	0.974	0.983	0.605
2017	0.712	0.972	0.984	0.590
2018	0.394	0.714	0.676	0.337
degree of association	0.803	0.766	0.910	0.640
Correlation order	2	3	1	4

From Table 2, we can see that the correlation degree of farmer's operational income with agriculture, forestry, animal husbandry and non-agricultural operational income is as follows: animal husbandry income > agricultural income > forestry income > non-agricultural operational income, which shows that the trend consistency of animal husbandry income and operational income is obvious, while that of non-agricultural operational income and operational income is weak. As can be seen from Figure 4, the correlation between agricultural income and operational income has been declining from 2010 to 2018, with the most obvious decline in 2014 to 2018, with the correlation coefficient dropping from 0.938 in 2010 to 0.394, which indicates that the dependence of farmers in Ma 'andi Township on agricultural income has been greatly reduced. The correlation degree between animal husbandry income and operational income increased continuously from 2010 to 2012, and maintained a strong correlation from 2013 to 2017. The trend of correlation degree changed slightly, and suddenly dropped sharply from 2017 to 2018. From the overall trend, the fluctuation trend of animal husbandry income and family operational income was consistent, indicating that farmers in Maandi Township were more dependent on animal husbandry income. The correlation degree between non-agricultural operational income and operational income increased obviously in 2010-2012, and decreased in 2013-2018 except in 2015, and the overall correlation coefficient decreased from 0.65 to 0.34 in 2010-2018, which shows that the consistency of the change trend between non-agricultural operational income and operational income is weakening, and the dependence of Ma 'andi rural households on non-agricultural operational income is getting lower and lower. In 2010-2017, the correlation between forestry income and operational income increased except for a slight decrease in 2011 and a significant decrease in 2014, and decreased in 2018. From 2010 to 2018, the correlation coefficient between forestry income and operational income increased from 0.543 to 0.714, which shows that the dependence of local farmers on forestry income is increasing.

Analyzing the proportion of different industrial incomes in operational income and the correlation between operational income and different industrial incomes is different. The former explains the contribution degree of different industrial incomes to operational income,

while the latter explains the consistency between the changing trend of different industrial incomes and operational income. From Figure 5, it is not difficult to find that the proportion of different income sources in operational income of Ma 'andi rural households is as follows: agricultural income > non-agricultural business income > animal husbandry income > forestry income. By comparing the above correlation analysis results, it can be seen that the proportion of animal husbandry income is only 22%, but it has the strongest consistency with the change trend of operational income, accounting for 24% of non-agricultural business income, but it has the weakest consistency with the change trend of operational income, and the proportion of forestry income is the least, but the correlation with operational income is higher than that of non-agricultural operational income. Therefore, it can be found that in the industrial development of Maandi Township, we should focus on the development of animal husbandry industry and forestry industry, and strengthen the development and cultivation of non-agricultural business industries, based on the development of agricultural industry.

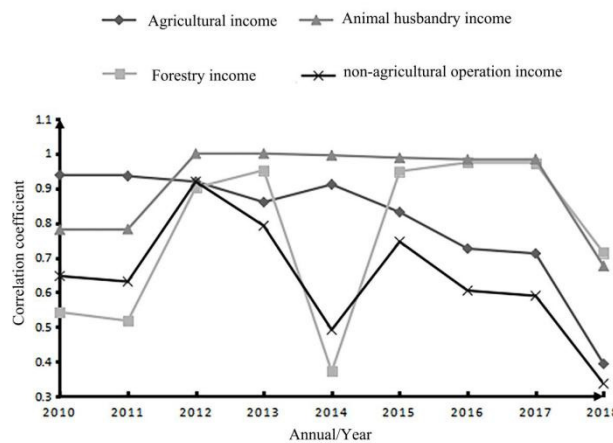


Figure 4. Grey correlation coefficient diagram between operational income and different industries in Maandi Township.

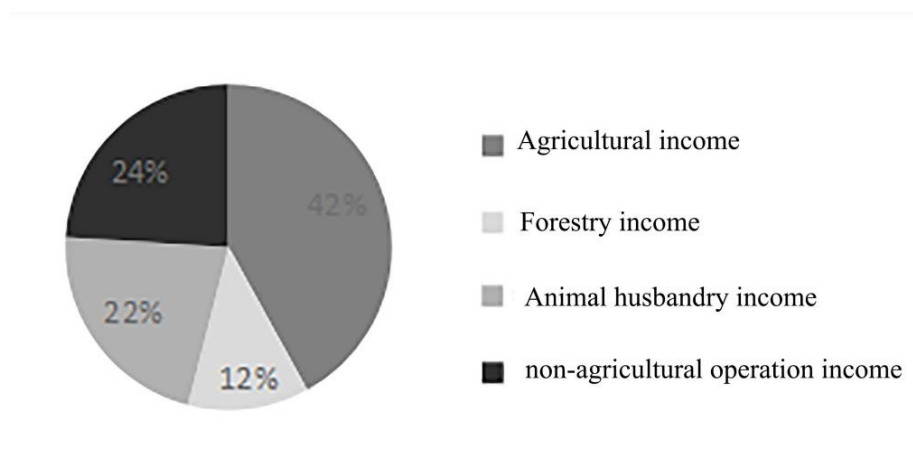


Figure 5. Proportion of farmers' income from different industries in Maandi Township in operational income.

4. Conclusion and Suggestions

4.1. Conclusion

Firstly, the per capita income of communities around Jinping Watershed Nature Reserve is relatively low, and the degree of rural development is far lower than that of Yunnan Province,

and even lower than the national average. Community income structure mainly includes operational income, wage income and transfer income. Among them, operational income has the largest proportion, the fastest growth rate of wage income and the most unstable transfer income.

Secondly, the correlation degree of different income structures of communities around Jinping Watershed Nature Reserve to per capita income is as follows: operational income > wage income > transfer income. From the change trend of correlation degree, the growth rate of wage income is higher than that of operational income and transfer income, which indicates that the dependence of community farmers on wage income is increasing, while the dependence on operational income and transfer income is decreasing.

Thirdly, the correlation degree of different industrial incomes around Jinping Watershed Nature Reserve to operational income is as follows: animal husbandry income > agricultural income > forestry income > non-agricultural operational income. From the changing trend of correlation degree, the dependence of community farmers on animal husbandry income and forestry income is increasing, while the dependence on agricultural income and non-agricultural operational income is decreasing.

4.2. Suggestions

4.2.1. Adjust the Industrial Structure and Broaden the Income Channels

Through investigation and study, it is not difficult to find that the income structure of communities around Jinping Watershed Nature Reserve has obviously changed due to the massive transfer of labor force, the dependence of communities on forest resources has been reduced, and the management pressure of nature reserve has been correspondingly reduced. However, as far as the current development is concerned, the effect of community condominium participatory management is far from reaching the win-win goal of community income and nature reserve development. Therefore, the following suggestions are given on the adjustment of community industrial structure around nature reserves:

Firstly, Agriculture is the basic industry of community income around Jinping Watershed Nature Reserve at present, and it is the main livelihood source of farmers. Because it is located around the nature reserve with high mountains and steep roads, it is obviously unrealistic to realize large-scale mechanized production in a short time. It is necessary to select cash crops suitable for local planting on the basis of fully considering the stock of livelihood capital and labor structure of the community. At the same time, the project of "changing slopes to ladders" will be implemented in some relatively gentle land, and the construction of water conservancy facilities will be strengthened to improve agricultural facilities in some areas.

Secondly, From the above research, it is found that animal husbandry has the greatest influence on operational income, which indicates that animal husbandry is the main growth point of surrounding communities in operational income in recent years. Considering the needs of comprehensive labor force and nature reserve protection, animal husbandry, as a local part-time income, needs to be kept in captivity, which requires the construction of large-scale breeding grounds and planting green fodder, training of breeding techniques and ecological breeding.

Thirdly, because it is located around the nature reserve, forestry income should be the main source of income for the surrounding communities. But at present, the income from forestry is not obvious, which will also lead to the low enthusiasm of community farmers to participate in the management of nature reserves. Therefore, it is necessary to carry out some undergrowth planting in the non-core areas of nature reserves to increase farmers' income. In addition, we should strengthen the development and utilization of non-wood forest products in the non-core areas of nature reserves, carry out introduction and cultivation, turn wild into household, protect natural resources and increase farmers' income, and have both.

Fourth, carry out eco-tourism, biodiversity education, and establish a scientific research and experiment center. Take advantage of the opportunity of beautiful countryside's construction to develop the lodging industry of villagers and increase the non-agricultural operational income of the community.

Fifth, With the transfer of rural labor force, a large number of labor force has gone out, but due to cultural quality and other factors, there are still some surplus labor forces. Continue to promote and expand public welfare posts in nature reserves, such as firemen, forest rangers, ticket sellers, etc., give priority to solving the employment problem of community residents around the nature reserves, and increase the wage income of local farmers.

4.2.2. Expand Investment and Change Production and Lifestyle

Through investigation, it is found that the energy utilization of the surrounding communities is highly dependent on the nature reserve, which is mainly reflected in the utilization of firewood. There are the following suggestions: First, invest special funds to develop alternative energy sources, such as purchase subsidies for electrical equipment. In addition, increase the construction of infrastructure to improve the accessibility of community residents to obtain commodities. Secondly, change the way of livestock feeding in rural areas, change the hearth and the internal environment of the kitchen. Finally, adjust the structure of capital investment to make it work. From a large number of field investigations, it is found that the utilization rate of biogas digesters and solar energy equipment built in the new rural construction period is low, mainly because they are located in the alpine region, and their energy supply is limited, so the degree of instability is great. Therefore, the energy substitution in communities around nature reserves should be mainly electricity, and some of the funds invested in biogas digesters and other engineering projects should be allocated to the purchase of electrical equipment and the adjustment of electricity charges.

4.2.3. Establish a Long-Term Compensation Mechanism for Nature Reserves

Transfer income, as a way for the government to supplement the surrounding communities of nature reserves, has a direct and effective role in alleviating the contradiction between communities and nature reserves. However, through investigation, it is found that the volatility of transfer payment in many areas is too great, which will greatly reduce the enthusiasm of farmers to participate in the management of nature reserves. Therefore, it is necessary to establish a long-term compensation mechanism for nature reserves, coordinate the transfer payment of surrounding communities, and try to make financial compensation to farmers on time and in quantity.

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