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# Rural Poverty Patterns and Influencing Factors in Yunnan Province, China: Based on County Level Dataset

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**Abstract:** The identification of poverty at the county level is the precondition for poverty alleviation by formulating accurate strategies that are targeted for a certain area. Yunnan Province has the largest number of poverty counties in China. The vast number of people living under the poverty-line, and the deep degree of poverty across a wide distribution range, pose major challenges. Based on the rural poverty incidence data, this paper describes the rural poverty patterns in Yunnan Province in 2010 and 2015, and then it explores the main factors which influence the incidence and changes in rural poverty at the county level in Yunnan Province using a stepwise regression analysis method. This study found that the rural poverty in counties of Yunnan Province was deeply affected by natural conditions and the geographical environment. In 2010 and 2015, the rural poverty situation in the middle region of Yunnan Province was relatively light, while it was more serious in the northwest, northeast and south regions. The pattern of county poverty is in good agreement with the topography and landforms of Yunnan Province and the poverty-stricken areas. There are strong correlations between the incidence of rural poverty in Yunnan Province with both the annual per capita net income of rural residents and the degree of agricultural mechanization. These factors are related to the living standards and agricultural production necessary for the peasantry to sustain their livelihood. The change in the incidence of rural poverty at the county level in Yunnan Province from 2010 to 2015 is significantly correlated with changes in the value-added of the primary industries and the degree of agricultural mechanization. These correlations indicate that the development of primary industry plays a key role in the process of lifting rural residents in Yunnan Province out of poverty so they can achieve prosperity. Therefore, improving the annual per capita net income of rural residents and the degree of agricultural mechanization for rural areas in Yunnan Province are still the main points for focused efforts. In the current phase of poverty alleviation, Yunnan Province should emphasize increasing rural residents' income and agricultural production and management in order to formulate effective policies and measures for poverty alleviation.

**Key words:** rural poverty; poverty incidence; stepwise regression analysis; Yunnan Province

## 1 Introduction

Poverty is a phenomenon of poor social material life and spiritual life, which means a lack of income-generating capacity and opportunities. Poor families have very limited resources and cannot achieve the minimum standard of living. Poverty is a widespread social and economic phenomenon in today's world. According to the current in-

ternational poverty standard of USD 1.90 per day, there were 736 million people living in poverty in 2015 (World Bank, 2015). Eradicating all forms of poverty remains one of the greatest challenges that humanity has to face. In 2011, China raised the poverty standard to 2300 yuan per capita net income in rural areas (unchanged price from 2010) (State Council of China, 2011), which included an increas-

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ing number of poor people. At the same time, the outlook for urban poverty is not too optimistic. According to the latest data from the World Bank, there were 244 million urban residents living on less than USD 1.90 per day in China in 2015 (World Bank, 2018). The reasons why poverty is so prevalent and intractable lie in the complexity and variability of the poverty phenomenon. Poverty is not only reflected in the level of income. Low income is just one manifestation of poverty, along with the deprivation of various rights, such as education, health, clean water and a proper environment (Awan et al., 2011). Furthermore, poverty is also reflected in the lack of ability, opportunity, rights and other aspects. For example, urban poverty in Pakistan was mainly caused by the severe local economic situation, where people were deprived of employment opportunities and the rising unemployment rate aggravated poverty (Ul-Allah et al., 2014). Some scholars considered that the spatial concentration of the poverty phenomenon was mainly caused by geographical factors which they called a spatial poverty trap (Bird and Shepherd, 2003; Kraay and Raddatz, 2007). Poverty is concentrated in certain areas, such as the remote villages, uplands and mountains, the landless, Dalits (or Scheduled Castes) and small and marginal farmers in the context of Nepal (Dhruba et al., 2015). Authors who focus on poverty often discuss the relationship between poverty alleviation and local environmental degradation. For example, a study by Arouri et al. (2017) in Vietnam found that urbanization can promote the transformation of farmers' agricultural activities into non-agricultural activities, which had a positive impact on poverty reduction. Obviously, poverty alleviation in rural areas has positive impacts on urban and rural development (Shahriar, 2019). A study by Josef (2019) in the countryside of European countries showed that national economic development and urbanization were the fundamental factors influencing rural poverty. Research in rural northeastern Germany showed that social networks were a good way to reduce poverty, but their influences diminished with the shrinking of the population and structural changes (Anderas and André, 2019). Meanwhile, in South Africa, unemployment, years of education and disability were the main factors related to poverty (Fransman, 2019). Poverty may exist in every country. Liu et al. (2017) systematically examined the status quo and spatial distribution characteristics of poverty in rural China. The results revealed that disease was the main cause of poverty in China, and the lack of natural endowment, poor geographical conditions and poor ecological environment were the main obstacles to poverty reduction. However, poverty is not caused by a single factor, but rather by a complex combination of factors. All of these aspects involve the level of economic and social development, political systems, national culture and many other factors at work in a country or region. In addition, natural environment, historical location and other factors tend to have far-reaching im-

pacts on regional development, and the eradication of poverty depends on the progress of the whole society (UNDP, 2016).

China is the most populous developing country in the world. The poor population in China is large in scale, widespread in distribution and deep in poverty, so the task of poverty alleviation and development will be arduous (Li et al., 2016; Liu, 2016). With the development of the social economy in China, absolute poverty and relative poverty in rural areas have been rising and falling. The number of people living in absolute poverty in rural areas has been decreasing, so the situation of absolute poverty has been alleviated. However, because of the regional imbalance of social economic development, the phenomenon of rural relative poverty is still very prominent in the deep rock mountains, high cold areas, ethnic minority areas and border areas in central and western China (Liu et al., 2016). Current studies commonly use one-dimensional methods to measure poverty, such as per capita expenditure and per capita income (Duclos et al., 2006), which are sometimes slightly biased. Alkire and Foster (2011) proposed the A-F multidimensional poverty measurement model to measure poverty. Chen et al. (2017) constructed a multidimensional poverty measurement model to comprehensively calculate the poverty degree of China's poverty-stricken villages nationwide, and found that the poverty situation in those villages basically follows a spatial pattern of high in the west and low in the east, and that there are significant regional differences in the degrees and scales of poverty in the poverty-stricken villages. Olivia et al. (2011) discussed the relationship between poverty and environmental variables in the rural areas of Shaanxi Province, and concluded that environmental variables affect poverty and consumption mainly by changing the regression rate of household characteristics. For example, good agricultural climatic conditions, such as low altitude and a mild and humid climate, are conducive to the development of a county economy. Yuan et al. (2014) conducted a multidimensional assessment of county poverty in Hebei Province and concluded that agricultural development is an important solution to regional poverty alleviation on a large scale. At the village level, Liu and Pei summarized a set of spatial poverty measurement index systems for contiguous areas with special difficulties, aiming to provide certain references for poverty measurement in poor areas (Liu et al., 2014; Pei et al., 2015). Cao et al. (2014) took Lianzhou City, Guangdong Province as an example, summarized the characteristics of rural poverty (such as spatial inheritance, concealment and agglomeration), and discussed the factors affecting rural poverty from the perspectives of administrative villages and residents. The applications of GIS technology to the distribution of poverty and visualization processes provide a more intuitive expression. For example, by using GIS analysis, Luo et al. (2016) showed that the poor villages in Qinba Mountain Area present a pattern

of “large dispersion and small concentration”, and concluded that the reservoir area is the main gathering place of the poor villages. That study showed that as time went by, the distribution of the poor villages showed a trend toward being farther away from the reservoir area and gathering moved to near the centers of towns and villages.

According to China’s central planning as a whole, for the overall responsibility of cities and counties to implement poverty alleviation and development strategies, the counties and county-level cities are the most basic administrative units for the organization and management of economic and social development in China (Mao, 1991). They are also the basic administrative units for carrying out poverty alleviation through development and implementing targeted poverty alleviation policies and measures. Therefore, it is necessary to analyze the regional poverty problem from the county scale. Yunnan Province is one of the provinces with the most prominent poverty problems in China, especially in rural areas. However, there are few articles related to the development of rural poor areas in Yunnan Province, and the county rural poverty pattern and its influencing factors need to be better understood. Based on the analysis of regional differences in the incidence of rural poverty in the counties of Yunnan Province in 2010 and 2015 and related socio-economic statistics, this study selects various indicators (Table 1) to explore the factors affecting poverty in the rural areas of Yunnan Province, and then to reveal the rural poverty pattern and its influencing factors in the counties of Yunnan Province from 2010 to 2015. As a result, this study provides a scientific basis for understanding and carrying out regional poverty alleviation and development in the country.

## 2 Data and methods

### 2.1 Regional overview

Yunnan Province is located on the southwest border of China, with a total land area of  $3.941 \times 10^5 \text{ km}^2$ . It is a large agricultural province where ethnic minorities live in the “border area, mountainous area and inland”. In 2018, the province’s total population was 48.295 million people, and includes a large variety of minorities. In addition to the Han nationality, there are 25 ethnic minorities that have lived there for generations, including the Yi nationality, the Hani nationality, the Bai nationality and the Dai nationality. The population of ethnic minorities in the province reached 16.1153 million in 2018, accounting for 33.57% of the total population in the province. The population distribution of the ethnic minorities is mainly concentrated in southeast Yunnan, and the spatial distribution difference has shown a tendency to expand (Zeng et al., 2015). The per capita disposable income of rural residents in Yunnan Province is 9862 yuan, which is relatively low compared to other provinces in China. There are 129 county-level administrative divisions in Yunnan, including 88 poverty-stricken counties.

Among them, 73 counties are the focus of the country’s poverty alleviation and development work. There are 14 contiguous poverty-stricken areas in China, including the mountainous areas in the western Yunnan border, the rocky desertification areas in Yunnan, Guangxi and Guizhou, the mountainous areas in Wumeng and the Tibetan areas in the four provinces, which all include parts of Yunnan Province. They are typical “old revolutionary bases, ethnic minority autonomous areas, national border areas and underdevelopment areas”. Ethnic, frontier, poverty, mountainous terrain and other attributes restrict the development of Yunnan Province and poverty relief (Lv, 2006; Yang and Zhang, 2015). Rural areas in Yunnan Province are lagging behind the rest of China. In 2010, the incidence of rural poverty in Yunnan Province ranked fifth in China, at 39.60 percent, more than twice as high as the national average (17.20%). By 2017, the rural poverty rate in Yunnan Province fell to only 7.5%, down 81.06% from 2010, with the number of rural poverty alleviation recipients dropping from 14.68 million to 2.79 million. From 2010 to 2017, consistent with the changing trend of the whole country, the incidence of rural poverty in Yunnan Province showed a rapid decline, but the incidence of rural poverty in Yunnan Province remained far higher than the national average (Fig. 1).

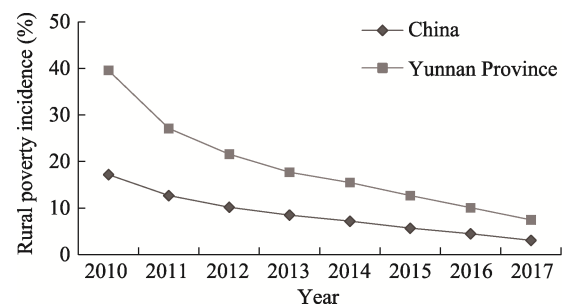


Fig. 1 The change of rural poverty incidence in Yunnan Province and China from 2010 to 2017

### 2.2 Data sources

Data for the incidence of rural poverty in Yunnan Province and the incidence of rural poverty at the county level of Yunnan Province used in this paper are from “Yunnan Statistical Yearbook”. The national rural poverty rate is derived from “Monitoring Report of China’s Rural Poverty”. According to the availability of data, the socio-economic data of Yunnan Province used in this paper are from “China statistical yearbook (County-Level)” and “Yunnan Statistical Yearbook” for 2011 and 2016. Other data came from “Chinese Yearbook of Household Survey” in 2016, “China Statistical Yearbook” and “China Rural Statistical Yearbook” and other sources. There are 129 county-level administrative units in Yunnan Province. Among them, nine districts (Wuhua district, Panlong district, Guandu district, Xishan district, Dongchuan district, Qilin district, Hongta district,

Longyang district and Gucheng district) were not included in the analysis due to a lack of data; so this study was based on the remaining 120 county units.

The incidence of poverty, also known as the proportion of the poor population index, refers to the proportion of the poor population in the total rural population with an income level lower than the national poverty alleviation standard and which does not meet the “Liang Bu Chou, San Bao Zhang”, which means that rural poor people are free from worries over food and clothing and have access to compulsory education, basic medical services and safe housing. The World Bank uses consumption per capita to measure poverty, while the European Union uses income per capita to measure poverty. China mainly uses the per capita basic living expenses, that is, household income and consumption data, to measure rural poverty and calculate the proportion of the population living under the poverty standard (Household survey department of national bureau of statistics, 2018). Based on the incidences of county rural

poverty in 2010 and 2015 in Yunnan Province, this paper used ArcGIS10.2 to visualize the poverty patterns in rural areas in Yunnan Province, and analyzed the county rural poverty pattern and its changing characteristics from 2010 to 2015.

**2.3 Analysis method for the factors influencing rural poverty in county areas**

**2.3.1 Socio-economic development indicators of rural poverty in county areas**

In this paper, our purpose was for the scientific, comprehensive and flexible determination of the indicators, with reference to those used by domestic and foreign scholars. Therefore, the index for the impacts of poverty measurement, and the poverty and human development reporting involves describing the problem of human well-being, so we selected a series of socio-economic development indicators that may affect rural poverty in Yunnan Province under the existing conditions, as shown below in Table 1.

Table 1 The socio-economic development indicators affecting rural poverty at the county level

Variables	Index (unit)	Variables	Index (unit)
$X_1$	The value-added of primary industry ( $\times 10^4$ yuan)	$X_8$	Per capita GDP (yuan person <sup>-1</sup> )
$X_2$	Total power of agricultural machinery ( $\times 10^4$ kW)	$X_9$	Staff average wages ( $\times 10^4$ yuan person <sup>-1</sup> )
$X_3$	The number of units of an industrial enterprise above a designated size (number)	$X_{10}$	Budgetary revenue from local public finances ( $\times 10^8$ yuan)
$X_4$	Gross industrial output value above a designated size ( $\times 10^4$ yuan)	$X_{11}$	Budgetary revenue from local public finances per capita (yuan person <sup>-1</sup> )
$X_5$	Fixed asset investment ( $\times 10^8$ yuan)	$X_{12}$	Total retail sales of consumer goods ( $\times 10^8$ yuan)
$X_6$	The number of beds in medical and health institutions (number)	$X_{13}$	Household savings at the end of a year ( $\times 10^8$ yuan)
$X_7$	GDP ( $\times 10^4$ yuan)	$X_{14}$	Annual per capita net income of rural residents (yuan person <sup>-1</sup> )

In order to eliminate the influence of the different dimensions of the indexes on the results, the indexes were first standardized:

$$\text{Forward dimensions: } x'_{ij} = \frac{x_{ij} - x_{\min}}{x_{\max} - x_{\min}} \tag{1}$$

$$\text{Negative dimensions: } x'_{ij} = \frac{x_{\max} - x_{ij}}{x_{\max} - x_{\min}} \tag{2}$$

In the formulas:  $x'_{ij}$  is the standardized value of the number  $i$  county's number  $j$  index,  $x_{ij}$  is index values of county  $i$ ,  $x_{\min}$  is the minimum value of this index of county  $i$ ,  $x_{\max}$  is the maximum value of this index of county  $i$ .

**2.3.2 Stepwise regression analysis**

Regression analysis is a mathematical method for studying the interdependence of multiple variables. It can not only establish a strict mathematical model for prediction, but also express the relationships between variables (Murayama and Thapa, 2011). Stepwise regression analysis can retain the most important explanatory variables in the model without serious multicollinearity. Taking the incidence of rural poverty in the county areas of Yunnan Province as the depend-

ent variable, the standardized values of each indicator in Table 1 were taken as the independent variables. Using the stepwise method of linear regression, the incidences of poverty in 2010 and 2015 were regressed with each indicator. The linear regression equation between the poverty incidence and each index was obtained by calculating the general form of multiple linear regression equations as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon_i \tag{3}$$

where,  $n$  is the number of independent variables,  $\beta_n$  is the regression coefficient, and  $\varepsilon_i$  represents the random error term. Before using Equation (3), goodness of fit test, population linear significance test and variable significance test should be carried out.

In order to further explore the influences of various influencing factors on the index system, the annual average rate of change in the incidence of rural poverty in the counties of Yunnan Province and the annual average rate of change in the various indicators from 2010 to 2015 were calculated, respectively. Regression analysis was then conducted to analyze both of them, with respect to the specific

influences of the changes of various indicators on the changes of poverty incidence. The calculation formula is:

$$RC_i = \sqrt[5]{\frac{P_i^{2015}}{P_i^{2010}}} \times 100\% - 1 \quad (4)$$

$$RX_j = \sqrt[5]{\frac{x_{ij}^{2015}}{x_{ij}^{2010}}} \times 100\% - 1 \quad (5)$$

where  $RC_i$  represents county  $i$ 's annual rate of change of rural poverty,  $P_i^{2015}$  and  $P_i^{2010}$  represent the incidences of rural poverty in county  $i$  in 2015 and 2010, respectively;  $RX_j$  represents the annual change rate of the  $j$  index; and  $x_{ij}^{2015}$  and  $x_{ij}^{2010}$  represent the index values of county  $i$  in 2015 and 2010, respectively. To facilitate the expression throughout the study, the annual average rate of change is given as the absolute value.

### 3 Results and analysis

#### 3.1 County rural poverty pattern in Yunnan Province

The distribution of the incidence of rural poverty in 2010 shows great differences in the degree of rural poverty among the counties of Yunnan Province. The degree of poverty in the northwest, south and northeast was relatively deep, while the degree of poverty in Kunming and its surrounding areas was relatively low. In 2010, there were 16 counties in Yunnan Province where the incidence of rural poverty was more than 80%, accounting for 13% of the whole province (for the 120 counties mentioned above). Among them, the poorest counties were Diqing Prefecture and Nuijiang Prefecture in the northwest, Honghe Prefecture in the south and Shaotong City in the northeast (Fig. 2a).

The pattern of rural poverty in the counties of Yunnan Province in 2015 was similar to that in 2010, showing a pattern of deeper poverty in the northwest, northeast and south, and less poverty in the central region. Among them, Fugong County and Gongshan County, which are located in Nuijiang Prefecture, Pingbian County in Honghe Prefecture, Huize County in Qujing City and Lancang County in Pu'er City have high incidences of rural poverty, all of which exceeded 30%, with a relatively deep level of poverty (Fig.

2b). In 2010 and 2015, the county poverty pattern in Yunnan Province was basically consistent with the distribution of the four contiguous poverty-stricken areas in the province. The counties with a higher incidence of poverty were generally distributed in the high-altitude areas. These areas are higher in elevation, and the construction of roads and other infrastructure is difficult, especially in rural areas, where living and production conditions are poor, making it difficult both for rural residents to get out and for capital and technology to enter. In addition, there are many underdeveloped ethnic groups in the rural areas of Yunnan Province, whose living environment is relatively isolated and their information exchange is not very effective. They still maintain the primitive "slash-and-burn" agricultural development state, which makes further development difficult; while the dam areas with relatively flat terrain, and their surrounding areas, had a better development situation. These areas have better transportation networks, information networks and other infrastructure conditions. They have more exchanges of manpower, resources, capital and technology with developed areas. The ability of cities to drive development can penetrate more easily into rural areas. As a result, these rural areas have obvious development advantages and relatively low levels of poverty, as can be seen below in Fig. 2c and Fig. 2d.

From 2010 to 2015, the incidence of rural poverty in all 120 counties in Yunnan had dropped by more than 50% (Table 2, Fig. 3), indicating that the work of poverty alleviation and development in rural areas had achieved remarkable results during this period. There were 13 counties with decreases of 50% to 60%, among which nine were state-level poverty-stricken counties, and all of them were located in the contiguous poverty-stricken areas. In most counties, the decreases ranged from 60% to 70% or from 70% to 80%, among which the proportion of state-level poverty-stricken counties was 68.18% and 60.38%, respectively. Fumin County and Jinning County which lie in Kunming City, Yulong County in Lijiang City, Menghai County in Xishuangbanna Prefecture, and Tonghai County in Yuxi City, all had the highest poverty incidence reductions (more than 80%), as can be seen in Table 2.

Table 2 The decreasing amplitude of rural poverty incidence and the numbers of counties from 2010 to 2015

Decreasing amplitude (%)	Number	Number of poverty-stricken counties at the national level	Number of counties in Wumeng Mountain	Number of counties in the Tibetan areas in four provinces	Number of counties in the western Yunnan border mountain areas	Number of counties in Yunnan-Guangxi-Guizhou rocky desertification area
50-60	13	9	4	1	1	3
60-70	44	30	10	2	12	7
70-80	53	32	1		39	1
80-90	5	1			3	
90-100	5					

Note: In the table, there are 72 state-level poverty-stricken counties in Yunnan Province, excluding Dongchuan district, and 83 district-type counties in Yunnan Province, excluding Longyang district. These two regions are not included in the research scope of 120 counties analyzed in this paper due to lack of data.

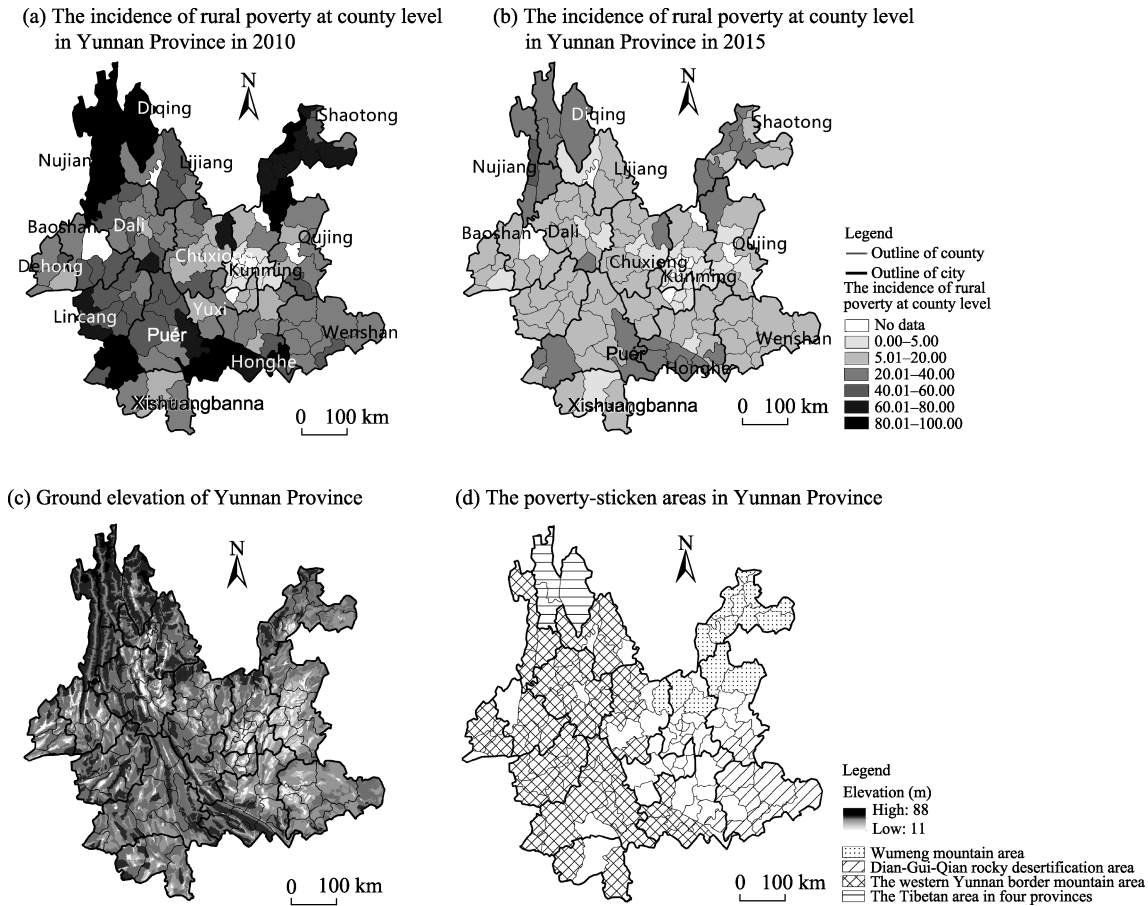


Fig. 2 The spatial patterns of rural poverty incidence at the county level in Yunnan Province in 2010 and 2015, elevation and the four concentrated contiguous areas

Note: (a) and (b) were drawn by the author according to the poverty incidence in Yunnan Province in the “Yunnan Survey Yearbook”; (c) is derived from Resources and Environment Science Data Center (<http://www.resdc.cn/Default.aspx>) of the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences; and (d) is compiled and drawn according to the instructions on releasing “the List of Counties in Contiguous Poverty-stricken Areas Nationwide” issued by the leading group office of poverty alleviation and development under the state council. The names of the prefecture-level cities and their abbreviations are also marked the above figures.

Through comparative analysis, the counties with a large poverty reduction rate are mostly those with a light poverty level, which are distributed in the areas with gentle terrain and near regions with rapid economic development, such as Fumin county and Jinning county in Kunming City, and Yulong County in Lijiang City. The foundation of rural economic development in these areas is relatively good. The counties with a relatively low poverty reduction rate are mostly in poor areas, and most of them are located in the contiguous poverty-stricken areas. For example, Huize County and Suijiang County in the northeast of Yunnan Province belong to the Wumeng Mountain Area, which is in the transition zone from Sichuan basin to Yunnan-Guizhou Plateau, and their development is restricted by the natural environment, infrastructure and other geographical conditions. Fugong County and Lanping County, which are located in the western part of Yunnan Province, belong to the mountainous areas in the western part of Yunnan, where the incidence of poverty is higher and the speed of poverty re-

duction is slow. This area has many mountains and rivers, a high average altitude, less per capita cultivated land, poor agricultural production and worse living conditions. It is a gathering place for ethnic minorities, far away from areas with high levels of economic development, and has lagging infrastructure construction such as transportation. Although this region is adjacent to Myanmar, Laos, Vietnam and other countries, the trade and cooperation resources with neighboring countries have not been fully exploited and utilized due to complicated constraints and limited development space. Luxi County and Malipo County, located in the south of Yunnan Province, belong to the rocky desertification area of Yunnan-Guangxi-Guizhou. The karst landform in this area is large, the rocky desertification problem is serious, the land is barren, the drought and flood disasters occur frequently, and the ecological environment is fragile. Therefore, their social and economic development is restricted by many factors. Located in the northwest of Yunnan Province, Shangrila City, Deqin County and Weixi

County belong to the Diqing area of the Tibetan area in the four provinces. This area is located at the southern edge of Qinghai-Tibet Plateau, the hinterland of Hengduan mountains, and the border area of Yunnan, Tibet and Sichuan provinces. It is densely covered with mountains, rivers and canyons, and the terrain elevation differences are huge, which has been the main factor restricting the agricultural production and social and economic development in this area (Fig. 2c and Fig. 2d). As a result, the extent of poverty

reduction in rural areas of Yunnan Province are clearly affected by many factors, such as terrain, topography, physiognomy, geographical location and other natural conditions; as well as manpower, cultivated land, infrastructure and other production conditions. Yunnan Province should adopt poverty reduction measures for rural areas that correspond with the different poverty situations in different regions. It is essential to suit poverty reduction measures to local conditions.

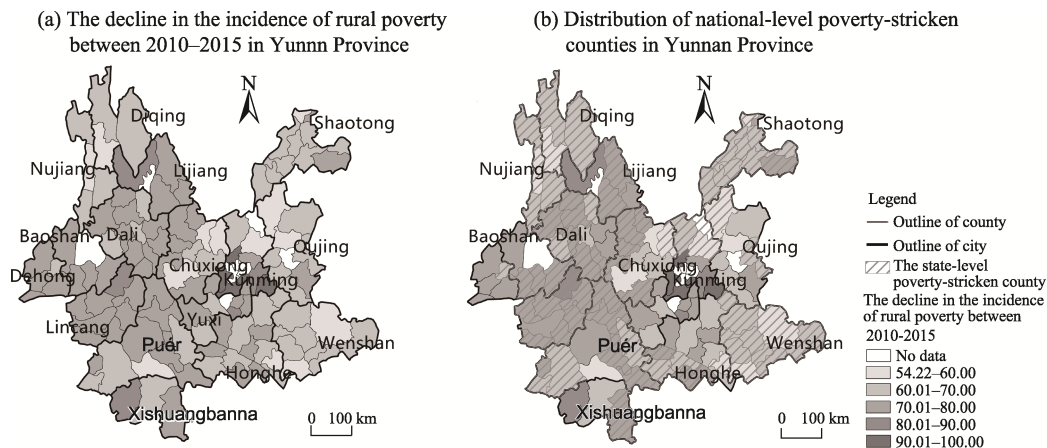


Fig. 3 The distribution diagram of the decreasing amplitude of rural poverty incidence and state poverty counties in Yunnan Province from 2010 to 2015

Note: b was drawn based on “the List of Key Counties in Poverty Alleviation and Development” issued by the leading group office of poverty alleviation and development under the state council in 2012.

### 3.2 Analysis of factors influencing rural poverty at the county level in Yunnan Province

#### 3.2.1 Regression analysis of rural poverty incidence and socio-economic development indicators in the counties in 2010 and 2015

The Pearson correlation test was carried out between the standardized socio-economic development indicators in 2010 and 2015 and the incidences of rural poverty in these two years, and then stepped-up regression analysis was carried out to establish a regression model and analyze the main factors influencing the incidence of rural poverty in the counties of Yunnan Province.

In 2010, the adjusted  $R^2$  of the goodness of fit between rural poverty incidence and the socio-economic development index regression model in Yunnan Province was 0.641, and the significance (F test) value was 107.063, which was significant at the level of 0.01, indicating that the socio-economic development indicators used in the model had an extremely significant impact on poverty incidence (Table 3). In the process of building the model, the value-added of primary industry ( $X_1$ ), the number of units of industrial enterprises exceeding a certain size ( $X_3$ ), gross industrial output value above a designated size ( $X_4$ ), fixed asset investment ( $X_5$ ), the number of beds in medical and health institutions ( $X_6$ ), GDP ( $X_7$ ), per capital GDP and some other indicators were excluded because of their collinearity, low

low correlation with poverty incidence or insignificant impact. Finally, the indicators incorporated into the model were the annual per capita net income of rural residents ( $X_{14}$ ) and the total power of agricultural machinery ( $X_2$ ), both of which passed the F test at the extremely significant level of 0.01. In the data standardization stage, both  $X_{14}$  and  $X_2$  were processed as negative indicators, and as shown in Table 3, the B value is positive. This indicates that the annual per capita net income of rural residents is negatively correlated with the incidence of rural poverty, and the impact is significant. With the increase of per capita net income of rural residents, the incidence of poverty will significantly decrease. The total power of agricultural machinery is negatively correlated with the incidence of rural poverty, so the higher the total power, the lower the incidence of poverty.

Table 3 The stepwise regression results for the incidence of rural poverty at the county level and influencing factors in Yunnan Province in 2010

Model variable	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
Constant	-47.381	6.743		-7.027	0.000
$X_{14}$	89.943	8.636	0.639	10.415	0.000
$X_2$	41.589	9.082	0.281	4.579	0.000

Note: The dependent variable is  $P_t^{2010}$ .

The adjusted  $R^2$  of the goodness of fit between poverty incidence and the socio-economic development index regression model in Yunnan Province in 2015 was 0.512, and the significance (F-test) value was 61.312, which was significant at the level of 0.01. The socio-economic development indicators used in this regression model are consistent with those in 2010, i.e., the annual per capita net income of rural residents ( $X_{14}$ ) and the total power of agricultural machinery ( $X_2$ ), and they pass the test at the extremely significant level of 0.01, indicating a very significant negative correlation with the incidence of poverty. Other indicators were excluded from the stepwise regression and were not included in the model (Table 4).

Table 4 The stepwise regression results for the incidence of rural poverty at the county level and influencing factors in Yunnan Province in 2015

Model variable	Unstandardized coefficients		Standardized coefficients	$t$	Sig.
	$B$	Std. error	Beta		
Constant	-16.347	2.810		-5.817	0.000
$X_{14}$	32.811	3.889	0.581	8.437	0.000
$X_2$	13.155	3.454	0.262	3.808	0.000

Note: The dependent variable is  $P_i^{2015}$ .

The analysis results in 2010 and 2015 showed that the annual per capita net income of rural residents ( $X_{14}$ ) and the total power of agricultural machinery ( $X_2$ ) are the main factors affecting rural poverty in the counties of Yunnan Province, and they involve the basic living and production activities of rural farmers in these counties. Per capita net income of rural residents is the main influencing factor, which represents the population average of rural residents from all sources of revenue after deducting costs incurred accordingly. Therefore, it reflects the average income level of rural residents in the region, and along with that income the rural and farmer's basic life needs, such as food, clothing, shelter and transportation are closely related. It can reflect the level of "Liang Bu Chou, San Bao Zhang". In recent years, according to the development status and poverty characteristics of different types of areas in China, policies and precise forms of assistance have been given to households and people in terms of education, industry, health, ecological protection, society and other aspects. Remarkable results have been achieved and the improvement of rural residents' income is inseparable from these effective measures. Agricultural machinery refers to the machinery and equipment used for crop cultivation, animal husbandry, fishery, primary agricultural production, agricultural transportation and farmland capital construction, etc. (National Bureau of Statistics of the People's Republic of China, 2013). The total power of agricultural machinery is the sum of the rated power of all agricultural machinery, so this index can reflect the mechanization level of agriculture laterally. The improvement of

agricultural mechanization is conducive to the liberation and development of productivity in rural areas. Agricultural mechanization can shorten farmers' working time, allowing them to have more time to go out for additional work, and broadening the options for farmers to increase their income. It can be seen that the series of anti-poverty actions and measures promoting the development of rural areas are mainly aimed at providing more scientific and convenient production conditions for the development of the rural areas. Agricultural mechanization support is particularly important. The production activities in the rural areas tend towards intensive and large-scale management, so that land and human resources can be used more intensively. For the remote rural areas with high altitudes and complex terrains, investment in agricultural mechanization is an effective boost to development. For rural areas with relatively flat terrain, investment in agricultural mechanization can improve labor efficiency, liberate productivity, expand employment channels and increase farmers' income. The increase in rural residents' income and living standards will ultimately have a beneficial impact on the stable poverty alleviation and harmonious social development in poor areas.

### 3.2.2 Analyzing the influences of socio-economic development on changes in rural poverty incidence in county areas

The F test of the regression equation for the change rates of each index and the rural poverty incidence in the county areas between 2010 and 2015 shows significance at the level of 0.01. The annual rates of change of both the value-added of the primary industry ( $RX_1$ ) and the total power of agricultural machinery ( $RX_2$ ) were incorporated into the model. Each of them has a significant negative effect on the rate of poverty incidence change (Table 5).

Table 5 The stepwise regression results of the rate of change of rural poverty incidence at the county level and influencing factors in Yunnan Province from 2010 to 2015

Model variable	Unstandardized coefficients		Standardized coefficients	$t$	Sig.
	$B$	Std. error	Beta		
Constant	-0.445	0.049		-9.086	0.000
$RX_1$	1.003	0.361	0.0246	2.779	0.006
$RX_2$	0.853	0.318	0.0238	2.686	0.008

Note: The dependent variable is  $RC_i$ .

The change in the value-added of the primary industry was included in the model, to account for the fact that the development of agriculture, animal husbandry, fishery and other basic industries can effectively reduce the incidence of poverty in rural areas. However, the mountainous and mid-level areas among the rural areas in Yunnan Province cover a wide area, with limited and scattered cultivated land resources, less effective irrigation areas, and barren land in some areas. The development of agricultural production in



many rural areas is restricted by natural conditions. Therefore, the improvement of agricultural production conditions will have a great impact on the development and change of the primary industry. The change of the total power of agricultural machinery is associated with the change of the primary industry. Increasing the input of agricultural machinery and production technology in rural areas and using the land and other resources fully and efficiently are obviously beneficial to the development of primary industry and the increase of farmers' income. Both of these reflect that the development of the primary industry is the foundation of poverty alleviation and the development of rural areas, and the support of the primary industry in all aspects will have a positive impact on rural areas, either directly or indirectly.

From 2010 to 2015, the added value of the primary industry in Yunnan Province increased from 110.838 billion yuan to 205.578 billion yuan. The primary industry accounted for more than 15% of the three secondary industries, ranking top among 22 provinces in the central and western regions. In 2010 and 2015, 43 and 30 counties, respectively, the primary industry accounted for more than 30% of their GDP. The proportion of household business income in total household income of rural residents in Yunnan Province decreased from 63.51% to 55.98%, but was still far higher than the national average of 39.43% (2015). In 2015, the per capita net income from primary industry operations of permanent rural residents in Yunnan accounted for 47.29% of the per capita disposable income, which was 19.69 percentage points higher than the national average (27.60%). The income structure of rural residents shows that operational income is still the main source, and agricultural production activities are the main development support. The primary industry still plays an important role in the socio-economic development of Yunnan Province, and the development of the primary industry is still very important to improving the living standard of its rural residents and the alleviation of poverty in rural areas. Yunnan Province has to attach great importance to the development of the primary industry. Poverty alleviation and development shall invest in the construction and repair of basic farmland, rural roads, rural power grids, agricultural transportation and other infrastructure in rural areas. All of these have positive impacts on agriculture, forestry, animal husbandry, fishery and other primary industries. In turn, they can help alleviate poverty in the rural areas.

#### 4 Discussion

The findings of the present analysis indicate that the natural environment, geographical conditions and others are the limiting factors for poverty alleviation in rural poverty areas. Income and agricultural production are still closely related to farmers. These findings were consistent with many previous studies conducted in poverty areas (Qu et al., 2012; Ou and Huang, 2015; Ding and Leng, 2018; Chen et al.,

2019), especially in Yunnan Province and other provinces with severe poverty conditions. For example, geographical conditions had a great influence on economic development in rural areas. The mountainous rural areas in Yunnan Province are more vulnerable to geological disasters and have relatively poor adaptability to geological disasters, which are the restricting factors for economic development (Jiang et al., 2016). Most farmers in mountainous areas in Yunnan Province still focus on agricultural production and migrant work, and traditional agriculture still needs to be developed in the mountainous areas (Su et al., 2019). The analysis in this paper shows that the incidence of rural poverty in county areas in Yunnan Province has decreased greatly from 2010–2015, and the poverty situation has been alleviated. On the whole, rural poverty in counties of Yunnan Province presents a pattern of a relatively low poverty level in the central region, and a relatively deep poverty level in the northwest, northeast and south. The rural poverty situation in county areas is basically consistent with the topography and landforms of Yunnan Province and the contiguous poverty-stricken areas. The natural environment, location conditions and national culture are also factors restricting poverty relief in Yunnan Province. The counties with the highest poverty are generally distributed in the areas with a high altitude and a harsh environment, while the areas with a flat terrain have better development trends. In 2010 and 2015, the main factors influencing the incidence of rural poverty in Yunnan Province are the annual per capita net income of rural households and the total power of agricultural machinery. Both show significant negative correlations. From 2010 to 2015, the rate of change of the incidence of rural poverty in Yunnan Province was significantly negatively correlated with changes in the value-added of the primary industry and the total power of agricultural machinery. These correlations indicate that agricultural development still plays a leading role in alleviating poverty in the rural areas of Yunnan Province at the present stage. With the development of the economy and the implementation of various poverty alleviation policies, the poverty situation in poor areas in Yunnan Province has been improved to some extent. In the process of rural revitalization, farmers should be provided with good conditions for agricultural production. As a matter of fact, investment in agricultural mechanization had a positive effect on improving soil quality, and soil quality and productivity can alleviate rural poverty effectively (Radosavljevic et al., 2020). Many countries in the world have studied poverty from different perspectives and have taken active measures to alleviate poverty (Imai et al., 2015; Arouri et al., 2017). Padda et al. (2018) concluded that rural development in Pakistan was primarily related to agriculture, living standards and environmental indicators. They believed that additional funds should be allocated for agricultural development, education and health in rural areas of Pakistan to attain poverty reduction. In some situations, policies can have

important impacts on poverty reduction. In Britain, for example, the Labor Party has been implementing spending programmes and reforms since 1999, and poverty in Britain has fallen in both rural and urban areas, proving that the right policies were good for poverty reduction (Vera-Toscano et al., 2020).

The poverty situation, distribution characteristics and causes of poverty in each country or area are different, and different approaches to poverty reduction are needed in different periods. Saleem et al. (2016) analyzed poverty reduction measures in 15 countries and summarized the four most effective approaches to poverty reduction: industrialization, rural development, social welfare and petroleum-generated employment. Studies conducted in Russia showed that rising incomes in poor areas led to a migration to the cities. This helped to lift people out of poverty, but it was detrimental to the development of the poor areas (Guriev and Vakulenko, 2015). Therefore, it is very important to exploit the resources that are in the rural areas, attract the population to return and balance the development of these areas. The abundance and diversity of natural and cultural resources also provide rural areas with great late-development advantages for their future development. Research in Tanzania showed that tourism can play an important role not only in economic and socio-cultural development but also in poverty reduction (Yusuf et al., 2018). The current research provided some references for poverty alleviation and development in rural areas of Yunnan Province. There is no doubt that in the fight against poverty around the world, China's targeted poverty alleviation policy is tailored to local conditions. China has achieved remarkable results through various measures, and Chinese achievements have played a great role in promoting world poverty reduction.

## 5 Conclusions

In this study, we analyzed the rural poverty pattern at the county level and influencing factors in Yunnan Province from 2010 to 2015. The final conclusion drawn is that the factors which determine whether farmers in poor areas in Yunnan Province can really get out of poverty are rising incomes and paying more attention to agricultural production. The per capita net income of farmers is the main basis for calculating the incidence of poverty, which is closely related to people's living standard and poverty degree. A sustained and stable source of income is the key to poverty alleviation. The level of agricultural mechanization is related to the production efficiency of rural areas, farmers' time spent farming, and the amount of time they have for outside work. According to "the central committee of the communist party of China under the state council about fight poverty tough action guidance for three years" and the latest fieldwork situation (such as the third party assessment of national targeted poverty alleviation), our country's crucial poverty-alleviation task has a long way. The "three dis-

tricts and three prefectures" (Tibet, Kashgar region, Hetian region, Aksu region and Kizilsu Kirghiz autonomous prefecture, the Tibetan area in four provinces, Linxia prefecture in Gansu Province, Liangshan prefecture in Sichuan Province and Nujiang Prefecture in Yunnan Province) and other areas with deep poverty, have poor infrastructures, multiple causes for poverty and relatively backward development. These aspects make it difficult for people in these rural areas to enjoy public services comparable to those in cities for poverty alleviation. In Yunnan region, there are still shortcomings in supporting industries for poverty alleviation and farmer employment. Farmers have been slow to increase their incomes. Agricultural production and farmers' economic levels need to be further strengthened and improved. Therefore, increasing the intensity of support for agricultural production and operations, such as the construction of production roads, the improvement of infrastructure and land, the input of agricultural machinery to improve agricultural production efficiency, and broadening the income channels of farmers are the main directions for poverty alleviation work in Yunnan Province. The rural areas of Yunnan Province can make use of the advantages of natural resources reasonably as well. With the help of national poverty alleviation and development policies, rural areas can be supported with development funds and opportunities, helping to attract people to return home to develop industries. Not only can this benefit the poor population, but also the overall prosperity of the rural areas.

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## 基于县域数据的云南省农村贫困格局及其影响因素研究

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**摘要:** 对县域农村贫困的认识是扶贫开发精准施策的基本前提。云南省是我国贫困县数量最多的省份, 贫困人口多、分布范围广、贫困程度深、扶贫难度大。本文基于农村贫困发生率数据刻画了 2010 年和 2015 年云南省县域农村贫困格局, 并运用逐步回归分析探索影响云南省县域层面农村贫困发生率及其变化的主要因素。研究发现, 云南省县域农村贫困受自然条件和地理环境的影响颇深, 2010 年和 2015 年, 在空间上均呈现出中部地区贫困程度较轻, 西北、东北和南部地区贫困程度较深的整体格局, 县域贫困格局与云南省地形地貌、集中连片特困区有较强的吻合性; 云南省县域农村贫困发生率与农村居民年人均纯收入和农业机械化程度有较强相关性, 这两个指标关系到农村居民生活水平和维持生计的农业生产情况; 2010–2015 年, 云南省县域农村贫困发生率的变化与第一产业增加值和农业机械化程度显著相关, 说明第一产业的发展在云南省县域农村居民脱贫致富的过程中起到关键作用。因此, 对云南省农村地区而言, 农民年人均纯收入以及农业生产水平的提高仍是其脱贫解困的主攻方向, 云南省在脱贫攻坚阶段应重点围绕农民增收和农业生产经营两方面制定有效的扶贫政策措施。

**关键词:** 农村贫困; 贫困发生率; 逐步回归分析; 云南省