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Karst Ecosystem In Gunungkidul, Southern Java: Natural Resources And Poverty

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ABSTRACT— The purpose of this study was to find a real variable to be the difference between poor and non- poor groups in the karst ecosystem. The research was located in Girisubo Sub-district, Gunungkidul District, Yogyakarta. The study was conducted in 2018 by using primary and secondary data. The primary data were obtained from in-depth interviews and the secondary data were obtained from related institutions. These two data were analyzed by using farming income analysis and discriminant analysis. The conclusions of this study were (1) the real variables that differentiate poor and non-poor groups were rice and peanut, the coefficient determination of rice farming income variable is 0.02 and the variable of peanut farming income is 0.056 and (2) peanut was more important than rice. As a suggestion, a peanut is a good commodity to be developed. Peanut is a commodity that does not need much water. Rice crop management must be considered, rice makes negative income for the poor group, but it makes positive for the non-poor one.

KEYWORDS: Ecosystem, Karst, Natural resources, Poverty

1. INTRODUCTION

Twenty-five percent of the earth's surface is karst so that 25 percent of world life depends on this region. The uniqueness of the karst region lies in the phenomenon of abundant water below its surface which forms an underground river network, but on the other hand, drought appears on the surface of the soil. In Indonesia, the karst area reaches 15.4 million hectares spread across several regions [10], and LIPI, 2019). Gunungkidul District Regulation No. 2 in 2011 states that the karst area in Gunungkidul is 114,888 ha or 77% of the total area of Gunungkidul. Karst in Gunungkidul is divided into two regions: (1) Wonosari Basin with an area of 310.17 km^2; (2) The karst hills of Gunung Sewu have many unique features, one of which is an underground river that can be used as a potential subsurface water resource. Karst is an ecosystem that is easily damaged so that the management must be carried out carefully so that it does not cause damage to the karst ecosystem. Karst is a form of earth's surface that is generally characterized by closed depression, surface drainage, and caves. This area is formed mainly by dissolved rocks, mostly limestone so that the agricultural land in the karst mountain is a dry land with a rain-fed system (PKPL, 2014). The ecosystem is an asset that economically provides material as an input in which through its production process will be transformed into the product [16], [21]. Karst ecosystem is a part of the environment. An ecosystem has natural resources that act as input that can be utilized by people living in the karst area. The resources are land, water, plants, livestock, and rocks. Karst ecosystem is a barren area and easily damaged. [15] state that economic and urban development has resulted in karstic spatial planning from the intensive and unsustainable distribution of settlers, infrastructure and industry, tourism development, and the intensive land use will cause damage to the karst ecosystem such as the surface shapes and the resources below. Furthermore, poverty is an international concern [3], [8]. It is manifested through the global agenda by the United Nations in the form of Sustainable Development Goals (SDGs). SDGs are used to encourage sustainable development to overcome the problem of poverty, inequality, and climate change. Nationally, it is realized in the form of Government Regulation No. 59 in 2017 concerning the implementation of sustainable development achievement. Poverty as the main problem is the responsibility of all elements of society to work hard to reduce and alleviating it. The

government has made poverty reduction as a national commitment and top priority. However, the economic growth that occurs in Indonesia is not in line with poverty reduction and economic inequality. The number of poor people in Indonesia increased by 6,900 people from September 2016 to March 2017 [2].

Most of the rural poor live in Java, especially in southern Java, where the karsts are commonly found. One of the efforts to reduce poverty is to increase prosperity. [20] states that economic development is an effort to increase prosperity. [13] declares that there are 4 sources of economic growth, namely human resources, natural resources, capital formation, and technology. Referring to Mankiw's opinion, the control of natural resources can spur economic growth that can reduce poverty. It is supported by the results of the study of [8] in Bangladesh which showed that natural resources in the form of land ownership affected poverty. Poverty decreases with the increase of land owned. Various approaches have been developed to measure poverty. The approaches are (1) infant mortality rate (IMR), used by [3], (2) expenditure by using expenditure for basic needs (CBN), including food and non-food, used by [8] in Bangladesh; and (3) income, BPS in 2018 provided a poverty standard that income/capita/month was smaller than IDR 401,220. The purpose of this study was to find a real variable to be the difference between poor and non-poor groups using discriminant analysis. [22] states that discriminant analysis is a dependent technique method in which the dependent variable is nonmetric, it is a technique to test whether the average group of the dependent variable for two or more groups is the same or not. The discriminant analysis departs from the assumption that the model must meet the normality and heteroscedasticity shown in the same variance-covariance matrix [22], [17].

2. Material and Methods

Karst landscape is characterized by sinking streams, caves, closed depressions, hollow rock outcrops, and large springs. Karst land is a land that has a special shape and hydrology that arises by a combination of high rock dissolution and well-formed secondary porosity [5].

Figure 1. Land Farming in Karst, Gunungkidul

This research was conducted in Girisubo Subdistrict, Gunungkidul District, Yogyakarta Special Region Province with in-depth interviews with 60 farmer households to collect primary data. The secondary data were obtained from BPS, Regional Government, Department of Agriculture, and related agencies. There is two data analysis used in this study, namely and discriminant analysis and regression analysis. The formulation of the discrete analysis equation refers to [7], [22] following:

$$Djk=a+w1X1k+w2kXik+\ldots+wnXnk$$

Information:

Djk	:	Discriminant value D of the discriminant function j object k
A	:	Intersept
W	:	Scales of discriminant independent variable i
Xik	:	Independent variable i for object k.

Variable i is categorized into (land area; the number of livestock including cows, goats, and chickens; damage; farm income including rice, peanuts, corn, cassava, income; off-farm and remittance)

Formulation of regression analysis specifically for rice commodities refer to [7], [4]:

$$Ln\ C=a+bLn\ Q+\ D1$$

Information:

C	:	Production Cost
Q	:	Production
a	:	Intercept
D1	:	1=non poor; 0=poor

3. Results

3.1 Description of Natural Resources Utilized by Farmers and Disturb Farmers

Reducing and eliminating poverty are the main agendas in international development (Fukuda-Par, 2004 and Hickey, 2008) in [3]. [3] brings attention to understand the causes of differences in poverty and welfare in the world. Analysis of the causes of poverty can be done with a geographical approach, government policies, the quality of domestic institutions, and international roles. Beaudin (2002) in his study of history poverty in world story in [3] states that before 1,500 poverty was generated from local sources such as natural disasters, war, and distribution systems, but since 1500 is directly related to colonialism rules and creation process of world economic order. [14] states that increasing agricultural products can be obtained by opening new land. Expansion of cultivation area is the main source in increasing agricultural productivity. The most dramatic thing related to opening new land in Western history is opening up new continents in South America and Australia to place Europeans in the 18th and 19th centuries. Countries in the New Continent became important sources of food and agricultural raw materials for Metropolitan cities in Western Europe for two decades. It is called the frontier model which shows efficiency as a source of growth. This illustration shows the importance of natural resources in supporting economic growth, in which turn will affect poverty. Thus, Table 1 provides information related to the ownership of natural resources in Girisubo. Table 1 shows the difference in natural resource ownership between poor and non-poor. For the non-poor, it excels in land tenure as much as 1.74 times wider than the poor. While for the poor, goats and cows are 1.86 times superior to the non-poor. Even chicken is only owned by the poor group. Non-poor farmers have more land and less damage to cultivated crops. This is what drives farmers' income to be more, which then they are grouped into non-poor farmers.

Table 1. Natural Resources Ownership of Poor and Non-Poor Farmers in Girisubo, Gunungkidul

Variables	Poor	Non-Poor	Overall
Land (ha)	0.43	0.75	0.45
Cows	1.86	1.00	1.80
Goats	1.86	1.00	1.80
Chickens	2.04	0.00	1.90

Damage (%)	17.23	7.50	16.58

3.2 Land Resources

The land is a part of the earth's surface that functions as a media that can produce agricultural products, which then serves as a source of income for the community, including those who live in the karst region. The products produced can be generally grouped into 2 related to agricultural and non-agricultural activities. Related to agricultural activities, the businesses developed are a seasonal or annual crop, livestock, fisheries, and forestry. In developing the farming business, the farmers use their land or lease to other parties. Table 2 shows the land area based on ownership.

Table 2. Land Tenure in Girisubo, Gunungkidul

NO	Land area	Number of farmers		Area of arable land	Percentage
		Owned	Rent		
1	0.25	10	14	24	40
2	0.5	14	16	30	50
3	1	4	2	6	10
The Number		28	32	60	100
The Percentage		46,7	53,3		

Land tenure is the main capital for farmers. The controlled land can be in the form of ownership and rent. Table 2 shows that the farmers have 53.3% of leased land and 46.7% of owned land. It indicates that most farmers operate agricultural businesses by renting the land. The amount of rent ranges from IDR 1,400,000/ha/year to IDR 8,000,000/ha/year. Land tenure by farmers is; 90% of farmers own 0.25 and 0.5 ha, and only 10% of farmers own 1 ha. It shows that the owned land is low. The average land area per farm is 0.45 ha or 4,500 m^2. The average land tenure per capita is 0.161329 ha or 1,613 m^2.

3.3 Livestock

Livestock resources managed by the community include cows, goats, and chickens. Livestock is a source of income for the community. It is an investment for farmers in which there is a sudden need, livestock is a resource that is easily sold to meet the sudden need.

Table 3. Number of Farmers with and without Livestock in Girisubo, Gunungkidul

Types of livestock	Number of Farmers		Percentage	
	Having	Not Having	Having	Not Having
Cows	30	30	50.0	50.0
Goats	32	28	53.3	46.7
Chickens	11	49	18.3	81.7

Table 3 shows that more than half of farmers have cows and goats, but only a few farmers have chickens. For goats and cows, the food provided is in the form of surrounding resources such as grass and leaves. As for the chicken, there is very limited food, such as bran. Since the availability of bran is very limited, few farmers have chicken farms. The number of cows managed by farmer's ranges from 1-5, while for goats around 1-7, and chickens around 2-25.

3.4 Plant and Production Disruption

The decline in production due to plant pests is around 9-45%. The pests that attack include apes, hedgehogs,

mice, planthopper, sangit grasshopper, mentul, and koret. While the decline in production due to lack of water and land degradation is 16-37%. Damage to plants due to pests such as rats and apes in the poor group is 2.3 times greater than that of the non-poor. The impact will reduce production and increase the cost that ultimately reduces the income. The amount of income especially related to types of plants cultivated by farmers is shown in Figure 1. Rice generates negative income, the cause is the presence of pests such as rats, planthopper and sangit grasshopper, besides the lack of water. Whereas other commodities generate positive income. Peanut is the main source of income for non-poor farmers.

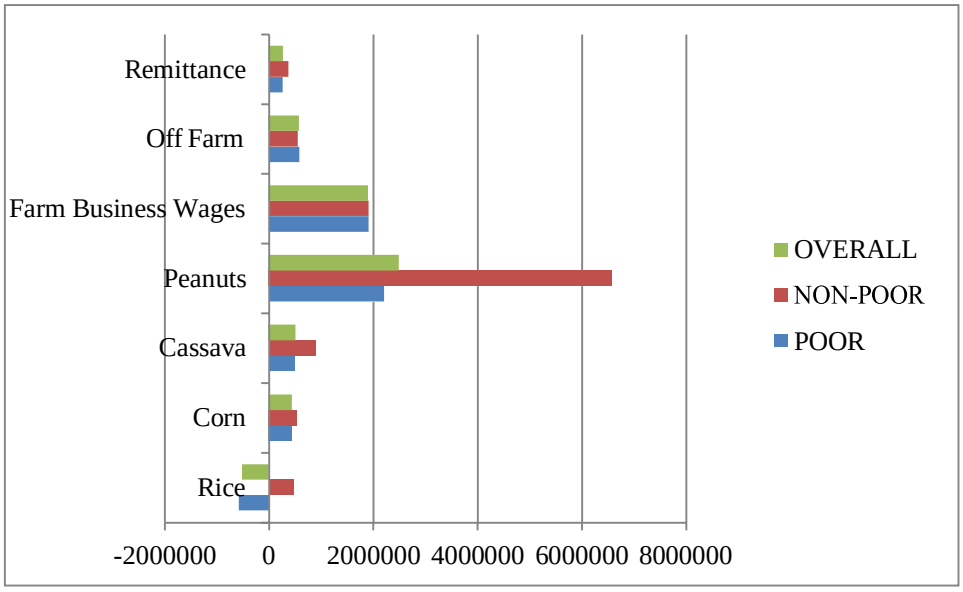

Figure 2. Income from Types of Plants Developed by Farmers

A. Water

The availability of water is very dependent on rainfall. Places that are located close to the beach have a relatively high temperature. The average rainfall is 2,498.91 mm/year with 103.67 rainy days. The rainy season is the best time for growth with a monthly rainfall of 202 mm/month. According to Surianysah et al. (2013), rainfall of 200 mm/month during the growing period is sufficient for upland rice to produce. Daily rainfall of 200 mm causes the plants to experience stress because the soil condition is too humid (moisture stress), and the plants suffer from drought if there is no rain for 20 days. [1] in Karanganyar, Central Java, proves that the presence of water will make farmers plant crops, especially rice, or not.

B. Discriminant Analysis

Discriminant analysis is used to determine the variables that make difference between poor and non-poor farmers. The method used is the stepwise method. [22], the stepwise method is a method that includes only independent variables that can be discriminated. There are several steps taken as follow:

1) Carry out a similarity test between groups by including all variables. The results are shown in Appendix 1. Referring to Wilk's Lambda values in Appendix 1, it shows that there are only 4 real variables that show differences between poor and non-poor groups, they are land, rice, cassava, and peanut.

2) The next step is conducting discriminant analysis using 4 variables from step 1 in which the results of variance and covariance are not the same, and the Box's M Test is significant.

3) The next step is carrying out a normality test using Kolmogorov-Smirnov test. The results are shown in Appendix 3. The Kolmogorov-Smirnov test shows that 2 variables are normally distributed, are rice and peanut, while land and cassava are not normally distributed.

4) The next step is conducting discriminant analysis using two normally distributed variables called rice

and peanut.

Table 4. Similarity Test of Groups

Variables	Wilks's Lambda	F	Sig
Rice	0.932	4.205	0.045
Peanut	0.721	22.470	0.000

Referring to Wilk's Lambda's value in Table 4, it indicates that the real variables show the difference between poor and non-poor groups, they are rice and peanut.

Table 5. Analysis Result of Variance and Covariance

Box's M		4.008
F	Approx.	1.001
	Df1	3
	Df2	316.202
	Sig.	0.393
Tests null hypothesis of equal population covariance matrices		

The result of the analysis of variance and covariance has the same value, shown by the Box's M Test, it is obtained a significance value of 0.395 or 39.3%, which means it is not significant compared to α=5%. It is concluded that the variance-covariance values are the same. It is in line with the demand of the assumption that the variance-covariance values are the same.

CR2 is the square value of canocial correlation. The result of the analysis obtains the canocial correlation value of 0.528. Furthermore, by squaring the value of canocial correlation, the CR2 value of 0.28 or 28% is obtained. It means that 28% of the variation between the poor and non-poor groups is explained by the independent variables called rice and peanut.

Table 6. Wilk's Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1	0.721	18.668	2	0.000

The next step is testing discriminant variables together using Wilk's Lambda. The significance value in the table above is 0.00, thus at the significance level of α = 5%, Ho is rejected and H1 is accepted. It means that the two groups of farmers are significantly different based on the discriminant variables.

The mathematical formulation of the discriminant equation is based on the results of the analysis presented in Table 7.

Table 7. Canonical Discriminant Function Coefficients

	Function
	1
Rice	0.002
peanut	0.056
(Constant)	-1.384

Unstandardized coefficients

The disciminant formula:

$$D = -1.384 + 0.02 \text{ Rice} + 0.056 \text{ Peanut}$$

If the income of rice farmers increases by IDR 100,000 it will increase poverty by 0.02. If the income of peanut farmers increases by IDR 100,000, it will increase poverty by 0.056. Thus the increase of peanut income towards non-poverty is greater than the income of rice farming.

Table 8. Standardized Canonical Discriminant Function Coefficients

	Function
	1
Rice	0.018
Peanut	0.992

In this discriminant equation, based on a standardized coefficient value, the peanut variable has a coefficient value of 0.992 while rice is 0.18. Based on the coefficient scale, the most important variable is peanut, followed by rice. Peanuts in Girisubo are cultivated during the dry season after farmer's plant rice. Rice is planted in the rainy season because there is enough water to grow. The agricultural production facilities used are seeds, urea, NPK, Phonska, and manure. The rice seeds used are sourced from the inside (farmers' harvest) and outside (buying). Rice productivity with an area of 0.45 ha is 394.794 kg of grain or 877.32 kg of grain/ha or 0.877 tons/ha. The fertilizers used by farmers are 117.433 kg/ha of urea, 97.32 kg/ha of NPK, and 176.2452/ha of manure.

Grain yields in Girisubo are still low when compared to the result from the [9] which states that cultivated land produces products ranging from 1.8 to 3.5 tons/ha. The recommendations from the Agricultural Research Institute are 200 kg of urea, 100 kg of KCl, 100 kg of SP-36, and 3-5 tons of manure. [11] state that in rain-fed rice fields, for example, Andong Boyolali, the ideal for each ha is 300 kg of urea, 75 kg of KCl, 50 kg of SP-36, in Jakenen Pati 200 kg of urea, 200 kg of KCl, 50 kg of SP-36, in Cibeber Cianjur 250 kg of urea, 50 kg of KCl, and 50 kg of SP-36. The use of superior rice has not shown tangible results compared to rice varieties commonly used by farmers. The low rice production in Girisubo is more caused by the lack of the type of production factors and the low use of production factors. The addition of these two components in the practice of cultivation does not always increase the farmers' income because the addition of production factors will increase the cost of farming so that it will reduce the farmers' income.

Based on the analysis of the effect of total production on cost, the regression equation is LnC=13,83+0,17LnQ+0,08D1, the variables of C (cost) and Q (product) are normal with the Kolmogorov-Smirnov test, no autocorrelation, the R^2 is 17%, and the Q variable significantly affects α=5%, while D1 does not affect. Since D1 does not affect, the cost function for the poor and not poor is the same. The elasticity value is 0.17, meaning that adding 1% of grain product will only increase the cost by 0.17%. Therefore, the cost position is decreasing, but if it is calculated using an average production value that is increased by 1% which is 3.5 kg, it will add to the cost of IDR 4,860. If the price of rice is assumed to be IDR 6,000/kg, there will be an additional revenue of IDR 21,000. Thus, the addition of production by raising the use of input can still increase the farmers' income. Peanut is a type of plant that does not need much water for growing. Peanuts are planted after farmer's plant rice. Peanuts are multifunctional commodities that can be consumed directly in the form of fresh seeds and used as industrial raw materials for various types of processed foods and vegetable oils [19]. Indonesia is one of the three largest peanut importing countries in the world besides the European Union and Vietnam. From 2003-2013, peanut import grew by 10.52% and the production decreased

by 1,120 tons. In the 2008-2013 period in Indonesia, three provinces experienced increased production, they were Yogyakarta, West Java, and West Nusa Tenggara [19]. Peanut is a commodity that can tether nitrogen through symbiotic mutualism with Rhizobium bacteria. Nitrogen is a key element in crop production, especially legumes, with nitrogen-fixing that can symbiotically reduce production costs, especially on infertile soils [18]. The amount of nitrogen that can be tethered by peanuts is 21- 206 kg/ha/year [6].

4. Conclusion

The conclusions of this study are: (1) the real variables that differentiate poor and non-poor groups are rice and peanut, and (2) peanut is more important than rice, the coefficient determination of rice farming income variable is 0.02 and the variable of peanut farming income is 0.056. The suggestion that can be taken based on this research is that peanut is a good commodity to be developed. Peanut is a commodity that does not need much water. Rice crop management must be considered, rice makes a negative income for the poor group, but it is positive for the non-poor group.

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