

Economic impact due to Cimanuk river flood disaster in Garut district using Cobb-Douglas analysis with least square method

T A S Bestari^{1*}, S Supian², S Purwani²

¹Master Student of Mathematics Study Program, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Indonesia

²Departement of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Indonesia.

*Email: tegarbestari@gmail.com

Abstract. Cimanuk River, Garut District, West Java which have upper course in Papandayan Mountain have an important purpose in dialy living of Garut people as a water source. But in 2016 flash flood in this river was hitted and there was 26 peple dead and 23 peole gone. Flash flood which hitted last year make the settlement almost align with the ground, soaking school and hospital. BPLHD Jawa Barat saw this condition as a disaster which couused by distroyed upper course of Cimanuk River. Flash Flood which happened on the 2016 had ever made economic sector paralyzed.

Least square method selected to analyze economic condition in residents affected post disaster, after the mathematical equations was determined by Cobb Douglas Method. By searching proportion value of the damage, and the result expected became a view to the stakeholder to know which sector that become a worse and be able to make a priority in development

Keyword : Cobb Douglas, Least Square Method, Proportion value

1. Introduction

Since long time ago, people have settled near the river and today this condition still continued. River becomes one choice for transportation, provides a water for industry and agriculture also be able to increase the quality of life because living in the in the middle of a beautiful nature. But, living near a river have a risk of flood, one of the most dangerous disaster on earth [1]. Cimanuk River location in Garut Resident, West Java, Indonesia which the upstream in Papandayan Mountain have an important role in daily life of Garut citizen such as a source of water. In 2016, was happened a big flash flood in this river and as a consequence there was 26 deaths dan 23 gone also the the economic activity was paralyzed. BPLH (Environmental Management Agency) Jawa Barat saw this condition caused by the damaged land in upstream of Cimanuk River. The flash flood in Cimanuk River in 2016 was the most damage flood ever in Garut. Data from BPLHD (Disaster Management Agency) Garut Resident showed that economic lost in that disaster touch 671 billion rupiahs [2]. In this case, the civilization activity still



near river like hospital, school and housing that means just only upstream and river revitalization can make this disaster stopped. In the other side, upstream revitalization need a time so this this paper aimed to model the economic lost if the condition still the same.

Some research related to this paper are Develop a dynamic optimization model, where inter-temporal decision of an economic agent are interacts with the hydrological system [3]. Input-Output Tables used to study the analysis of the economic impact of a Natural Disaster Tokai Flood in 2000 in Japan [4]. They proposed analysis methodology to estimate returns to scale in case of Cobb-Douglas production function [5]. Partial least square used to identify the information about the correlation of multivariate cognitive abilities and local brain structure in children and adolescents [6]

This paper showed the mathematical model which formed by Cobb-Douglas Method and the index and constant gotten by Partial Least Square Method. The main data was generated by normal distribution. This paper aims to derive a mathematical model of Cimanuk river flash flood, that can be used to predict the total of economic lost

2. Preliminaries

This section describe the main theoretical tools that used to formed mathematical model for flash flood in Cimanuk River.

2.1. Cobb-Douglas Method.

Cobb-Douglas production function is a function or a model that involves a dependent variable and two or more independent variables. The model can be written as follow:

$$Y = aX_1^b X_2^c \tag{1}$$

Where:

Y is an output

a is an efficiency index

X₁, X₂ is a kind of input

b, c is a production elasticity from the used input

In order for data to be obtained can be analysed by Cobb-Douglas Method, so the data must be transformed into a linier form by using natural Logarithm (Ln). The model showed:

$$\ln Y = \ln a + b \ln X_1 + c \ln X_2 . \tag{2}$$

and transform back to (1) [7]

2.2. Partial Least Square Method

Partial Least Square (PLS) Method designed to be an alternative from Structural Equation Modelling (SEM) which used to solved the condition between variable really complex but the sample size is small [8]. This method was introduced by Herman O.A Wold to forming a prediction model. (Talbot) PLS used to predict the effect of X variable to Y variable and explained the theoretical correlation between the variable. PLS is a regression method that can be used to identify the factor which combination X variable as an explanation and Y variable as a response.

PLS regression is a method to find a component from X variable which have correlation with Y variable. The concept of PLS regression is describing Y variable as a response and X variable as a predictor by equation:

$$y = Tq^T + f \tag{3}$$

$$x = TP^T + E \tag{4}$$

Where :

y is a vector variable response

x is a predictor variable matrix

T is a PLS component score

q is a vector loading from y

P is a factor loading matrix from x

Vector Q obtained from the regression the indicator variable with the PLS component score using Ordinary Least Square (OLS) [9]

2.3 Significance Test

2.3.1 Significance Test (F statistics test)

The F test aims to determine the significance of the correlation of independent variable to dependent variable. The F test is done by comparing the value of F-test and F-table with a level of significant 95%.

The way to test the hypothesis are:

1. Determine the hypothesis

H_0 = the lost of housing, lost of infrastructure, lost of social criteria, lost of economic source and lost of cross sector simultaneous do not have a correlation into the economic impact.

H_1 = the lost of housing, lost of infrastructure, lost of social criteria, lost of economic source and lost of cross sector simultaneous have a correlation into the economic impact.

2. Determine the level of significant (α)

In this case, the level of significant is 5% with the level of confidence 95%

3. Determine the Testing Criteria

H_0 is not accepted if F-test > F-table

H_1 is accepted if F-test \leq F-table

4. Conclusion

If H_0 not accepted so the lost of housing, lost of infrastructure, lost of social criteria, lost of economic source and lost of cross sector simultaneous have a correlation into the economic impact.

If H_1 accepted so the lost of housing, lost of infrastructure, lost of social criteria, lost of economic source and lost of cross sector simultaneous have a correlation into the economic impact.

2.3.2 Wald Test (t test)

Test t aims to determine the differences of each other data by means. The t test also showing how significant the difference are. The t test is done by comparing the value of t-test and t-table with a level of significant 95%. The way to test the hypostasis are:

1. Determine the hypothesis

a) $H_{01};\beta_1=0$, lost of housing as a partial have no correlation to economic impact.

$H_{11};\beta_1^1=0$, lost of housing as a partial have correlation to economic impact.

b) $H_{02};\beta_2=0$, lost of infrastructure as a partial have no correlation to economic impact.

$H_{12};\beta_2^1=0$, lost of infrastructure as a partial have correlation to economic impact.

c) $H_{03};\beta_3=0$, lost of social criteria as a partial have no correlation to economic impact.

$H_{13};\beta_3^1=0$, lost of social criteria as a partial have correlation to economic impact.

d) $H_{04};\beta_4=0$, lost of economic as a partial have no correlation to economic impact.

$H_{14};\beta_4^1=0$, lost of economic as a partial have correlation to economic impact.

e) $H_{05};\beta_5=0$, lost of cross sector as a partial have no correlation to economic impact.

$H_{15};\beta_5^1=0$, lost of cross sector as a partial have no correlation to economic impact.

2. Determine the level of significant (α)

In this case, the level of significant is 5% with the level of confidence 95%.

3. Determine the testing criteria

$H_{01}, H_{02}, H_{03}, H_{04}, H_{05}$ are not accepted if : t-test > t-table or -t-test < -t-table.

$H_{01}, H_{02}, H_{03}, H_{04}, H_{05}$ are accepted if : $-t\text{-table} \leq t\text{-test} \leq t\text{-table}$

4. Conclusion

- a) If H_{01} not accepted so the lost of housing as partial not have correlation to economic impact.
If H_{01} accepted so the lost of housing have correlation to economic impact.
- b) If H_{02} not accepted so the lost of infrastructure not have correlation to economic impact.
If H_{02} accepted so the lost of infrastructure have correlation to economic impact.
- c) If H_{03} not accepted so the social criteria not have correlation to economic impact.
If H_{03} accepted so the social criteria have correlation to economic impact.
- d) If H_{04} not accepted so the lost of economic not have correlation to economic impact.
If H_{04} accepted so the lost of economic have correlation to economic impact.
- e) If H_{05} not accepted so cross sector not have correlation to economic impact.
If H_{05} accepted so cross sector have correlation to economic impact.

2.3.3 Normality assumption test

Normality test aims to measure the data having the normal distribution so be able to use on parametric statistic. In this case, Kolmogorov-Smirnov test used to determine the normal distribution from data. If the probability > 0.05 so the data is normal distribution and if probability ≤ 0.05 the data is not normal distribution instead.

3. Results and Discussion

To know the economic impact, the data using the total economic loss (Y) which consist in 5 variable there are 1. The loss of housing 39.318% (X_1), 2. Loss of infrastructure 15,477% (X_2), 3. Social 4,779% (X_3), 4. Economic source 7,021% (X_4), 5. Cross sector such as banking and living environment 33,405% (X_5). Those data will generated into 50 data using Normal Distribution with 1% standard deviation from original data.

3.1 Significance Test (F statistics test)

After the data convert to logarithm natural and processed with the F test, the result is

Table 1 ANOVA table which show the F-test value

| | df | SS | MS | F | Significance F |
|------------|----|----------|----------|----------|----------------|
| Regression | 5 | 0,000836 | 0,000167 | 2,767859 | 0,029363274 |
| Residual | 44 | 0,002659 | 6,04E-05 | | |
| Total | 49 | 0,003495 | | | |

Based on the table of ANOVA showed that F-test 2.767859 $>$ F-table 2.42 and the value of significance > 0.05 (α), so the conclusion is H_0 not accepted that means the lost of housing, lost of infrastructure, lost of social criteria, lost of economic source and lost of cross sector simultaneous have a correlation into the economic impact.

3.2 Wald Test (t test)

After the data convert to logarithm natural and processed with the t test, the result is

Table 2 Table which show the value of t-test

| | <i>Coefficients</i> | <i>Standard Error</i> | <i>t Stat</i> |
|------------------------|---------------------|-----------------------|---------------|
| Intercept | 26,96087815 | 5,463150823 | 4,93504189 |
| Lost of Housing | -0,02969591 | 0,098459932 | -0,301604 |
| Lost of Infrastructure | -0,230823501 | 0,124361944 | -1,85606219 |
| Lost in Social | -0,15389522 | 0,113426691 | -1,35678136 |
| Lost of Economic | 0,244718139 | 0,110096817 | 2,22275398 |
| Lost in Cross Sector | 0,176663318 | 0,107127912 | 1,64908766 |

- a) First hypothesis
The value of t-test $-0.30160 > t\text{-table } -1.68$ so other lost of housing have correlation to economic impact
- b) Second hypothesis
The value of t-test $-1,85606219 < t\text{-table } -1.68$ so the lost of infrastructure not have correlation to economic impact
- c) Third hypothesis
The value of t-test $-1,35678136 > t\text{-table } -1.68$ so the social criteria have correlation to economic impact.
- d) Fourth hypothesis
The value of t-test $2,22275398 > t\text{-table } 1.68$ so the lost of economic have correlation to economic impact
- e) Fifth hypothesis
The value of t-test $1,64908766 < t\text{-table } 1.68$ so cross sector have no correlation to economic impact.

3.3 Normality assumption test

After the data convert to logarithm natural and processed with the normality assumption test, the result is

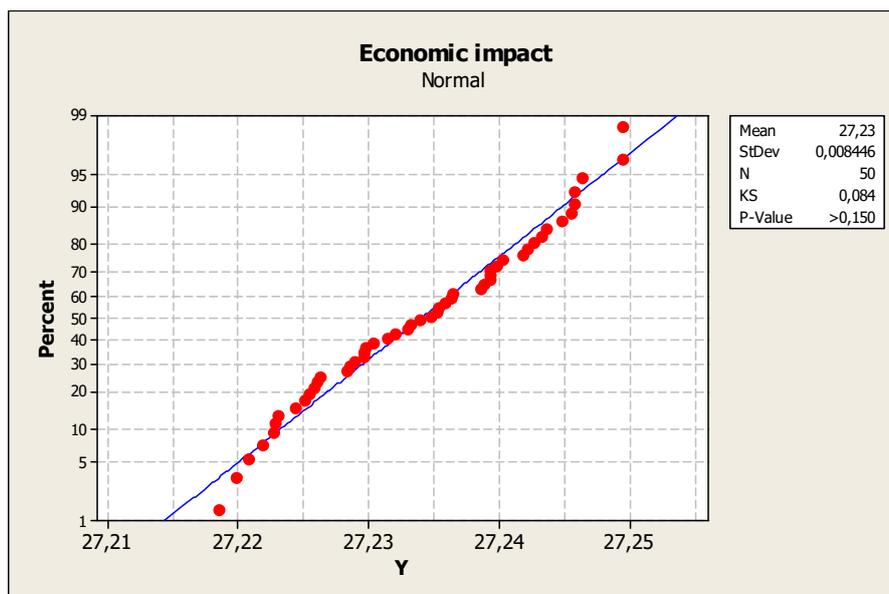


Figure 1. Normality assumption test

The value of KS 0.084 and the P-Value > 0.150 which mean bigger than 0.05 (α) so the variable determined as a normal distribution.

3.4 Partial Least Square Method

The 50 data changed into the Ln data to follow Cobb-Douglas function. After all data processed by PLS the result is

$$\text{Constant} = 26.9609, X_1 = -0.0297, X_2 = -0.2308, X_3 = -0.1539, X_4 = 0.2447, X_5 = 0.1767$$

3.5 Cobb-Douglas Method

so the regression result followed Cobb-Douglas Function (2)

$\ln Y = \ln 26.9609 - 0.0297 \ln X_1 - 0.2308 \ln X_2 - 0.1539 \ln X_3 + 0.2447 \ln X_4 + 0.1767 \ln X_5$
and can be written as (1)

$$Y = 511.647.000.000 X_1^{-0.0297} X_2^{-0.2308} X_3^{-0.1539} X_4^{0.2447} X_5^{0.1767}$$

4. Conclusion

The model solution in the economic impact due to Cimanuk river flood impact was created by Cobb-Douglas Method after the constant got by Partial Least Square Method. From the result of the discussions, it can be conclude that The Cobb-Douglas Method be able to forming the mathematical model of the flood depend on the data of the economic lost. And the mathematical model can be used by government to make the regulation to anticipate the flood.

References

- [1] Ohl, C., Tapsell, S., 2000. Flooding and human health: the dangers posed are not always obvious. *Br. Med. J.* 321 (7270). 1167e1168
- [2] BPBD reports. 2016. Kegiatan Penanggulangan Bencana Banjir Bandang Sungai Cimanuk Kab. Garut. Penerbit BPBD Kabupaten Garut
- [3] Grames Johanna, et al. 2016. Modeling the interaction between flooding events and economic growth. *Ecological Economics* 129 (2016)193-209
- [4] Ishikawa Yoshifumi, Katada Toshitaka. 2006. Analysis of the Economic Impacts of a Natural Disaster Using Interregional Input-Output Tables for the Affected Region: A Case Study of the Tokai Flood of 2000 in Japan. *Intermediate Input-Output meeting*
- [5] Pavelescu Florin Marius. 2014. Methodological consideration regarding the estimated returns to scale in case of Cobb-Douglas production function. *Elsevier. Procedia Economic and Finance* 8 (2014) 535-542
- [6] ziegler G, et al. Partial least square correlation of multivariate cognitive abilities and local brain structure in children and adolescents. *Elsevier. NeuroImage* volume 82 pages 284-294
- [7] Soekartawi. 1990. Teori Ekonomi Produksi Dengan Pokok Bahasan Analisis fungsi Cobb-Douglas. Jakarta : Radar Jaya Offset.
- [8] Hair, Black, Babin, & Anderson. 2010. *Multivariate Data Analysis* 7th. New Jersey: Prentice Hall.
- [9] Abdi, H. 2003. *Partial Least Squares (PLS) Regression*. The University of Texas at Dallas.