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The Estimated Value of Losses and Insurance Due to Citarum River Flooding

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Abstract

Flooding in Citarum always happens in Bandung District which causes loss of property, household damage, diseases moreover decease. The government provides aid for flood victims, but the help is not cover losses. In this circumstance, people need insurance. This study aims to set up flood insurance based on economic conditions, areas, and losses due to flooding. To find out the conditions, interviewed the village chief of Baleendah. The analytical methods used are linear regression analysis and analysis method mix. Linear regression analysis was used to estimate flood losses that will serve as the sum insured in the form of insurance products. Analysis mixture consisting of identification areas, conditions, and alternative insurance models used to establish the right flood insurance for Baleendah. Results show the estimation of flood losses and flood insurance appropriate to the condition of Baleendah.

Keywords: Flooding, losses, flood insurance

1. Introduction

According to the 2011 Great River Basin, flood disasters often occur in the Upper Citarum Watershed (DAS) and cause a lot of losses, ranging from loss of property, damage to houses, damage to rice fields, affected by illness to loss of life. The government and several social institutions provide compensation in the form of assistance such as refugee camps, food and medicines and building equipment for those whose homes have been damaged. But often the amount of compensation does not fully compensate for losses, so households must find ways to cover these losses. Insurance is the right solution because insurance can minimize the risk or loss experienced during a flood (Sidi et al., 2017; 2018).

Referring to Setiadi (2012), the escalation and intensity of the Citarum River flooding in Bandung regency have increased from year to year. It even happens repeatedly so that it gives an impact on the lives of people who live along the Citarum River Basin and its surroundings. The immediate impact felt by people's lives is damage to various buildings and the cessation of residential infrastructure functions. Setiadi conducts research aimed at identifying how floods hit settlements along the Citarum River banks, damage to various forms of buildings, and settlement infrastructure functions. The study was conducted using qualitative methods by utilizing a case study of the Citarum River flood in Bandung District in 2010. The research was conducted in residential areas in the Citarum riverbanks and surrounding areas, with the data collection methods of observation and interviews. The identification of floods in settlements along the banks of the Citarum River is described using an ecological perspective, identification of the effect of floods on building damage using the concept of damage mechanisms on building components, and identification of the impact of floods on infrastructure functions using the concept of public infrastructure. Descriptions of the research results are grouped into 3 categories according to the above identification.

Based on this description, the problem raised in this study is how to estimate the value of losses due to Citarum river floods and insurance products which are appropriate to the conditions of the residents of Baleendah based on economic conditions, residential zones, and the number of losses suffered due to river flooding Citarum.

2. Literature Review

2.1. Multiple Linear Regression

According to Sukono et al. (2016), Multiple Regression Analysis is the relationship between a dependent variable (Y) with two or more independent variables (X_k), $k \geq 2$. In general, the multiple linear regression model for the population is

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + \varepsilon_i, \ \ i = 1,2,\ldots,n \quad (1)$$

If formed in a matrix

$$\begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} = \begin{bmatrix} 1 X_{11} X_{21} \ldots X_{k1} \\ 1 X_{12} X_{22} \ldots X_{k2} \\ \vdots \ \vdots \ \ \vdots \ \ddots \ \vdots \\ 1 X_{1n} X_{2n} \cdots X_{kn} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_k \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \quad (2)$$

Where:

$\boldsymbol{Y}$: response matrix $n \times 1$

$\boldsymbol{X}$: independent variable matrix $n \times (k+1)$

$\boldsymbol{\beta}$: parameter matrix $(k+1) \times 1$

$\boldsymbol{\varepsilon}$: error matrix $n \times$

According to Sukono et al. (2016), the linear regression model of the population can be estimated from the sample, so the model changes to:

$$Y_i = b_0 + b_1 X_{1i} + b_2 X_{2i} + \cdots + b_k X_{ki} + e_i, \ \ i = 1,2,\ldots,n \quad (3)$$

with$b$ is an estimated β and e is an estimate of ε. So that equation (2) in the sample can be written as:

$$\boldsymbol{Y} = \boldsymbol{Xb} + \boldsymbol{e} \quad (4)$$

2.1.1. The Least-square Method of Multiple Regression Model

Referring to Sukono et al. (2016) and Sidi et al. (2017), the least-squares method is used to estimate the parameter values by minimizing the form of the least-squares error.

Suppose that the dependent variable Y depends on k the independent variables$X_1, X_2, \ldots, X_k$, then multiple linear regression can be estimated by the model:

$$\hat{Y}_i = b_0 + b_1X_{1i} + b_2X_{2i} + \cdots + b_kX_{ki} \quad (5)$$

If written in the form of a matrix becomes

$$\boldsymbol{\hat{Y}} = \boldsymbol{Xb} \quad (6)$$

Based on equation (6), the equation (4) can be changed to:

$$Y = \hat{Y} + e \quad (7a)$$

$$e = Y - \hat{Y} \quad (7b)$$

Making the value of $\sum {e_i}^2$ minimum, $\sum {e_i}^2$ must be partially derived from its parameters and equal to zero. So that the following results are obtained:

$$\sum_{i=1}^{n} Y_iX_{ki} = b_0\sum_{i=1}^{n} X_{ki} + b_1\sum_{i=1}^{n} X_{ki}X_{1i} + b_2\sum_{i=1}^{n} X_{ki}X_{2i} + \cdots + b_k\sum_{i=1}^{n} {X_{ki}}^2 \quad (8)$$

If it is written in matrix form it becomes:

$$\boldsymbol{b} = (\boldsymbol{X'X})^{-1}\boldsymbol{X'Y} \quad (9)$$

2.1.2. Significance Test of Multiple Linear Regression

This test is conducted to ascertain whether the regression model obtained is meaningful or not, with the intent of knowing the effect of the relationship that occurs between the dependent variable and the independent variable.

Referring to Dickson (2005) and Juric (2013), 2 stages of testing must be carried out in a significance test that is partially by the t-test and simultaneously by F-test.

Partial Significance Test with t-Test

$H_0: \beta_j = 0$ (jth independent variable does not contribute to changes in the dependent variable)
$H_1: \beta_j \neq 0$ (jth independent variable contributes to changes in the dependent variable)
Test statistics:

$$t_j = \frac{b_j}{Sb_j} \quad (10)$$

with the criteria: Reject H_0 if $|t| > t_{\frac{\alpha}{2}(n-k-1)}$; α is the level of significance

Simultaneous Significance Test with Test F

This test will explain the effect of the independent variables simultaneously on the dependent variable.
$H_0: \beta_1 = \beta_2 = \cdots = \beta_k = 0$ (independent variables have no simultaneous effect on changes in the dependent variable)
$H_1: \exists\beta_i \neq 0\ ; i = 1,2, \ldots, k$ (there are independent variables that influence changes in the dependent variable)

Table 1: ANOVA Table

Variance	Degree of freedom	Number of Squares	Average Squared	F
Regression	k	JKR	$\frac{JKR}{k}$	$\frac{RJKR}{RJKG}$
Error	$(n-k-1)$	JKG	$\frac{JKG}{(n-k-1)}$	
Total	$(n-1)$	JKT		

where: k is the number of independent variables entered into the model, JKR is the Number of Regression Squares, JKG is the Number of Error Squares, and JKT is the Total Squared Number, with the criteria: Reject H_0 if $F_H > F_{\alpha(k,n-k-1)}$.

2.1.3. Estimating the Multiple Linear Regression Model

Independent variables included in the model are variables that contribute to the dependent variable, while variables that do not contribute are excluded from the model. The parameter estimation calculation is repeated until the value is obtained by the conditions, where there are only independent variables that contribute to changes in the dependent variable entered into the model (Bortoluzzo et al., 2011).

2.1.4. Model Compatibility

According to Sidi et al. (2017), there are several types of correlation coefficients in statistics, including:

Partial Correlation Coefficient

$r_{YX_1.X_2X_3X_4\ldots X_k}$: the coefficient of partial correlation Y over X_1 where X_2,X_3,X_4,…,X_k the effect is constant. If it involves k independent variable called order correlation coefficient$(k-1)$, the formula is as follows:

$$r_{YX_i.X_1\ldots X_{(i)}\ldots X_k} = \frac{r_{YX_i.X_1\ldots X_{(i)}\ldots X_{(k-1)}} - \left(r_{YX_k.X_1\ldots X_{(i)}\ldots X_{(k-1)}}\right)\left(r_{X_iX_k.X_1\ldots X_{(i)}\ldots X_{(k-1)}}\right)}{\sqrt{\left(1-r^2{}_{YX_k.X_1\ldots X_{(i)}\ldots X_{(k-1)}}\right)\left(1-r^2{}_{X_iX_k.X_1\ldots X_{(i)}\ldots X_{(k-1)}}\right)}} \quad (11)$$

$X_{(i)}$means without the variable X_i

Looking for zero-order correlation coefficients (simple correlation coefficients), can be found using the following formula

$$r_{YX_i} = \frac{\sum yx_i}{\sqrt{\sum y^2 \sum x_i{}^2}} \quad (12)$$

The magnitude of the correlation coefficient, which is $-1 \leq r \leq +1$

To determine the closeness of the relationship between the independent variable and the dependent variable, the following criteria are used (Sarwono, 2006):

$r = 0$	: there is no correlation
$-0.25 \leq r < 0$or$0 < r \leq +0.25$	: correlation is very weak
$-0.5 \leq r < -0.25$or$+0.25 < r \leq +0.5$	: the correlation is quite strong
$-0.75 \leq r < -0.5$or$+0.5 < r \leq +0.75$	: a strong correlation
$-1 \leq r < -0.75$or$+0.75 < r \leq +1$	: correlation is very strong
$r = -1$or$r = +1$	: perfect correlation

Multiple Correlation Coefficient

The correlation coefficient between the dependent variable (Y) with $X_1, X_2, X_3, \ldots, X_k$ together is called the multiple correlation coefficient.

$$r_{Y.X_1,X_2,X_3,\ldots,X_k} = \sqrt{\frac{JKR}{JKT}} \quad (13)$$

The Coefficient of Determination

$$R^2 = \frac{JKR}{JKT} \tag{14a}$$

Or

$$R^2 = \frac{b_1 \sum x_1 y + b_2 \sum x_2 y + \cdots + b_k \sum x_k y}{\sum y^2} \tag{14b}$$

The maximum value of R^2 is 100%. The closer the value of R^2 to 100%, the more suitable the model represents the data held.

2.2. Flood Disaster Insurance Products

According to the Financial Services Authority (OJK) 2013, currently, general insurance companies have marketed flood risk insurance in Indonesia. Here are some insurance products that guarantee flood risk:

2.2.1. Property Insurance

This insurance guarantees property against the risk of fire, lightning, explosion, fall of an aircraft or falling objects from an aircraft and smoke which is guaranteed in the Indonesian Fire Insurance Standard Policy (PSAKI). When buying this insurance product, the insured can increase the need for flood risk coverage. By regulations stipulated by the OJK in Circular Letter Number: SE-06/D.05/2013, general insurance companies that market flood risk guarantees on property insurance are required to apply premium rates based on zoning.

2.2.2. Motor Vehicle Insurance

This insurance is a loss insurance product that protects the insured against the risk of using motorized vehicles. Now this insurance can add to flood risk insurance. By the regulations stipulated by the OJK in Circular Letter Number: SE-06/D.05/2013, general insurance companies that market flood risk insurance on motor vehicle insurance are required to apply premium rates based on the division of territory.

According to Bártováa & Hanzlíka (2015), of the two insurance products, there are still many residents who do not have insurance as risk protection against flooding. The biggest reason is that citizens cannot afford to pay large premiums and lack of knowledge about insurance. There is a flood disaster insurance model that has been developed by developed and developing countries that can be applied in Indonesia, namely flood disaster insurance cooperation between the government, insurance companies, and reinsurance companies. Some insurance that has been applied is flood disaster insurance from the US and Thailand governments.

2.2.3. National Flood Insurance Program (NFIP)

NFIP which is regulated by the Federal Emergency Management Agency (FEMA) provides insurance protection based on the level of risk of the insured asset. NFIP distinguishes insurance protection into 2 zones, namely:

- High-risk zone
- Medium and low-risk zones

2.2.4. National Catastrophe Insurance Fund (NCIF)

The Thai government developed a disaster insurance model called the National Catastrophe Insurance Fund (NCIF) with a premium rate of 5% and a maximum guarantee of 100,000 Bath. NCIF covers all-natural disasters such as floods, tsunamis, earthquakes, and hurricanes.

Assuming the conditions of the Baleendah citizens are the same as the conditions of the residents in Thailand, the premium rates used resemble NCIF premium rates, which are modeled as follows:

$$\text{Premium} = \frac{(\text{Average Income})-(\text{Average Expenses})}{\text{Insured Assets}} \times 100\% \times \text{Coverage Value} \qquad (15)$$

In this case, the coverage value will be determined based on the losses suffered by Baleendah residents who are estimated using multiple linear regression analysis methods (Mahmoudvand and Edalati, 2009; Nino & Paolo. 2010).

3. Materials

The data used in this study are secondary, namely Data on Flood Victims in Bandung District in 2010 obtained from the Regional Disaster Management Agency (BPBD) of Bandung Regency and primary data, namely the results of interviews with the Village Head of Baleendah Village. The calculation of the value of losses due to flooding of the Citarum river was carried out by multiple linear regression analysis with the dependent variable (Y) is the value of losses due to citarum river flooding and the independent variable (X) is the number of families suffering(X_1), the number of houses submerged(X_2), the number of damaged houses (X_3) and the number of damaged rice fields(X_4). Following is a data table of several flood victims villages in Bandung Regency in 2010.

Table 2: Data of several flood Victims villages in Bandung regency in 2010

No	Village	Families Suffer	Submerged Home	Damaged Home	Damaged Paddy	Loss (IDR)
1	Sukapura	0	0	9	0	150,000,000
2	Bojongmanggu	926	755	0	8	1,798,500
3	Rancatungku	747	649	45	20	124,000,000
4	Langonsari	570	450	0	0	525,000,000
5	Sukasari	2847	2400	1050	56	1,500,000,000
6	Rancamulya	722	678	68	8	1,100,000,000
7	Majalaya	3293	2516	88	21	216,500,000
8	Majasetra	766	648	0	3	20,450,000
9	Majakerta	1163	992	45	42	150,000,000
10	Sukamaju	552	552	47	8	270,000,000
11	Padaulun	110	92	0	0	110,000,000
12	Loa	0	0	6	0	4,000,000
13	Sukamantri	979	578	578	0	250,000,000
14	Banjarsari	322	156	80	4	575,000,000
15	Cilampeni	244	200	20	15	100,000,000
16	Sukamukti	261	100	0	5	200,000,000

4. Results and Discussion

4.1. Estimated Value of Losses Due to Citarum River Flooding

After conducting linear regression analysis, it is known that the independent variable contributes to the change in the dependent variable only the home damage variable X_3. Using the IBM SPSS 23 application, the following results are obtained:

$$Y = 202666304{,}538 + 1008883{,}903X_3 \quad (16)$$

Using equation (12), the correlation coefficient values are as follows:

$$r_{YX_3} = \frac{1{,}21373\text{E}+12}{\sqrt{(2.61796\text{E}+18)(1203047)}} = 0.683913 \text{ Strong correlation} \quad (17)$$

Using equation (14b), the correlation coefficient values are as follows:

$$R^2 = \frac{(1008883.903)(1.21373\text{E}+12)}{2{,}61796\text{E}+18} = 0.468 = 46.8\% \quad (18)$$

So 46.8% change in the value of losses (Y) is caused by damage to the house (X_3) the rest is caused by other variables not included in the model.

Based on data obtained from Data of Flood Victims in Bandung Regency in 2010, it is known that the amount of damage to houses that occurred in the village of Baleendah amounted to 3125, to obtain the value of losses due to flooding of the Citarum River amounting to 3,355,428,501 IDR.

Estimated loss value of Baleendah village is 3,355,428.501 IDR each time a flood occurs and the number of households that experience flooding is as much as 3,375 households, then the estimated value of losses for every household affected by the Citarum river flood are:

$$\frac{3{,}355{,}428{,}501 \text{ IDR}}{3.375} = 994{,}201 \text{ IDR per family}$$

According to the Village Head of Baleendah, the Village of Baleendah experiences flooding about three times a year so that it can be said that each household suffered a minimum loss of:

$$3 \times 994{,}201 \text{ IDR} = 2{,}982{,}603 \text{ IDR}$$

Bandung Regency BPBD has made flood disaster risk maps in an area into three zones namely low zone, medium zone, and high zone.

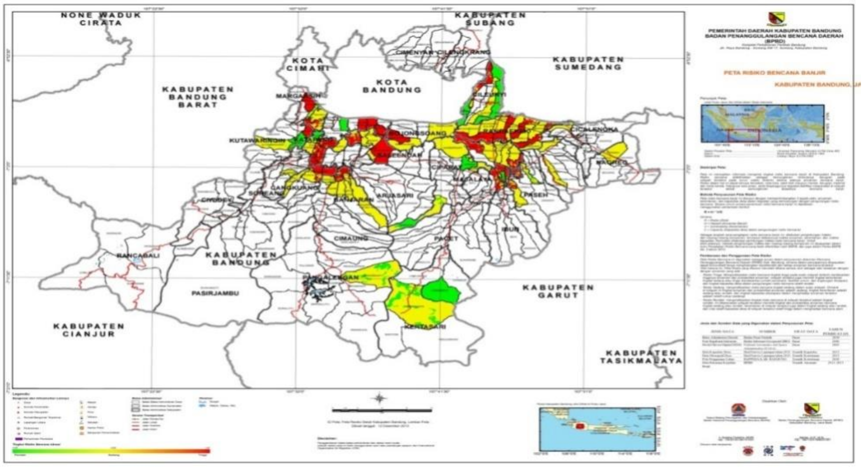

Figure 1: Bandung Regency flood risk map

In 2010, the government provided compensation to residents who suffered seven billion housing damage, which means that on average each household received compensation of:

$$\frac{7{,}000{,}000{,}000 \text{ IDR}}{3{,}375} = 2{,}074{,}074 \text{ IDR per family}$$

Compensation provided by the government can only compensate about 69.54% of the value of the losses suffered by households due to the CitarumRiver flooding each year. If it is assumed that compensation money provided by the government every time a flood is allocated to work with insurance and reinsurance companies, the insurance company only needs to bear the risk of:

$$2{,}982{,}603 \text{ IDR} - 2{,}074{,}074 \text{ IDR} = 908{,}529 \text{ IDR per family}$$

According to Olivia and Argo (2015), people are divided into four groups based on economic aspects.

The following four classes of people are seen from the amount of expenditure that is directly proportional to the amount of community income:

- Lower class
  Expenditures less than 700,000 IDR/month. His work is not permanent and his income is not stable. Awareness of risk management is still low so it is not interested in buying insurance.
- Lower Middle Class
  Expenditures 700,000 IDR/month - 1,500,000 IDR/month. Occupational work, but income is more stable than the lower class. Awareness of risk management is still low, but this group knows little about insurance and would be interested in buying insurance if the premiums are low.
- Upper Middle Class
  Expenditures of 1,500,000 IDR/month - 3,000,000 IDR/month. The work is fixed and the income is stable. Awareness of risk management is good, and already knows the benefits of insurance so they are interested in buying insurance.
- Upper Class
  Expenditures above3,000,000 IDR/month. Permanent employment so that income is stable, you can get income not only from one place. Awareness of risk management is very good so that this group on average already has insurance.

Based on the results of interviews with the Village Chief of the Baleendah Village, it is known that the data of Baleendah residents are as follows:

- Average income of 2,275,715 IDR/month or 27,308,580 IDR/year
- Average expenditure of 2,243,128 IDR/month or 26,917,536 IDR/year

Looking at the average expenditure of Baleendah residents, it can be concluded that Baleendah residents are included in the upper middle-class community so that a large premium can be sought as follows:

$$\text{Premium} = \frac{27.308.580 - 26.917.536}{100.000.000} \times 100\% = 0.391 \approx 0.4\% \text{ of insurance coverage every year.}$$

Based on these calculations, a premium of 0.4% per year is a large premium for residents living in Baleendah with a high zone and upper-middle class. Then it can be assumed that premium rates are by the zone of the region and according to community groups, namely as follows:

Table3: Premiums based on residential zones and community groups

Zone	Community Large	Premium (%)
High	Down	0.2
	Lower Intermediate	0.3

	High Intermediate	0.4
	On	0.5
Medium	Down	0.1
	Low Intermediate	0.2
	High Intermediate	0.3
	On	0.4
High	Down	0.1
	Low Intermediate	0.1
	High Intermediate	0.2
	On	0.3

Based on the existing OJK rules, the loading factor is one of the factors that become an insurance company reference in determining the amount of premium to be paid by the insured. So loading factors are added as a consideration in calculating the level of risk in determining premium rates. The following insurance schemes take into account residential zones, and community groups and add loading factors.

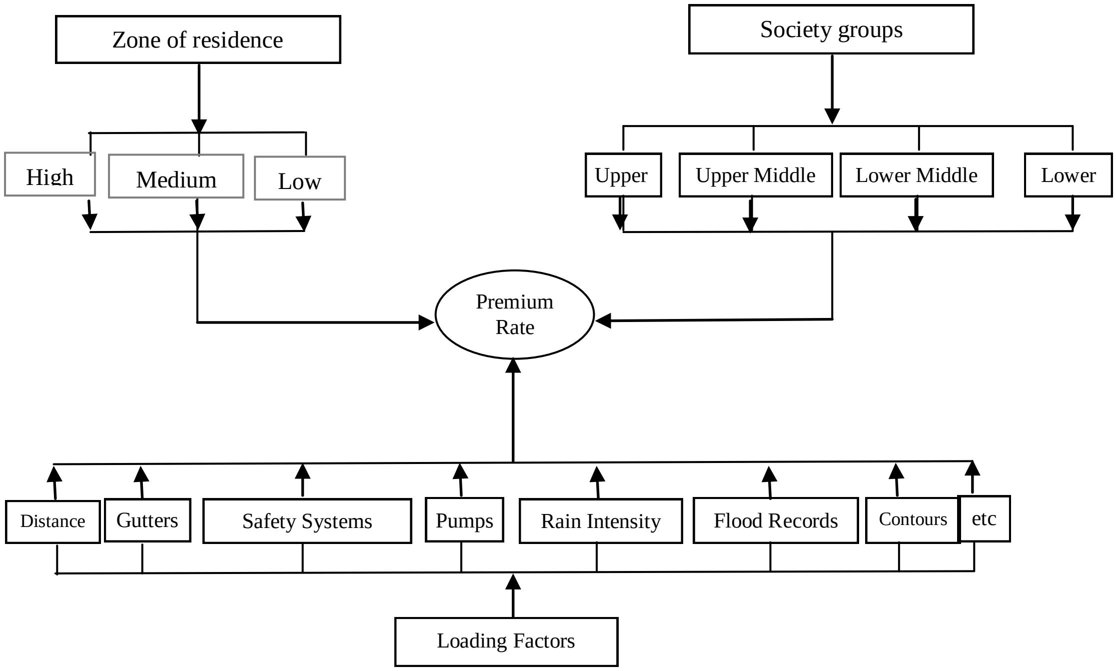

Figure 2. Flood disaster insurance scheme

The loading factor is determined by the underwriter of the insurance company, but in this study, we assume that the loading factor is 0.1%. Based on the calculation of the amount of premium for residents living in Baleendah which is a high zone and is a middle-upper class society is 0.4% so if the loading factor is added to 0.5% (Sukono et al., 2017; 2018).

The estimated value of the loss suffered by every household in Baleendah citizens every year is 2,982,603 IDR, so it is assumed that the coverage value is 3,000,000 IDR so that each household in Baleendah village must pay a premium rate of:

$$0.5\% \times 3{,}000{,}000 = 15{,}000 \text{ IDR per year}$$

If the conditions are different from the average household of Baleendah residents, then the following premium rates must be paid:

Tabel 4: Premium rates by zone, community group and loading factor

Zone	Large Community	Big Premium (%)	Premium (%)	Premium Rate (IDR)
High	Down	0.2+ loading factor	0.3	9,000
	Lower Intermediate	0.3+ loading factor	0.4	12,000
	Upper Intermediate	0.4+ loading factor	0.5	15,000
	Over	0.5+ loading factor	0.6	18,000
Medium	Down	0.1 + loading factor	0.2	6,000
	Lower Intermediate	0.2+ loading factor	0.3	9,000
	Upper Intermediate	0.3+ loading factor	0.4	12,000
	Over	0.4+ loading factor	0.5	15,000
Low	Down	0.1	0.1	3,000
	Lower Intermediate	0.1	0.1	3,000
	Upper Intermediate	0.2	0.2	6,000
	Over	0.3	0.3	9,000

Based on the rules as follows:

- This insurance is insurance for house damage caused by flooding, because the estimated value of the loss is only the amount of damage to the house.
- Claims are given to residents who do not receive monetary assistance from the government because this insurance product assumes that flood relief compensation money has been allocated for cooperation with insurance and reinsurance companies.
- Maximum claims received are three times a year because this product assumes that Baleendah experiences a maximum of three floods a year.
- This insurance product is a flood insurance product that only covers the risk of damage to homes and property insured with the condition that the flood inundation height follows the rules established by the OJK.

5. Conclusion

Based on the analysis and discussion that has been done, it can be concluded that: Based on the results of data processing using multiple linear regression analysis, it is known that only the damage variable of the house contributes to the variable value of losses due to flooding. Based on this model, it is known the estimated value of losses due to flooding of the Citarum river in the Baleendah village in 2010, namely: 2,982,603 IDR. Based on a mixed analysis consisting of community groups, residential zones, and loading factors from insurance companies, an estimate of the right insurance product for Baleendah residents is obtained with a premium rate of 0.5% of the annual sum insured. The amount of coverage is by the estimated value of the loss suffered by households every time a flood is assumed to be 3,000,000 IDR based on Citarum river flood data in the Baleendah sub-district in 2010 so that each household must pay a premium of 15,000 IDR/year.

References

Bártováa, H.&Karel, H. (2015).Foreign Approaches to Cover Uninsurable Risks Offering Opportunities for the Czech Insurance Market.*Procedia Economics and Finance,Issue 25,* 615-621.

Bortoluzzo, A.B., D. P. Claro, M. A. L. Caetano, R. & Artes. (2011). Estimating Total Claim Size in the Auto Insurance Industry: a Comparison between Tweedie and Zero-Adjusted Inverse Gaussian Distribution. *BAR, Curitiba*, 8 (1), 37-47.

Dickson, D.C. (2005). *Insurance Risk and Ruin.* Cambridge University Press.

Djuric, Z.(2013).Collective Risk Model in Non-Life Insurance, Economic Horizons, May-August 2013, 15(2) 167–175.

Setiadi, H.A. (2012). Identification of Building Damage and Infrastructure Function due to Citarum Flood in Bandung Regency. *Research Paper.* Pusat Litbang Permukiman, Balitbang, Kementerian Pekerjaan Umum, 51-64.

Mahmoudvand, R.,& Edalati, A. (2009). On the Distribution of Discounted Collective Risk Model. *Journal of Statist. Res. Iran* 6, 193-207.

Nino, S. &Paolo, C.G.(2010, March 7-12th). A Collective Risk Model for Claims Reserve Distribution. In*29th International Congress of Actuaries* (pp. 1-22). *ICA* 2010.

Sidi, P., Mamat, M., Sukono, & Supian, S. (2017). Supply and demand analysis for flood insurance by using logistic regression model: case study at Citarum watershed in South Bandung, West Java, Indonesia. *IOP Conf. Series: Materials Science and Engineering* 166 (2017) 012002.

Sidi, P., Mamat, M., Sukono, Supian, S., & Putra, A.S. 2018. Demand analysis of flood insurance by using logistic regression model and genetic algorithm. *IOP Conf. Series: Materials Science and Engineering*, 332 (2018), 012053.

Sukono, Nahar, J., Putri, F.T., Subiyanto, Mamat, M., & Supian, S. (2017). Estimation of Outstanding Claims Reserving Based on Inflation Risk on Car Insurance Companies by Using the Bootstrap Method. *Far East Journal of Mathematical Sciences* (*FJMS*), 102(4), 687-706.

Sukono, Hidayat, Y., Suhartono, Sutijo, B., Bon, A.T.B., & Supian, S. (2016). Indonesian Financial Data Modeling and Forecasting by Using Econometrics Time Series and Neural Network. *Global Journal of Pure and Applied Mathematics*, 12 (4) 3745–3757.

Sukono, Riaman, Lesmana, E., Wulandari, R., Napitupulu, H., & Supian, S. (2018). Model Estimation of Claim Risk and Premium for Motor Vehicle Insurance by Using Bayesian Method. *IOP Conf. Series:Materials Science and Engineering*,300(2018)012027.