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ESTIMATION OF SOCIETY ECONOMIC COSTS DUE TO FLOODS

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Abstract

This study aims to estimate the value of economic losses due to river floods and interpret the perceptions of the affected community on flood risk. This study uses a descriptive analysis method to look at people's perceptions of flooding and uses the actual market price approach, cost of time, and Human Capital Approach to measure how much the estimated value of losses due to flooding is in the Sembakung District area. Community economic losses are calculated based on direct losses and indirect losses. The results of this study show that the direct losses experienced by the community after the floods in January 2021 amounted to Rp.48,685,514.97. The indirect losses experienced by the community after the floods in January 2021 amounted to IDR 131,600,000. The total estimated Loss experienced by households is IDR 180,254,514.97. The community knows that their house is in a flood-prone area. As a result of the flood, some of the community's houses have become dirty with silt and garbage carried by the flood.

Keywords: *Economic Loss; Flood risk; Direct Costs; Indirect Costs; Externalities.*

JEL classification: *D6*

1. INTRODUCTION

The occurrence of a series of floods in a relatively short time and repeated every year requires greater efforts to anticipate them so that losses can be minimized (Ramkumar, Menier, Kumaraswamy, Santosh, Balasubramani, & James, 2019). Various government efforts that are structural (structural approach) in terms of flood prevention which only carry out physical development, have not been fully able to overcome the problem of flooding in Indonesia. (Gustini, Subandi, & Oktarina, 2021). So far, flood management has focused more on providing physical buildings to control floods to reduce the impact of disasters (Rustinsyah, Prasetyo, & Adib, 2021).

Losses due to floods that hit various cities and regions in Indonesia include (1) human victims; (2) loss of property; (3) damage to residents' houses; schools and social buildings, road infrastructure, bridges, airports, river embankments, irrigation networks, and other public infrastructure; (4) disruption of transportation, as well; (5) damage to the Loss of cultivation land such as rice fields, ponds, and fish ponds (BAPPENAS, 2020). Losses are calculated based on damage to household furniture, income, and increased medical expenses (Prihantini, 2020). The environmental impact assessment method has been practiced in many activities in various countries. Flood damage can be tangible and intangible (Andrade & Szlafsztein, 2018). Direct losses are divided into direct and indirect losses. Direct losses occur due to direct contact of flood water with property damage; the damage level is assumed to be the cost of property repairs. Indirect losses are losses caused by disruption of physical and economic relations, including Loss of production, Loss of Income, Loss of business, and delays in the transportation

of goods. Intangible losses include fear, anxiety, disruption, ill health, and Loss of life (Tabucanon, Kurisu, & Hanaki, 2021).

Floods are natural events that are difficult to avoid, so they can cause losses, not only material losses, such as Loss of property due to being swept away by water currents, damage to various facilities and infrastructure, and even Loss of life due to floods. In addition, inundation can affect environmental health and the emergence of various diseases, such as skin diseases, especially for people who live in densely populated areas. Therefore, to avoid losses due to the flood, floods must not only be overcome but must also be prevented before they occur.

Floods caused rice fields to be inundated so that they could not be harvested and destroyed housing and settlements, damaged community socio-economic service facilities and public infrastructure, and even claimed lives. Losses are even greater if economic and governmental activities are disrupted, even to the point where these activities stop. Even though community participation in flood management is very real, especially in emergency response activities, floods cause an additional burden on state finances, especially in rehabilitating and restoring the functions of damaged public infrastructure.

Flood is a natural phenomenon that often occurs on this earth. One of the main factors causing flooding is climate change (Abass, et al., 2021). Climate change is causing floods, but also causing an increase in the average temperature of the earth's surface, rising sea levels, and drought in various parts of the world. The incident caused an environmental impact that affected the social and economic life of the community (O'Sullivan, 2021).

Floods occurred in several locations in Sembakung District, including Roof Village, B. Bagu Village, Labuk Village, Pagar Village, Tujung Village, M. Bungkul Village, Luurkan Village, Tagul Village, Pelaju Village, and Tepian Village. Material losses were recorded, including 533 submerged houses, one submerged mosque, one submerged Posyandu, one submerged Pustu, 115 hectares of submerged paddy fields, and 2 hectares of submerged garden land, which impacted 2,752 people (BNPB, 2021). Flood events, directly and indirectly, impact social, economic, and environmental life (He, Thies, Avner, & Rentschler, 2021). It is necessary to carry out a flood loss analysis to measure the magnitude of the impact arising from the flood event (Sesunan, 2014). Natural disaster loss assessments provide important information to support decisions and policy development in natural disaster management and adaptation to climate change (Murieta, Galarraga, & Olazabal, 2021; Nofal & Lindt, 2021).

2. RESEARCH METHOD

This research is qualitative research with a descriptive approach. This study calculates the value of post-flood community economic losses, namely direct and indirect (Pilla, Gharbia, & Lyons, 2019). Direct losses include the cost of losing household furniture and the cost of repairing household equipment. Indirect losses include medical expenses, lost income, and additional costs (Mondor, Watson, Kornas, Bornbaum, Wodchis, & Rosella, 2020; Wang, Li, Yu, & Zhang, 2021).

Direct losses include the cost of losing furniture and repairing household equipment:

1) The cost of lost household furniture is household furniture that is damaged, and the household furniture is not normally used according to its function.
2) The cost of repairing losses is the number of the respondent's costs to repair household furniture damaged by flood waters.

Indirect losses include medical expenses and lost income.

1) Medical expenses are losses arising from the post-flood medical expenses seen from the expenditure of several costs by respondents for treatment due to diseases originating from flood waters.
2) Lost Income This Loss is seen in residents who lost their daily income due to the flood, which prevented them from working.

Furthermore, to obtain this information, this research uses a descriptive analysis method to look at people's perceptions of flooding. It uses the actual market price approach, cost of time, and Human Capital Approach to measure how much the estimated value of losses due to flooding is in the Sembakung District area.

Direct losses

This Loss is estimated using the actual market price approach, namely repair and loss costs (Filatova, 2014). Repair costs the respondent bears are calculated from the money spent to repair damaged components of the house and household appliances (Walliman, Baiche, Ogden, Tagg, & Escarameia, 2013). The average repair cost value can be seen in the following equation:

$$RPBK = \frac{\sum_{i=1}^{n} BPK_i}{n} \quad \text{.....(1)}$$

Description:

RPBK = Average Cost of repairs (Rp/KK)
BPKi = Repair costs for respondent-i (Rp)
n = number of respondents (KK)
i = Respondent-i (1,2,3,....,n)

Furthermore, the Cost of Loss is calculated based on the residual value of household equipment in the damage year by considering the depreciation cost per year. The property depreciation value per year is calculated using the straight-line method (Straight Line Method). The straight-line method results in the same amount of depreciation expense each year over the useful life of the item (El-Reedy , 2021). In this study, it is assumed that the residual value at the end of the year for the useful life of the goods is equal to zero. The depreciation value per year of household appliances is obtained by using the following equation:

$$NP = \frac{HB}{MM} \quad \text{.....(2)}$$

Description:

NP = Value of goods depreciation (Rp/year)
HB = Purchase price of goods (Rp)
MM = The useful life (year)

Respondent's household appliances are fixed assets whose benefits can be enjoyed for more than one year. The unit benefit of fixed assets is relatively more non-quantifiable (Rossi & Tinn, 2021). As a result, alternative indicators such as estimates of potential useful lives are used for fixed assets that do not have units of use that are not specifically quantified. In this study, the useful life of household appliances is adjusted to the physical characteristics of the equipment. The cost of lost household appliances is the residual value of household furniture in the year the damage occurred. The Cost of this Loss can be obtained from

equation 3. Then, the average Cost of Loss for respondents is obtained by dividing the total Cost of Loss by the number of respondents who suffered damage to household appliances. The average Cost of Loss can be seen in Equation 4 below.

$$BK = HB - AP \quad \text{.....(3)}$$

Description:
BK = Loss cost (Rp)
HB = Purchase price (Rp)
AP = Depreciation Accumulation (year)

$$RBK = \frac{\sum_{i=1}^{n} BK_i}{n} \quad \text{.....(4)}$$

Description:
RBK = Average Cost of Loss (Rp/KK)
BKi = cost of losing respondent-i (Rp)
n = number of respondents (KK)
i = Respondent-i (1,2,3,....,n)

Indirect Loss

Indirect losses include medical expenses, lost income, and additional costs (El-Reedy , 2021). Health loss is a number of costs incurred by respondents to treat their illnesses that come from flood inundation and Loss of Income of respondents due to not working due to illness (Sabermahani, Sirizi, Zolala, & Nazari, 2021). This Loss is estimated using the human capital approach (Human Capital Approach), namely health costs (Islam & Managi, 2021). Public health costs are obtained by adding up the Loss of Income due to illness with medical expenses. The following is the health cost equation:

$$C = P + MC \quad \text{.....(5)}$$

Description:
C = Health costs (Rp)
P = Lost income (Rp)
MC = cost of treatment (Rp)

The value of the respondent's lost income due to illness is calculated based on the cost of time. Cost of time is the Loss of respondents who do not come to work when they are sick. For respondents who work as employees, the Loss of working time is not a direct loss of Income (Vijayasingham, Jogulu, & Allotey, 2021). The cost of time for respondents who work as non-employees is the same as the Loss of Income per day. The formula is as follows:

$$P = \frac{\sum_{i=1}^{n} JHTK_i \, x \, PR_i}{n} \quad \text{.....(6)}$$

Description:
P = Loss of Income of respondents not coming to work (Rp/KK)
JHTKi = number of days not working due to illness of respondent-i (day)
PRi = income of respondent per day (Rp/day)
n = number of respondents (KK)
i = Respondent-i (1,2,3,....,n)

The medical expenses borne by the respondent were calculated from the amount of money spent on treatment, consisting of visits to doctors or puskesmas and/or drug purchase costs. The respondent's medical expenses are costs incurred by the respondent to treat illness or the respondent's family members who suffer from an illness which are the responsibility of the respondent (Islam & Managi, 2021). Medical expenses incurred by respondents can be seen in the following equation:

$$MC = \sum_{i=1}^{n}[BBi] \quad \text{.....(7)}$$

Description:
MC = Medical expenses per respondent (Rp/KK)
BBi = cost of medical treatment respondent-i (Rp)
n = number of respondents (KK)
I = Respondent-i (1,2,3,…..,n)

3. RESULTS AND DISCUSSION

3.1 General Description of the Research Object

Sembakung District is one of the areas in Nunukan Regency, North Kalimantan Province. The Sembakung Sub-District experienced regional expansion to become the Sembakung Sub-District and the Sembakung Atulai Sub-District. So that at this time, the administrative area of the Sembakung District Government consists of 10 Villages, with Roof Village as the Capital of the District. The area of the Sembakung Subdistrict after division is 1,764.94 km2 or 12.39 percent of the area of the Nunukan Regency.

The topography of the village area in Sembakung District includes plains with altitudes ranging from 2-165 m above sea level. Most of the access that can be passed to the villages in the Sembakung District is by a river. The river route is the main choice of the community in carrying out activities in and out of the village, including economic activities and managing population administration in the sub-district. Most of the village areas in Sembakung District are located on the edge of the forest, and only a few villages are located inside and outside the forest area. There are seven villages on the edge of the forest, two villages outside the forest, and one village inside the forest. Due to the location of the village area, which is in direct contact with the forest, the forest in Sembakung District has an important role in people's lives.

The level of village development in Sembakung District is still slow. This could be due to the location of the villages in Sembakung District. Most of them are located in forest areas. So to get information about science and technological progress is still very limited. In grouping villages based on village development, almost all villages in Sembakung District are still classified as self-help villages, namely nine villages. And only one village is classified as a Self-Working Village (BPS, Kecamatan Sembakung Dalam Angka 2019).

Table 1
Characteristics of Respondents

Respondent	Total	Presents (%)
Education		
SD/Sederajad	12	40

Respondent	Total	Presents (%)
SLTP/Sederajad	6	20
SLTA/Sederajad	6	20
Akademi/Diploma	3	10
Perguruan Tinggi	2	6,66
Pasca Sarjana	1	3,33
Job		
Petani	16	53,33
IRT	3	10
Pedagang/wiraswasta	4	13,33
PNS	3	10
Honorer	4	13,33
Age		
20-30	11	36,66
31-40	15	50
> 41	4	13,33
Residence		
Asli	26	86,66
Pendatang	4	13,33
Status of residence		
Milik sendiri	26	86,66
Menumpang	2	6,66
Berpindah-pindah	2	6.66
Sewa	-	-
Flood Affected Intensity		
1 Kali	3	10
2 Kali	3	10
3 Kali	5	16,67
>4 kali	19	63,33
Length of stay		
1-10 tahun	8	26,66
11-20 tahun	18	60
21-30 tahun	2	6,66
31-40 tahun	2	6,66

Source: Primary Data, 2021.

Estimation of Post-Flood Community Economic Losses

Community economic losses in this study only calculate tangible losses. Tangible losses are divided into two, namely direct losses and indirect losses. Information on direct (direct) and indirect (indirect) losses was obtained through open interviews and direct observation of the communities around the settlements. This direct (direct) and indirect (indirect) Loss is only calculated in 2021 because the floods that occur each year have different levels of flood severity.

Direct Loss

Cost of Loss

Lost household furniture and the amount varied for each respondent, including cupboards, basins, mattresses, stoves, fans, televisions, dish racks, buckets, water-resistant machines, refrigerators, carpets, chairs, plates, glasses, spoons, washing machines, and pots. The approach to the cost of losing household furniture uses the annual depreciation of household furniture using the straight-line method. Determination of economic age is adjusted from the characteristics of an item owned by the respondent.

Table 2
Total Loss of Household Furniture

Description	Total
Loss cost (Rp)	Rp.15.966.003
Respondent	23
Respondents who did not lose furniture	7
The average cost of Loss (Rp/Respondent)	Rp.694.174,03
Respondents	30
Total Cost of Loss	Rp.20.825.220,97

Source: Primary Data, 2021

Cost of Repairs

Respondents need to repair household components and household appliances so that household components and household appliances can function again. The cost of repairing household components and household appliances is calculated based on the respondents who made the repairs.

Table 3
Total Repair of Household Components and Household Appliances

Description	House component	Household appliances
Repair costs (Rp)	Rp.6.450.000	Rp.6.450.000
Respondent	12	17
Respondents who did not incur repair costs	18	13
Improvement average	Rp.537.500	Rp.391.176
Respondent	30	30
The total cost of repairs (Rp)	Rp.16.125.000	Rp.11.735.294
Total	RP.27.860.294	

Source: Primary Data, 2021

Total Direct Loss

Based on calculations, the total direct losses experienced by the community after the floods in January 2021 amounted to Rp 48,685,514.97, which can be seen in Table 4.

Table 4
Total Direct Loss

Description	Total
Total Loss of Household Furniture	Rp.20.825.220,97
Repair of Household Components and Household Appliances	Rp. 27.860.294
Total	Rp. 48.685.514,97

Source: Primary Data, 2021

Indirect Loss

Cost of treatment

The medical expenses borne by the respondent were calculated from the amount of money spent on treatment, consisting of visits to doctors or puskesmas and/or drug purchase costs. The respondent's medical expenses are costs incurred by the respondent to treat illness or the respondent's family members who suffer from an illness which are the responsibility of the respondent.

Table 5
Total Cost of Treatment

Description	Total
Cost of treatment (Rp)	Rp.1.510.000,00
Respondent	24
Respondents who did not incur medical expenses	6
The average cost of treatment	Rp.62.916,67
Respondent	30
Total	Rp.1.887.500,00

Source: Primary Data, 2021

Lost Income

During the flood, the work activities of the local community stopped. This was due to the severe flood heights. In this study, the Loss of Income in question is household income. This is because employees have a fixed salary, so it does not reduce income even though they are not working (including on work leave).

Table 6
Total Cost of Lost Revenue

Description	Total
Lost Income	Rp 86.475.000,00
Respondent	20
Respondents who did not lose Income	10
Average lost income	Rp 4.323.750,00
Respondent	30
Total	Rp 129.712.500,00

Source: Primary Data, 2021

Total Indirect Losses

Based on the calculations, the total direct (indirect) losses experienced by the community after the floods in January 2021 amounted to IDR 32,510,000 can be seen in Table 7.

Table 7
Total Indirect Losses

Description	Total
Total Cost of Treatment	Rp. 1.887.500
Total Lost Income	Rp 129.712.500
Total	Rp 131.600.000

Source: Primary Data, 2021

Total Economic Losses experienced by the community

Based on calculations, the total economic losses experienced by the post-flood community per flood period in 2021 amounted to Rp.81,195,514.97 can be seen in Table 8

Table 8
Total economic Loss

Description	Total
Direct Loss	Rp. 48.685.514,97
Indirect Loss	Rp 131.600.000
Total	Rp 180.254.514,97

Source: Primary Data, 2021

Community Perceptions Affected by Floods

Several questions were given to flood-affected respondents, with the aim of identifying the extent of information that is known to the public about the impact of flooding. Question items are presented in table 9.

Table 9
Question Items Perceptions of Affected Communities

Question item
1) Do you know that the house where you live is in a flood-prone area?
2) Does the flood affect the condition of your residence and the quality of the environment around you?
3) Did the silt that was carried away by the flood clog the drains or sewers, causing the environment around your house to become dirty?
4) Does the garbage carried by the flood make the condition of your house and the environment around where you live dirty?
5) Is it difficult to clean up the silt that was carried away by the flood, making the house you live in and the environment around it dirty?
6) Did the silt and garbage carried by the flood damage public facilities in your neighborhood?
7) Does the silt carried by the flood cost you extra to clean up your

Question item
surroundings and your house?
8) Were your MCK activities disrupted after the flood?
9) Will the dirty surroundings after the flood increase community participation in mutual cooperation?
10) Does the flood make you feel uncomfortable when doing work?
11) After the flood receded, did you feel uncomfortable doing activities at home?
12) Does the flood cause mental stress or stress for you because the flood is gradual?
13) Does the flood raise fears of crime against property that you own or decrease security in your home environment?

Source: Primary Data, 2021

3.2 Discussion

Based on calculations, the Cost of Loss was obtained from the total number of respondents who experienced the Loss of only household furniture, amounting to Rp.15.966.003,00. The total cost was divided by 23 respondents who experienced damage and seven people who did not experience Loss of household furniture (Fuerst & Warren-Myers, 2021). Furniture so that the average cost of losing furniture is Rp 694.174,03/respondent. The proportion of people who experienced Loss of household furniture was 76.67% of the total sample of 30 respondents, so 23 respondents were obtained. The total cost of losing household furniture experienced by the community per flood period in January 2021 amounted to Rp 20.825.220,97 can be seen in Table 2.

Based on the calculation results, the total costs and average costs incurred by respondents to repair damaged house components amounted to Rp.6.450.000,00, 12 respondents and Rp.16.125.000,00 the cost of repairing household components. Then for damage to household appliances, the total costs and average costs incurred by respondents to repair damaged household appliances were 17 respondents amounting to Rp.537.500,00, Rp.391.176,00 per respondent, and the total cost of repairing household appliances was Rp. 11.735.294.00.

The total cost of repairing damage to house components and household equipment borne by the community, with a total of 30 respondents, due to the 2021 flood is Rp 27.860.294,00 (Table 3).

The total cost of losing household furniture experienced by the community per flood period in January 2021 was Rp 20.825.220,97, and the total cost of repairing damage to home components and household appliances borne by the community with a total of 30 households due to the 2021 flood, it was Rp. 27.860.294,00. So that the total direct Loss due to flooding in Sembakung District is Rp.48.685.514,97. The total costs are presented in table 4.

Diseases caused by floods such as itching and diarrhea, water fleas, respiratory tract, coughing, and diarrhea (Niemeyer-Corbellini, et al., 2017; Sajid & Bevis, 2021; Aboyitungiye & Gravitiani, 2021). In this study, there were 24 respondents who contracted the disease and paid for medical treatment at a doctor or clinic. The remaining six

did not pay for treatment. The average cost of treatment for each respondent is Rp 62.916,67/respondent. Total community losses for medical expenses experienced by the community per flood period in January 2021 amounted to Rp 1.887.500,00 can be seen in Table 5.

In this study, there were 24 respondents who contracted the disease and paid for medical treatment at a doctor or clinic. The remaining six did not pay for treatment. The average cost of treatment for each respondent is Rp 62.916,67/respondent. Total community losses for medical expenses experienced by the community per flood period in January 2021 amounted to Rp 1.887.500,00 can be seen in Table 5.

Total community losses for medical expenses experienced by the community per flood period in January 2021 amounted to Rp 1.887.500,00 and Rp 129.712.500,00 for the total lost income. Those who did not have lost income were ten respondents per flood period in January 2021 of Rp. 129.712.500,00. So that the total indirect losses due to flooding in the Sembakung District are Rp 131.600.000,00.

The house where they live is in a flood-prone area. This is in accordance with the results of the questionnaire; as much as 96.67% of respondents already know that the house where they live is in a flood-prone area, while only one respondent, or 3.33%, does not know the house where they live is in a prone area flood. Floods affected living conditions and environmental quality to become dirty. 19 or 63.33% of respondents who experienced living conditions and environmental quality became dirty, and 11 respondents who did not experience dirty living conditions and environment.

Mud deposits carried by floods clog drains or gutters. Sixteen respondents answered that silt deposits clogged water or gutters, and 14 respondents answered no. Garbage carried by the flood made the condition of the house and the environment around the residence dirty. As many as 13 respondents, or 43.33%, experienced dirty house conditions due to flood-borne waste, while 17 respondents did not experience dirty house conditions due to flood-borne waste. As many as 13 respondents answered that the silt and garbage carried by the flood damaged public facilities in their neighborhood, and 17 respondents responded that the mud and garbage carried by the flood did not damage public facilities in their neighborhood. MCK activities were disrupted after the flood. Fourteen respondents experienced MCK activities that were disrupted due to flooding, and 16 respondents did not experience MCK activities after the flood (Christian, Dovie, Akpalu, & Codjoe, 2021).

The dirty surrounding environment after the flood increased the participation of residents in working together (Maryati, Eraku, & Kasim, 2019), 19 People answered that the flood increased the participation of residents in carrying out mutual cooperation. Floods disturb the feeling of discomfort in doing work. As many as 24 respondents answered that flooding makes them uncomfortable in doing work. A total of 22 respondents felt that after the flood receded, they felt uncomfortable doing activities at home. There were 14 respondents who felt that flooding caused mental stress or stress due to gradual flooding (Meltzer, Dame, & Gabrysch, 2021). Meanwhile, as many 12 respondents felt that flooding raised fears of crime against property owned or decreased security in the home environment (Zinda, Williams, Kay, & Alexander, 2021).

It can be concluded that the community knows that the house they live in is in a flood-prone area. As a result of flooding, some of the community's houses become dirty with silt and garbage carried by the flood. Many people's jobs were disrupted after the flood, and the community also felt uncomfortable with the condition of their houses after the flood. As

a result, many people felt stressed due to the gradual flooding, and the flood also raised fears of crime against their property.

4. CONCLUSIONS

Based on the research, the results showed that the direct losses experienced by the community after the floods in January 2021 amounted to Rp. 48.685.514,97, the indirect losses experienced by the community after the floods in January 2021 amounted to Rp.32.510.000, and the total economic Loss to the community was calculated based on direct (direct) and indirect (indirect) losses. The total estimated Loss experienced by households is Rp.81.195.514,97.

Meanwhile, based on the results of interviews related to the perceptions of the affected people, they know that the house they live in is a flood-prone area. Many people's jobs were disrupted after the flood, and the community also felt uncomfortable with the condition of their houses after the flood; as a result, many people felt stressed due to the gradual flooding, and the flood also raised fears of criminality against a property. However, local people are reluctant to move to a better location. The reason, do not have the cost or because they feel they have a bond with the current location of residence.

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