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POST-FLOOD DISASTER RECOVERY PLAN THROUGH ECONOMIC VALUATION IN THE AREA AROUND LAKE TEMPE, WAJO REGENCY

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Abstract

This area is located in Tempe sub-district, Wajo Regency. The vulnerability of the area around Lake Tempe to flooding, especially during the rainy season, is also stated in the Wajo Regency Regional Spatial Planning and the Indonesian Disaster Risk Index book by the National Disaster Management Agency. Continuous flooding can cause large economic losses in the Settlements sector and road infrastructure in 3 sub-districts in Wajo Regency. This research aims to produce estimates of the value of damage and losses due to flooding as a form of implementing post-disaster recovery plans and realizing disaster mitigation-based regional planning and development. The method used in this research is the DALA (Damage and Loss Assessment) method combined with spatial analysis using ArcMap 10.8 software. The results of this research produce estimates of the value of losses in the 2 affected sectors, namely the settlements sector with a value of damage and loss worth IDR 225.607.883.500 and the value of damage and loss in the road infrastructure sector worth IDR 1.122. 215.826. The total value of damage and losses experienced by the two sectors in the 3 affected sub-districts was IDR 226.730.099.326 with the largest estimated value of damage and losses in the settlements sector.

Keywords: Post-disaster recovery, Mitigation-based Regional, Value of Damage.

INTRODUCTION

Floods are natural disasters that can cause problems both physically and socially, so serious attention is needed. The problem of flooding can have an impact on several elements such as damage to agricultural land, settlements, transportation facilities, infrastructure, and can even claim human lives and other asset [1].

Wajo Regency is known as an area that has rich water resources, namely Lake Tempe. Lake Tempe is one of the lakes that has quite large potential in South Sulawesi Province. Administratively, Lake Tempe is also located in 3 different district administrative areas with regional divisions, namely Wajo Regency (54.6%), Sidrap Regency (10.8%) and Soppeng Regency (34.6%) [2]. There is a problem that often occurs around Lake Tempe, namely flooding caused by the overflow of water from Lake Tempe due to the Walanae River, Bila River, Belokka River, Batu-batu River and Lawo River which carry sedimentation from upstream areas and then empty into Lake Tempe. Floods, which occur almost every year, cause material and non-material losses for the community, especially those in the area around Lake Tempe.

The area's vulnerability to flooding is also included in the Wajo Regency RTRW (Wajo Regency Spatial Planning Plan for 2023-2042) which determines this area to be one of the areas in Indonesia that is prone to flooding during the rainy season, especially in Tempe District. Flood events cannot be prevented, but can only be controlled and reduced, such as the resulting losses. Because it comes relatively quickly, to reduce

losses due to this disaster it is necessary to prepare for fast, precise and integrated treatment.

The floods that occurred in the area around Lake Tempe, especially Tempe District, Wajo Regency, had an impact on several sectors such as agriculture, settlements and infrastructure sectors such as roads and bridges. The inundation that occurs as a result of these floods usually lasts a long time and of course causes damage and loss to the affected sectors so that it can be said that the flooding phenomenon that occurred in Wajo Regency is a natural disaster that can result in loss of life, property (economic) and objects.

The links between flood disaster and economic systems, have become another pillar of consideration for sustainable development. Floods, however, cannot be totally prevented but their devastating impacts can surely be significantly minimized if advance warning of the event is available [3]. Because it comes relatively quickly, to reduce losses due to this disaster it is necessary to prepare for fast, precise and integrated treatment. Based on the Post-Disaster Needs Assessment (JITU PASNA), Post-Disaster Needs Assessment (PDNA), Human Recovery Needs Assessment (HRNA), and Head of BNPB Regulation Number 15 of 2011, economic valuation calculations are the first step that must be taken to implement post-disaster recovery and reconstruction.

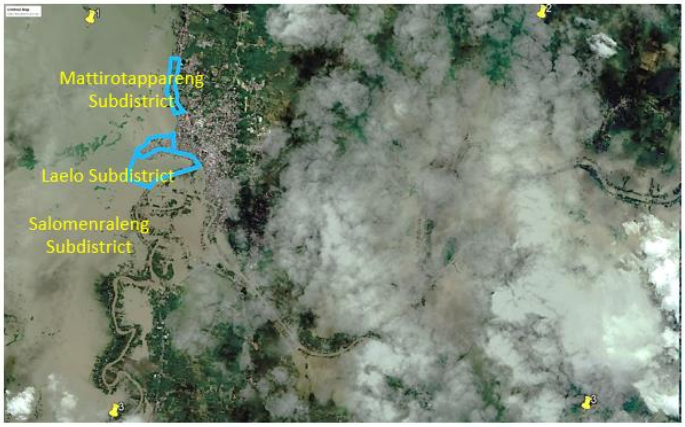
Post-disaster economic valuation calculations are closely related to regional development and planning from a disaster mitigation perspective. In order to recover the condition of the community from the impact of a disaster, the government is obliged to allocate an adequate disaster management budget from the APBN in the form of ready-to-use funds. However, to be able to determine the amount of funds needed for a disaster, information is needed regarding the condition of damage, estimates, and the value of losses (loss estimates) resulting from the disaster [4].

Based on this, the author is interested in conducting research related to calculating post-flood disaster economic valuations in the area around Lake Tempe, Wajo Regency as a form of post-flood disaster recovery plan. Apart from that, this research also aims to assist local governments in realizing sustainable development which is able to increase the potential of individuals and communities in improving their situation after a disaster.

RESEARCH METHOD

Research Location

The location of this research is in three sub-districts in Tempe District, Wajo Regency, South Sulawesi Province. These three sub-districts are seriously affected areas, especially in the residential areas of these sub-districts, namely Mattirotappareng Subdistrict, Laelo Subdistrict, and Salomenraleng Subdistrict. These three sub-districts have become sub-districts prone to flooding, especially in the western part of the sub-district (the part near the lake). This sub-district has a low contour in the West and slightly high in the East shown in Figure 1 below.



(Source: Wajo Regency Regional Disaster Management Agency, 2023)

Figure 1: Map of Flood Locations and Conditions in Wajo Regency

This research uses two types of approaches, namely qualitative and quantitative approaches. A qualitative approach is carried out with descriptive analysis. Descriptive Analysis is an analysis method by looking at the state of the research object through descriptions, understanding or explanations of measurable or non-measurable analyzes (DQLab, 2021). Descriptive research is used to describe, or provide a clear picture of the variables studied (sectors affected by flooding). In this approach the data used is secondary data. Secondary data is a type of data obtained from government agencies or work units (South Sulawesi Province Meteorology and Geophysics Agency, Wajo Regency Regional Disaster Management Agency, Wajo Regency Regional Development Planning, Research and Development Agency, and Wajo Regency Public Works and Public Housing Service.) as well as other sources related to research. The data in question includes:

- Textual data related to rainfall in Wajo Regency
- Spatial data: data on administrative boundaries of the research location, land use in Wajo Regency, data related to river watersheds, SHP data for the Wajo Regency Regional Regulations (Regional Spatial Plan) for 2023-2042.
- Tabular and textual data regarding residential locations affected by flooding.
- Textual data on the location of settlements and road infrastructure affected by flooding.

Meanwhile, the quantitative approach in this research was carried out with spatial main component analysis, namely analyzing damage to each sector affected by the flood disaster and tabular analysis for calculating nominal losses using the DALA (Damage and Loss Assessment) method while still paying attention to the values of physical damage caused post-flood disaster such as damage to capital and stocks (industrial factories, agricultural plants, settlements, warehouses, etc.), economic infrastructure (roads, electricity systems, drinking water, etc.), and social infrastructure (health facilities, schools, etc.) . This kind of loss is sometimes the greatest value. To evaluate the value of losses like this, economic principles are generally used, for example estimating the economic value of resources lost [4]. In this approach the data used is primary data.

Primary data is a type of data obtained through field surveys and interviews using worksheets, these data are:

- Data from checking the research location is the condition of damage to several sectors that were affected and experienced damage due to flooding, such as the housing sector and the road infrastructure sector.
- Data from interviews with several related agencies such as: Regional Disaster Management Agency Wajo Regency, Regional Development Planning, Research and Development Agency Wajo Regency, Department of Public Works and Public Housing Wajo Regency, Service and related stakeholders such as the village head, village head, and the community living in the research location. This aims to obtain a real picture of the symptoms occurring in the field which can support objective data collection.

ANALYSIS METHOD

Spatial Analysis in GIS (Geographic Information System)

Geographic information systems is a computer based information system used to process and store geographic data [5]. Geographic information systems are designed to work with spatially referenced or geographically coordinated data and have special capabilities for handling spatially referenced data. In processing data analysis, spatial can be used to provide solutions to spatial problems and help carry out mathematical calculations in analyzing spatial study material with unique visualization, namely mapping. The spatial analysis process includes activities to create buffers around points, lines and areas (polygons), analyzing maps with points, lines and areas with an overlay process using slice, union, identity, clear and clip methods [6]. Spatial Analysis in this research is used to calculate the area of flood inundation, the number of buildings in the residential sector, calculate the length of roads affected in the infrastructure sector, and map the locations of sectors affected by flooding. The types of spatial analysis include the following in this research are:

1. Overlay

   Overlays are an important part of spatial analysis. Overlays can combine several spatial elements into new spatial elements. In other words, overlay can be defined as a spatial operation that combines different geographic layers to obtain new information. Overlays can be done on vector or raster data.

2. Changing Spatial Elements

   When processing GIS data, you often have to combine spatial elements. This combination can use spatial analysis, namely union, merge or combine. This merger can make several spatial elements into just one spatial element without changing some of the spatial elements being combined [7].

3. Calculate Geometry

   Calculate Geometry is a process in ArcMap 10.8 software that is commonly used to carry out spatial analysis in geographic information systems. This section functions to calculate distance or area accurately, see elevations, and calculate lines of sight to maximize precision [8].

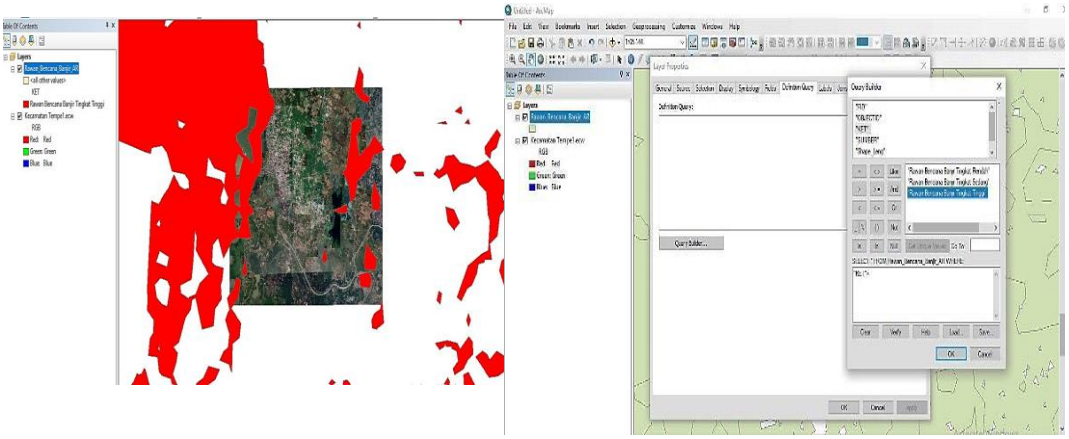


Figure 2: The Flood Impact Analysis Process Using Arcgis 10.8

RESULTS AND DISCUSSION

Settlements Sector Affected By Damage And Loss

Based on the results of analysis and data inventory carried out through field surveys, the total damage to the organizational sector in the 3 affected sub-districts was 1,397 units of building submerged due to the flood disaster that occurred. These buildings consist of housing or residences, public service facilities such as: mosques, schools, sub-district offices, sub-district health facilities, savings and loan cooperatives, and fish laying places.

This is a comparison of the damage and loss valuees at each location ordered from largest to lowest shown in Table 3 and Figure 2. The affected location that experienced the greatest loss among other sub-districts was Salomenraleng Subdistrict with a total damage and loss value of IDR 90.923.188.300, then followed by Laelo Subdistrict with a damage loss value of IDR 74.228.021.700 and in last place was Mattirotappareng Subdistrict with a damage value the lowest is IDR 60.456.673.500. Total estimated value of losses experienced by all sub-districts affected by flooding in this sector is IDR 225.607.883.500.

Table 1: Recapitulation Table of Damage and Loss Values in The Settlement Sector

No.	Sub District	Damage Estimaton (IDR)	Loss Estimation (IDR)	Total Damage and Loss (IDR)
1.	Mattirotappareng	26.343.973.500	34.112.700.000	60.456.673.500
2.	Laelo	17.670.521.700	56.557.500.000	74.228.021.700
3.	Salomenraleng	36.492.288.300	54.430.900.000	90.923.188.300
TOTAL				**225.607.883.500**

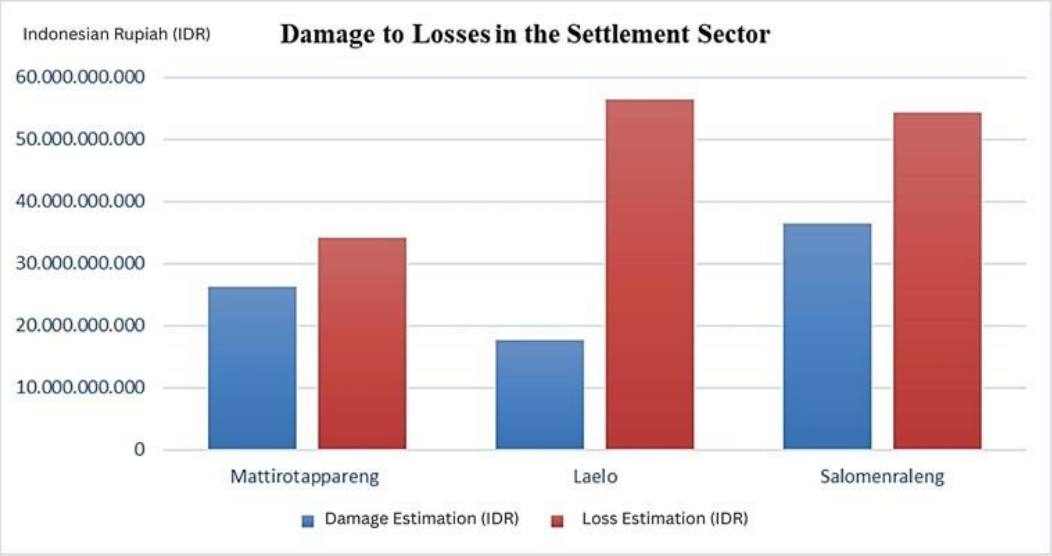


Figure 3: Graph of Estimated Value of Damage and Losses to the Settlement Sector

This difference in value can occur because the calculation process uses several different variables such as: the level of damage to the building, the area of the house/building, and the unit price of the building. The values of these variables also vary, thus influencing differences in results and calculation values. This is also supported by (Perka BNPB No. 15 of 2011) which states that damage to each sector and sub-sector, such as buildings or supporting infrastructure, has a loss value and level of damage that is different from one another other.

The condition of damage building in the residential sector in the three sub-districts is different, in Mattirotappareng Subdistrict there is 1 residential building in a heavily damaged condition which is about to collapse, while in Laelo Subdistrict there are 3 residential buildings in a heavily damaged condition which have collapsed and in Salomenraleng Subdistrict there are none residential buildings are in a condition of serious damage because there are many permanent types of houses with concrete material that are much stronger even though they are submerged in current floods or submerged in floods for a long time shown in Figure 8 below.

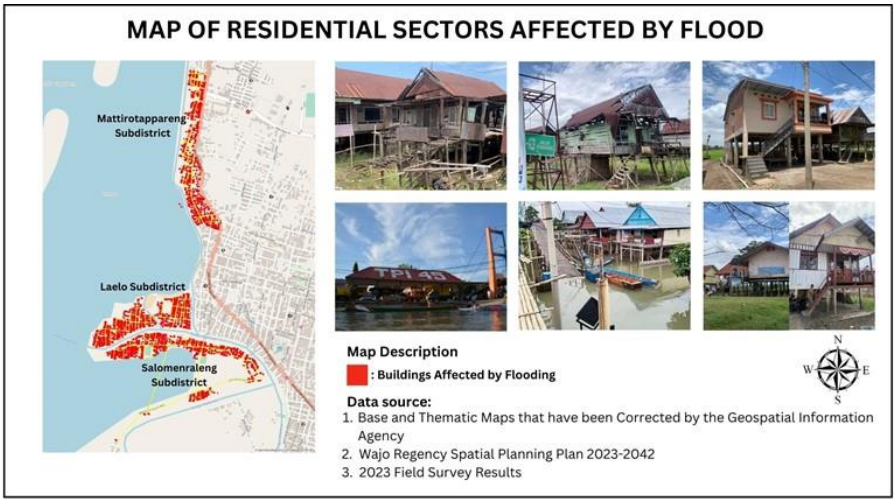


Figure 4: Map Of Residential Sectors Affected By Flood

Road Infrastructure Sector Affected By Damage And Loss

Based on the results of analysis and inventory of data carried out through field surveys, the total damage to the road infrastructure sector in the 3 affected sub-districts was 16.44 km with a road type classification, namely local roads and neighborhood roads. The total length of local roads affected is 4.16 km and neighborhood roads are 12.28 km.

On the image below, you can see the comparison of the value of damage and losses in the road infrastructure sector shown in Table 2 and Figure10. The damage and loss values at each location are added up to obtain the damage and loss results from largest to lowest. The affected location that experienced the greatest losses in the road infrastructure sector was Mattirotappareng Subdistrict with a total value of damage and losses amounting to IDR 778.406.049, followed by Salomenraleng Subdistrict with a damage and loss value of IDR 198.011.330, and in last place was Laelo Subdistrict with damage values and losses the lowest is IDR 145.798.446. The total estimated value of losses experienced by all sub-districts affected by flooding for this sector is IDR 1.122.215.826. From the estimated loss values in the residential sector and the road infrastructure sector, tables and diagrams were created to see the comparison of the estimated loss values for each sector.

Table 2: Recapitulation Table of Damage and Loss Values in The Road Infrastructure Sector

No.	Sub District	Road Type	Damage Estimation (IDR)	Loss Estimation (IDR)	Total Damage and Loss (IDR)
1.	Mattirotappareng	Local Road	389.235.728,60	7.550.000	778.406.049
		Neighborhood Road	381.620.320		
2.	Laelo	Local Road	75.889.270,48	49.050.900	145.798.446
		Neighborhood Road	20.858.276		
3.	Salomenraleng	Local Road	120.094.586,60	45.550.000	198.011.330
		Neighborhood Road	32.366.744		
TOTAL					**1.122.215.826**

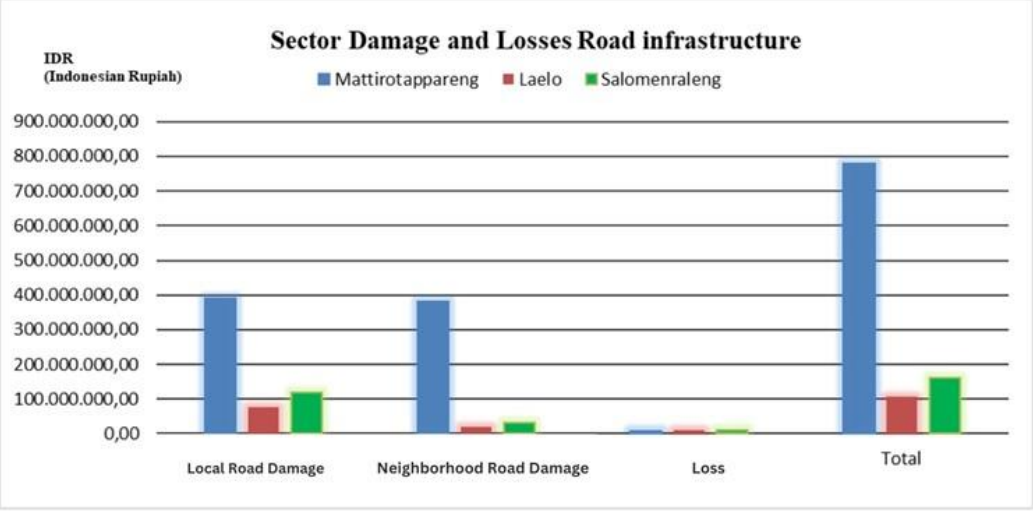


Figure 5: Graph of Estimated Value of Damage and Losses to the Road Infrastructure Sector

Similar to the residential sector, this sector also has different damage and loss values because the calculation process uses several different variables such as: the level of damage, the length of the road affected, and the price of the replacement unit (road) which is different for each road type classification. This is also supported by (Perka BNPB No. 15 of 2011) which states that damage to each sector and sub-sector, such as buildings or supporting infrastructure, has a loss value and level of damage that is different from one another.

The condition of damage roads in the three sub-districtsthat is all sub-districts' damage conditions are at the level of low damage. This condition is characterized by crack lines at several points on the road, small holes, and eroded parts of the road shown in Figure 11. Road materials in the three affected sub-districts consist of asphalt roads, concrete roads and there are a small portion which are still dirt roads with a little gravel on the neighborhood roads.

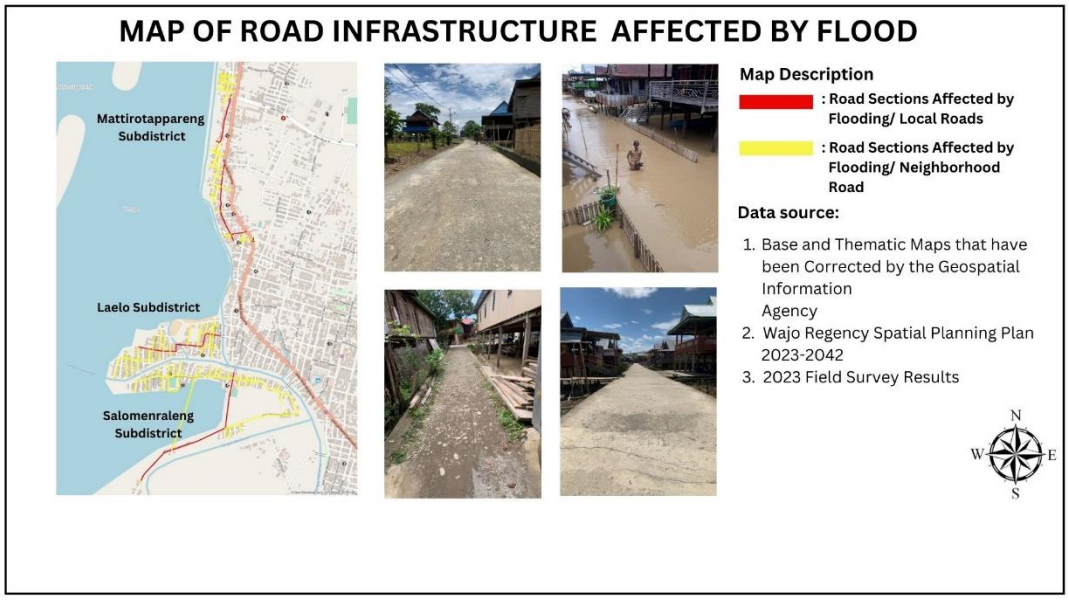


Figure 6: Map Of Road Infrastructure Sectors Affected By Flood

Recapitulation Of Economic Valuation Of All Sectors Affected By Floods

Based on the image below, you can see the comparison of the value of damage and losses in the road infrastructure sector shown in Table 3 and Figure12. The damage and loss values at each location are added up to obtain the damage and loss results from largest to lowest. The affected location that experienced the greatest losses in the road infrastructure sector was Mattirotappareng Subdistrict with a total value of damage and losses amounting to IDR 778.406.049 then followed by Salomenraleng Subdistrict with a damage and loss value of IDR 198.011.330 and in last place was Laelo Subdistrict with damage values and losses. the lowest is IDR 142.297.526. The total estimated value of losses experienced by all sub-districts affected by flooding for this sector is IDR 1.118.714.925. From the estimated loss values in the residential sector and the road infrastructure sector, tables and diagrams were created to see the comparison of the estimated loss values for each sector.

Table 3: Recapitulation Table of Estimated Value of Damage and Losses Both Of Sectors Are Affected

Recapitulation of Estimated Value of Damage and Losses Due to Floods In the sub-districts of Mattirotappareng, Laelo and Salomenraleng				
No.	**Sector**	**Damage Estimation (IDR)**	**Losses Estimation (IDR)**	**Total Damage and Losses (IDR)**
1.	Settlements	80.506.783.500	145.101.100.000	225.607.883.500
2.	Road Infrastructure	1.020.064.925	102.150.900	1.122.215.826
TOTAL		**81.526.848.426**	**145.203.250.900**	**226.730.099.326**

Based on the characteristics of respondent data (coffee consumers), respondents who consume coffee based on gender are 28% men and 22% women. This data shows that coffee connoisseurs in coffee shops (cafés) today also come from many women. Thus, the number of male and female coffee connoisseurs is balanced by 22-28%.

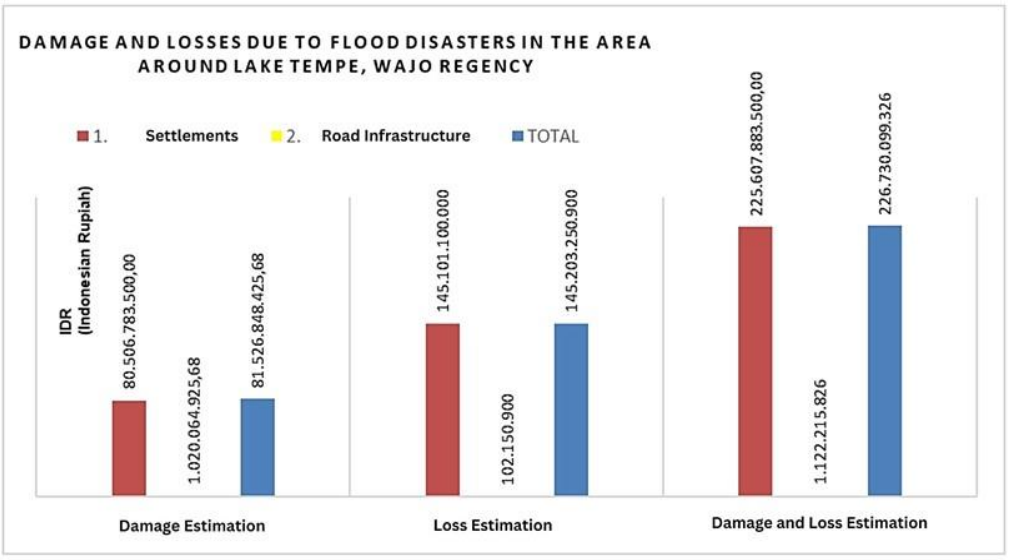


Figure 7: Graph of Recapitulation of Loss Values for All Affected Sectors

The total value of damage and losses in all affected sectors is IDR 226.730.099.326. The residential sector is the sector with the largest total damage and loss value, namely IDR 225.607.883.500, while in the road infrastructure sector the total value of damage loss is IDR 1.122.215.826. Based on the recapitulation results, the comparison of the total value of damage and losses between the household sector and the road infrastructure sector has a large difference in value. The lower the percentage of building damage will result in a low building loss value, conversely if the percentage value of building damage is high it will result in a high building loss value. This is adjusted to the factual conditions in the residential sector in the 3 affected sub-districts, the total number of which reached 1,397 building units with the average damage value in each sub-district reaching tens of billions of rupiah in the categories of light damage, moderate damage and heavy damage.

Meanwhile, in the road infrastructure sector, the total value of damage and losses is much smaller than in the residential sector because the length of the road sections affected is shorter (slightly) compared to the residential sector. The total length of roads affected in the road infrastructure sector is 16.44 km so that when analysis and calculations were carried out regarding estimates of damage and loss the results were also smaller. Apart from that, the damage category in this sector was also in the lightly

damaged category in all affected sub-districts. In this sector, the conditions are actually different from the residential sector because the loss value is smaller than the damage value. This is because the variables that are components of the calculation of loss estimates are much smaller (cheaper) than the value of the damage. The variables used in calculating damage estimates are the length of the affected road multiplied by the width of the road and the level of damage to obtain greater calculation results.

CONCLUSION

Sectors affected by flooding namely settlements and road infrastructure found that Laelo Subdistrict was the location with the highest number of building units submerged/affected by flooding, namely 473 units. Meanwhile in the road infrastructure sector the location with the longest road length that was submerged/affected by flooding was mattirotappareng subdistrict, namely 7,24 km, which was divided into several road classifications, namely local roads and neighborhood roads. Based on the results of this identification, an economic valuation is obtained in the form of an estimate of the value of the damage. Losses in the residential sector amounted to IDR 225.607.883.500 and in the road infrastructure sector IDR 1.122.215.826. The estimated total loss experienced by the two affected sectors Is IDR 226.730.099.326 with the largest estimated total damage and losses being in the settlements sector. By paying attention to the large potential and results of economic valuation, it is imperative to pay attention to aspects of economic value in sustainable development activities. Sustainable development is impossible to realize without incorporating disaster risk factors into development programs. Sustainable development goals can also be coordinated in the disaster recovery process so as to increase the potential of individuals and communities in improving the situation after a disaster, compared to previous situation improvement programs. Integrated development planning that includes risk factors must be incorporated at every stage of investment project planning. In implementing this integrated planning, there is a need for good coordination between regional development planners from various groups, including students, government level and disaster management practitioners (Under BNPB). In this way, it can improve community welfare and make investments made more efficient.

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