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PROCEEDINGS

“Communicating Multi-Scientific Analyses on Disaster Risk Management”

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EVALUATION OF DAMAGE SETTLEMENT DUE TO LAHAR FLOOD IN KALI PUTIH

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Abstract
Merapi volcano eruption 2010 effected lahar flood in Kali Putih. Lahar flood cause damage settlements in five villages in kali Putih, i.e. Jumoyo, Gulon, Seloboro, Sirahan (Salam sub-district), and Blongkeng (Ngluwar sub-district). The aims of this research are to know the distribution of lahar flood, assess the classification of damage settlement due to lahar flood and to analyze the classification of damage settlement due to lahar flood.

The method that used to know the distribution of lahar flood are GPS tracking and cross section, while to know how the damage settlement it ascertainable with community perception in Focus Group Discussion (FGD) and field survey. The classification of damage settlement divided into five classes, i.e. Collapse, High Damaged, Moderate Damaged, Low Damaged, and No Damaged.

The results of this research show that the most widely lahar flood distributions was happen in Sirahan with 0,80 km². The most damage settlements due to lahar flood found in Sirahan with 553 houses was Collapse, 43 houses have Heavy Damaged, 149 houses have Medium damaged, 75 houses Lightly Damaged and 40 houses was Not Damaged. Damage settlement due to lahar flood is not only cause by the distance between settlement and the river or lahar flood sediment but also by the material of settlement.

Keyword: Lahar Flood, Focus Group Discussion, Damage Settlement

I. Introduction
Indonesia is located at ‘ring of fire’, between three plate tectonic active, i.e. Eurasian plate, Pacific plate, and Australian plate. The consequence of this condition is the country has a fertile land all at once it has high vulnerability of much disaster. One of the disasters that happen in Indonesia is a volcano disaster. In Indonesia, there are 129 active volcanoes or 15% from the total amount of volcanoes on the earth (Sumintadiredja, 2000).

One of the most active volcanoes in Indonesia is Merapi. It's located at the boundary between DIY and Central Java (Latitude 7° 32.5’ and Longitude 110° 26.5’), with elevation about 2980 MSL, Merapi Volcano has an eruption
frequency of every 3 – 5 years (Sumintadiredja, 2000 and Cholik, 2011). Merapi has erupted since 1006 A.D. (Ministry of Settlement and Regional Infrastructure Republic of Indonesia. 2001) and it has lahar flood since 1587 A.D. (Lavigne, 2000).

Lavigne (2000) has classified lahar into debris flow, it decipherable as a mixed of liquid and solid; with sediment concentrate is about 60% of its volume and 80% in its heaviest. According to Beverage and Culbertson (1964) in Lavigne (2000), the concentration of very concentrated lahar sediment is about 20 – 60% of its volume and 40 – 80% in its heaviest. By the mechanism of lahar figuration, Lavigne (2007) in Hadmoko (2011) explain there are three groups, i.e. (1) syn-eruptive, it divided into two there are happened coincide with volcanic eruption in crater (mixed of pyroclastic flow with flowing water that result of inundation in crater) and happened coincide volcanic eruption and heavy rain (mixed of debris avalanche and flowing water), (2) post-eruptive, lahar that happened post-volcanic eruption due to heavy rain that bring the materials, and (3) non-eruptive, result from collapse of the crater or heavy rain (Figure 1).

![Classification of lahar figuration mechanism (Lavigne, 2007 in Hadmoko, 2011)](image)

Sumintadiredja (2000) explain that the specific gravity of lahar is about 2 – 2.5 gr/cc, it can be dangerous if it flowing with very heavy, because it has rocks and can ruin every building infrastructure. Sumintadiredja (2000) divided lahar into two types; there are hot lahar and cold lahar. Hot lahar just happened in the volcano that have cratered. Cold lahar can be happened in volcano that have or not crater (Table 1).

This research in Magelang Regency that located in western slopes of Merapi Volcano because Lavigne (2000) claim that the rivers that located in western slopes of Merapi Volcano are included in high lahar flood hazard. It proven in Merapi
volcanic eruption in 2010, lahar flood was happened and result damage settlement. It comes from Kali Putih that located in the western slopes of Merapi Volcano.

Another theory that supported the selection of research area is the material of Merapi Volcano that located in it western slopes is more refined and easily carried by rain, so that lahar flood can be dominated in this area (Surono, 2011). Amount of material from Merapi Volcano which have transported in a lahar flood in 2011 is just about 30%, if happened rain with intensity about 40 mm per hour, it's able to dissolve the material and become lahar flooded (Subandriyo, 2011). Around 80,000 houses are threatened by lahar flood because it located less than 300 m from river that upstream in Merapi Volcano (The Government of Magelang Regency, 2011).

Table 1. The Comparison of Hot Lahar and Cold Lahar

<table>
<thead>
<tr>
<th>Temperature</th>
<th>The origin of water</th>
<th>Heavy rain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot</td>
<td>Eruption/primary lahar, come from crater</td>
<td>Secondary hot lahar</td>
</tr>
<tr>
<td>Cold</td>
<td>Lahar stopped, due to wall of crater collapse</td>
<td>Secondary cold lahar</td>
</tr>
</tbody>
</table>

Source: Sumintadireja (2000)

II. Methods

Sampling method that used in this research is stratified random sampling. Mustafa (2000) explain that there are several procedures in this method, i.e. (1) prepare the sampling frame, (2) divide the sampling frame into some desired strata, (3) determine the amount of sample in every strata, (4) choose a random sample from every strata. Sampling frame that used in this research is lahar flood sediment, and then it divided into some desired level in accordance with lahar flood sediment.

2.1 Spatial Distribution of Lahar Flood

Spatial distribution of lahar flood can be known from field survey, GPS tracking and Cross Section.

a. GPS Tracking

We do tracking in the overflow of lahar flood in research area using Global Positioning System (GPS). This method used to know the widespread of lahar flood overflow. The result of GPS tracking must be converted to a polygon data structure so it can be processed further (Figure 2).

![Figure 2. GPS Tracking](image-url)
b. Cross Section

Cross section done for calculating sectional area of the river according to the field survey using laser ace and topographic analysis (primary data, 2012). This method assumes the volume of half a tube then we can get the volume scenario for every cross section. Lahar flood predicted lead up to lower contour, according that it can be known direction of lahar flood overflow (Figure 3).

![Cross Section Diagram]

**Volume calculation formulas:**

\[ V = \left( \frac{L_1 + L_2}{2} \right) \times L \text{ (Distance)} \]

Keterangan:

**Figure 3. Cross-section**

2.2 Assessment the Classification of Damage Settlement Due to Lahar Flood

Classification assessment of damage settlement due to lahar flood consist of two parts, i.e. settlement condition before lahar flood and settlement condition after lahar flood. Assessment of the level of damage caused by lahar flood settlement done based on public perception through Focus Group Discussion (FGD) and field surveys (Primary data, 2012). FGD participant consists of various layers of society (the villagers, community leaders, and communities affected by lahar flood). FGD participants were given an IKONOS imagery and was accompanied by a team of researchers in providing information (Figure 3.3). We choose IKONOS because it has high resolution (4 m in multispectral) (Kusumowidagdo et al, 2007).

![FGD in Sirahan Village](image1)

**Figure 4. FGD in Sirahan Village (Photos by: Rosalina Kumalawati, 2012)**
Table 2. Criteria of Damage Settlement due to Lahar Flood

<table>
<thead>
<tr>
<th>No</th>
<th>Damage Category</th>
<th>Criteria</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Collapse</td>
<td>Buildings swept away by floods of lava, collapsing buildings, total building buried under lahar or most damaged structural components</td>
<td>• Missing or total building collapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Building buried by lahar sediments more than 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Part of the building is lost by 50% or more</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Most of the columns, beams, and roof damaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Most of the walls and ceiling collapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Electrical installations damaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Door/window/frame lost/damaged</td>
</tr>
<tr>
<td>2.</td>
<td>High Damaged</td>
<td>The building still stands, mostly damaged structural components and architectural components damaged</td>
<td>• The building still stands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 50% of Building buried by lahar sediments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Some broken roof truss</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Beam column fraction fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Some walls and/or roofs collapsed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Some electrical installations damaged /disconnected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Doors/windows/sills damaged</td>
</tr>
<tr>
<td>3.</td>
<td>Medium Damaged</td>
<td>The building still stands, a small component of the structure is damaged and broken architectural components</td>
<td>• The building still stands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 30% of Building buried by lahar sediments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Cracks in the walls or roof</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Partially damaged electrical installations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Doors/windows/sills partially damaged</td>
</tr>
<tr>
<td>4.</td>
<td>Low Damaged</td>
<td>The building still stands, there is no structural damage, there is only damage to architectural components</td>
<td>• The building still stands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Less than 30% of building buried by lahar sediments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Doors/windows/sills need to be repaired</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Electrical installation is not damaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The walls need to be painted again</td>
</tr>
<tr>
<td>5.</td>
<td>No Damaged</td>
<td>Whole building, no structural damage, just hit a puddle of lahar on the porch</td>
<td>• The building still stands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• No damage to doors/windows</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Exposed lahar inundation on the terrace is less than 20 cm</td>
</tr>
</tbody>
</table>

Source: BAKORNAS in Public Works Department, 2006 and modification, 2012
Methods Focus Group Discussion (FGD) is intended to determine the community perception of lahar flood. Some things to note include the hamlet boundary in the study area, the condition of the settlement before lahar flood, sediment of lahar flood and classification of damage settlement caused by lahar flood. The information to be absorbed from the community about the condition of the settlement before the lahar flood is wall material, floor material, type of roof, floor number, and distance of the house from the river. The parameter is used to specify the types of houses in the study area, i.e., non-permanent, semi-permanent or permanent. To classify damage settlements, community should determine into five classes (Table 2).

2.3 Analysis of Damage Settlement due to Lahar Flood

Analysis of damage settlements caused by lahar flood based on lahar flood sediment and the house distance to the river. The high of lahar flood sediment known from a few control points. At some control point community should give it an elevation of lahar flood and distance from the river. The values are then interpolated, as an approach to determine the height limit of lahar flood sediment and the distance from the river.

III. Result and Discussion

3.1 Spatial Distribution of Lahar Flood from Kali Putih

Lahar flood from Kali Putih pass through Jumoyo, Gulon, Seloboro, Sirahan and Blongkeng (Ngluwar Sub-district). Lahar flood from Kali Putih overflow for the first time in Jumoyo, Gulon, Seloboro, Sirahan and Blongkeng (Table 3).

<table>
<thead>
<tr>
<th>No</th>
<th>Sub-district</th>
<th>Village</th>
<th>Administrative area (km²)</th>
<th>Lahar Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Salam</td>
<td>Jumoyo</td>
<td>5.68</td>
<td>0.54 27.25</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Seloboro</td>
<td>1.83</td>
<td>0.23 11.60</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Sirahan</td>
<td>2.38</td>
<td>0.80 40.36</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Gulon</td>
<td>4.40</td>
<td>0.14 7.06</td>
</tr>
<tr>
<td>5</td>
<td>Ngluwar</td>
<td>Blongkeng</td>
<td>0.27</td>
<td>0.272 13.72</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>1.98 100</td>
</tr>
</tbody>
</table>

Source: Calculation Result, 2012

Differences extent of lahar flood that occurred in each village because of the Kali Putih (as a source of lahar flood) that flows in every village. Kali Putih was right in the middle of the Sirahan, Seloboro, and Jumoyo, Kali Putih flows from the center and then to the border village Jumoyo-Gulon. Besides Gulon village, Kali Putih flows in the middle of villages, it results Gulon has a lahar flood total area are
not greater than other villages. *Kali Putih* is not right in the middle of Gulon, it's located in the boundary of Gulon-Jumoyo. Based on Table 4.1. We can know that the overall width of the lahar flood from *Kali Putih* is 1.98 km². The most lahar flood widespread is in Sirahan i.e. 0.80 km² or 40.36%. The smallest lahar flood occurs in Gulon i.e. 0.14 km² or 7.06%.

![Figure 5. Kali Putih Riverbank (Photos by: Rosalina Kumalawati, 2012)](image)

Height of lahar flood from *Kali Putih* is about 1 m up to 3 m. The distribution of lahar flood sediment can be known from Table 4.

<table>
<thead>
<tr>
<th>Table 4. Lahar Flood Sediment in Each Village</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Source: Calculation Result, 2012

Lahar flood distribution has a different height in each village. The height of the lahar flood in Gulon is 2 m and 3 m. Height of lahar flood in Jumoyo decreased
to 2 m in Gulon. In Jumoyo, height of lahar flood is 1 m up to 3 m. 3 m of lahar flood is dominating riparian of Kali Putih, then it decreased to 2 m to Gulon up to Seloboro, 1 m of lahar flood height located in the near of Gendol Hill (South of Kali Putih). Entering Seloboro, 2 m of lahar flood from Jumoyo is still overflowing. Lahar flood with 2 m of height flow with Kali Putih stream up to Sirahan, but before it comes to Sirahan, in the boundary of Seloboro-Sirahan, lahar flood increased again to 3 m. Lahar flood that overflowed in riparian of Kali Putih decreased to 1 m. Height of lahar flood increased again to 3 m before boundary of Sirahan and Blongkeng. It is affected by the morphology of Kali Putih in each village. If Kali Putih slope of riverbank is low, then the overflow will be high, when Kali Putih slope of riverbank is high, then it is not overflowed but it will be eroded the riverbank (Figure 5).

Based on Table 4. It can be known that Sirahan is dominated by highest lahar flood sediment, 3 m widespread of lahar flood sediment is 0.35 km² or 17.69% from the total amount of lahar flood in Kali Putih. The minimum lahar flood sediment in Gulon with 3 m of lahar flood is 0,017 km². Lahar flood in Kali Putih is ending in Blongkeng. In Blongkeng, it has height from 1 m up to 3 m, with each widespread is 0,02 km² for 1 m height, 0,022 km² for 2 m and 0,23 km² for 3 m. Although lahar flood height in Blongkeng is dominated by 3 m, lahar flood is not overflowing into settlement, it just eroded the river bank then cause landslide then sweep the settlement that located above the riverbank (Figure 6).

**Figure 6.** Lahar Flood Cause Landslide in Blongkeng (418488 mT, 9156100 mU) (*Photos by : Rosalina Kumalawati, 2012*)
3.2 Assessment of Damage Settlement Due to Lahar Flood

Assessment of damage settlement due to lahar flood is divided into two parts, first is settlement condition before the lahar flood and second is settlement condition after lahar flood.

a. Settlement Condition Before Lahar Flood

Settlement that we used to know settlement condition before lahar flood is about 89 houses. It's known to decide how is the kind of house in the research area, permanent, semi-permanent or non-permanent. Parameters that used to know the house's condition there are wall material, floor material, type of roof, floor number and distance of the house from the river.

Silitonga (2010) for the permanent, it must have criteria that it's having foundation-bed, wall from concrete brick, tiled-roof, and floor from ceramics (Figure 7.). Based on data processing, it's known that the settlement is dominated by concrete brick on the wall, tiled-roof, floor from cement, have a foundation. Distance from the river has classified into 42 houses in the 0 – 50 m, 30 houses 51 – 100 m, and 17 houses are in the 101- 250 m from the river (Table 5.). House that using cement as the floor is 42 houses. All of the houses are tiled-roof and just have one floor number.

<table>
<thead>
<tr>
<th>No.</th>
<th>Distance from river (m)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0-50</td>
<td>42</td>
</tr>
<tr>
<td>2.</td>
<td>51-100</td>
<td>30</td>
</tr>
<tr>
<td>3.</td>
<td>101-250</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>89</td>
</tr>
</tbody>
</table>

Source: Calculation Result, 2012

Figure 7. Permanent House (Photos by: Rosalina Kumalawati, 2012)
b. Settlement Condition After Lahar Flood

Settlement condition after lahar flood is classified into several damage settlement classes as the criteria those set in Table 6. The total amount of houses that damage by lahar flood are 1,290 houses. Criteria that dominating is Collapse 814 houses, Damage 71 houses, Medium Damage 200 houses, Low Damage 140 houses, High and No Damage 65 houses.

<table>
<thead>
<tr>
<th>No</th>
<th>Sub-district</th>
<th>Village</th>
<th>Damage Settlement Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Collapse</td>
</tr>
<tr>
<td>1</td>
<td>Salam</td>
<td>Jumoyo</td>
<td>108</td>
</tr>
<tr>
<td>2</td>
<td>Gulan</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Seloboro</td>
<td></td>
<td>97</td>
</tr>
<tr>
<td>4</td>
<td>Sirahan</td>
<td></td>
<td>553</td>
</tr>
<tr>
<td>5</td>
<td>Ngluwar</td>
<td>Blongkeng</td>
<td>56</td>
</tr>
</tbody>
</table>

Total: | 814 | 71 | 200 | 140 | 65 | 1290 |

Source: Calculation Result and Analysis, 2012

The most settlement affected by lahar flood are in Sirahan, about 860 houses. The most damage settlements are in Sirahan which 553 houses Collapse, then Jumoyo 108 houses collapse, Seloboro 97 houses, Blongkeng 56 houses. Figure 8. are showing distribution of damage settlement in each village.

Figure 8. Damage Settlement in Jumoyo, Gulan, and Seloboro in Salam Sub-district and Blongkeng in Ngluwar Sub-district, 2012
Medium Damage is dominated by Sirahan with 149 houses, Gulon 25 houses, Jumoyo 19 houses, Seloboro 5 houses, and Blongkeng 2 houses. Almost all of the villages have Medium Damage. Blongkeng are not included in Low Damage. It dominates by Sirahan 75 houses. Villages that not included in High Damage are Gulon. The villages that have High Damage are Sirahan 43 houses, Seloboro 15 houses, Jumoyo 8 houses, and Blongkeng 5 houses.

The lowest amount of damage houses is No Damage. With this criteria, the house that affected lahar flood does not mean it is not damaged at all. But, based on the criteria, the house in No Damage still exists, no damage on door/window and affected lahar flood by 20 cm. No Damage is dominated by Sirahan 40 houses.

3.3 Analysis of Damage Settlement Due to Lahar Flood

Analysis of damage settlement due to lahar flood based on height of lahar flood sediment and distance of a house from the river. Height of lahar flood sediment is 1 m up to 3 m, while distance a house from the river is between 0 – 250 m. Houses that affected lahar flood with 1 m of height are included in Low Damage, Medium Damage and Collapse. Houses that included in Low Damage is located between 0 up to 37 m from the river, but there is a house that located in 87 m from the river is still having Low Damage, it causes the house’s wall is consist of wood and floors is made from ground. Consequently, when the lahar flood hit the house, it becomes Low Damage although a considerable distance from the river. The house that had Medium Damage had a distance to the river in the range of 13 to 70 m.

Figure 9. House in Gempol, Jumoyo Village, Salam Sub-district have Collapse although it has distance 100 m from Kali Putih (422814 mT, 9159309 mU) (Photos by : Rosalina Kumalawati, 2012)
A height of 1.5 m lahar flood cause damage in the form of Low Damage, Medium Damage and High Damage. The house suffered Low Damage, was at a distance of 69 m from the river, this walls house is a mixture of brick and wood and ground floor. The house has a distance from the river as far as 21 m and 25 m where High Damage, because the walls are made of just wood and other materials such as cement floor.

Lahar flood which has a height of 2 m sediment have caused damage in the form of Collapse, High Damage, Medium Damage, Low Damage. The Collapse houses have a distance to the river as far as 14 m, 15 m and 20 m and have materials such as brick, wood walls, and the floor is made of ceramic and cement. The house suffered Low Damage on lahar flood sediment as high as 2 m located at a distance of more than 100 m from the river, the houses in the Gulon Village, Salam District.

The height of the lahar flood sediment as high as 3 m occurred in the Jumoyo, Seloboro, Sirahan (Salam Sub-district) and Blongkeng (Ngluwar Sub-district). The settlement damage that occurred in the Jumoyo, Seloboro, Sirahan and Blongkeng not only depend on the distance to the river and building materials. Lahar flood that occurs in four villages overflow by cutting the actual river channel, resulting in a house that's located at a distance of more than 100 m from the river were also Collapse Damage (Figure 9).

Based on the analysis it can be seen that in addition to the distance of the river and the height of the lahar flood sediment, housing conditions (materials) also played a role in determining the damage caused by the lahar flood. Lahar floods such as those in the Kali Putih, where it is overflowing the actual river channel cut, then the worst possible damage settlements may occur, although the house is a permanent, and is at a distance of more than 100 m from the river.

IV. Conclusion
1. Lahar flood overflow from Kali Putih is 1.97 km². The village’s most widespread lahar flood from Kali Putih is Sirahan, in Salam Sub-district which it 0.74 km².
2. Settlements are located in research area included in the category of permanent, which has a foundation, wall of bricks, roof tile and floor in the form of plaster/ceramics.
3. A village with the most severe level of damage settlements from Kali Putih’s lahar flood is Sirahan, in Salam Sub-district, with total amount of damage settlement is 860 houses, details are 553 houses Collapse, 43 houses High Damage, 149 houses Medium Damage, 75 houses Low Damage and 40 houses No Damage. Damage settlement than caused by the distance of a house to the river and sediment of lahar flood also caused by the material of the house.

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VI. References


