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Study of Flood Vulnerability in Pesanggrahan District, South Jakarta

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Abstract

Pesanggrahan Sub-district is located in South Jakarta Administrative City, DKI Jakarta Province, Pesanggrahan Sub-district is crossed by Pesanggrahan River which divides sub-districts and crosses several villages that are included in Pesanggrahan District. In the rainy season, floods often occur due to overflowing water in this Pesanggrahan river and resulting in material and non-material losses. The purpose of this study is to determine the level of flood vulnerability that has occurred, especially in areas that have not been affected in order to avoid the risks that occur. The benefit of this research is to input mitigation efforts that will be carried out in the event of a flood. The research variables used in this study are the area of the flood ranging from the river, elevation, slope, and land use. The research method is using GIS technique to superimpose or map overlay, scoring, and weight using Geographic Information System (GIS) software. The expected result is the creation of a classification of the level of flood vulnerability and its extent. The planned mitigation directives are directives related to river body improvement, and utilization of river commensurate space intended for the government, and the community. This research is one of the personal research roadmaps and is in accordance with the faculty research roadmap. This research is included in the building and environmental disaster mitigation research cluster, the leading field of the green urban environment, and the national research master plan on disaster management. The planned output is scientific work published in reputable international journals and Intellectual Property Rights.

Keywords: Flood Vulnerability, Geographic Information System, Disaster Mitigation, River Basin Area, Land Use.

1. Introduction

1.1 Sub Introduction

The Pesanggrahan River flows from the Bogor Regency, Depok City, West Java Province, and Tangerang City, Banten Province until it enters the South Jakarta, West Jakarta, and North Jakarta areas in the DKI Jakarta Province. This river passes through Tanah Cereal District, Bojong Gede District, Sawangan District, Limo District, Kebayoran Lama District, Pesanggrahan District, Kembangan District, Kebon Jeruk District, until finally to Cengkareng. Djoharam et. al (2018) stated in their research that the Pesanggrahan River is a strategic river in its designation as mandated in DKI Jakarta Governor Decree No. 582/1995 namely for fisheries and the South Tangerang City Government plans to utilize water from the Pesanggrahan River as raw material for drinking water for consuming. The existing land uses along the Pesanggrahan River include residential, industrial, vacant land, and green open space activities.

Pesanggrahan District experiences regular flooding, especially during the rainy season, this flood is caused by local rain or flooding from upstream areas. This flood caused losses to the community including the interruption of daily activities, cessation of transportation, and damage to public facilities and infrastructure. The DKI Regional Government noted that the last flood occurred in 2021 and hit 22 urban villages which caused 840 residents to evacuate (Republika, 2021). Pesanggrahan sub-districts are among those experiencing flooding as a result of overflowing the Pesanggrahan river which inundated the river border area along the river channel. The pattern of settlements that are close to rivers with high density increases the potential for this disaster risk.

There are flood events that occur every year and sometimes in cycles of several years causing quite high floods. For this reason, a study is needed to determine the level of flood vulnerability in the area. This knowledge of flood vulnerability which is

equipped with regional zoning will be very helpful in disaster mitigation so that this research can assist local governments in preventing it as early as possible (Taki, 2021).

The purpose of this study was to identify the level of vulnerability to flooding in Pesanggrahan District, South Jakarta administrative city, DKI Jakarta City, with theoretical limitations on flooding and the level of vulnerability. The discussion limits include scoring the DKI Jakarta, especially for areas that have not been affected and have the potential for flood risk. Regional boundaries are the administrative area of Pesanggrahan Sub-district, level of flood vulnerability, environmental planning related to faculty research on building and environmental disaster mitigation towards a green urban environment and leads to the Trisakti University research master plan, namely green Jabodetabek.

2. Methodology

The source of data used in this research is secondary data. The data needed in this study include 1. SAS Planet Image Data in the Pesanggrahan District; 2. SRTM DEM data from USGS; 3. Indonesian Earth Map (RBI) scale 1:25000 Pesanggrahan District DKI Jakarta.

The data analysis technique used Geographic Information System with overlay and scoring analysis. Overlay analysis is combining two or more different maps to produce a combined map unit that contains new information. This analysis serves to identify vulnerable areas based on the level of vulnerability to flood disasters. The data is overlaid using ArcGIS software to produce a map of the level of vulnerability to flood disasters in Pesanggrahan. Scoring analysis is the assignment of a score to a map polygon to provide a level of proximity, relatedness, or the severity of a certain impact on a phenomenon spatially. This analysis is carried out to assign a value based on the magnitude of its influence on flood vulnerability

3. Literature Study

3.1 Flood

Based on the Ministry of Public Works and Public Housing in Gunawan (2010), the problem of flooding in urban areas is mainly caused by the dense population that occupies the floodplain of a river. In this area, the flat topography and rapid development hinder the establishment of an effective drainage system. The particular flood problem in urban areas in Indonesia is caused by an ineffective urban drainage system.

The development of urban drainage is difficult to implement due to the flat topography, extensive urban development in floodplain areas, high levels of rain and extensive watertight areas, and damage to reservoir areas (Syarifudin, et al, 2017). In general, flooding is an event or condition in which a plain area is inundated or submerged due to an excessive increase in the volume of water. In other words, flooding is an event that occurs when overflowing water flows inundate or submerge land. Flooding is defined as runoff that exceeds the normal water level and cannot be absorbed by the plains or riverbeds, resulting in flooding in the lowlands around the river.

Heavy rainfall is usually the cause of floods. The increase in rainfall is not matched by good infiltration and runoff, the amount of water exceeds the allowable level and causes runoff. Nugroho (2015) said that in the water cycle, the distribution of inputs in the form of rainwater is different, namely the flow of stems (steam fall) water that passes (throughfall), and rainwater that is directly on the ground surface, then separated into runoff, infiltration, and evaporation. Water escape and stem flow are closely related to land use, while infiltration and runoff depend on the parameters of soil type and slope.

According to Darwis (2018), flooding is an event of inundation of arid land caused by river runoff that flows beyond the capacity of the drainage area and inundates the surrounding area. When the water flow exceeds the capacity of the aqueduct, and when the river water enters the surrounding area, flooding will usually occur. Meanwhile, Nurrahmah (2015) argues that "flood disasters are events that overflow the river flow due to water exceeding the river's storage capacity so that it overflows and inundates land or lower areas around it." If the area affected by the overflow is an area used by the community, and there is damage that causes suffering and loss to the community, then the flood is considered a natural disaster.

Natural floods usually affect sunken or flat areas, which usually include low-lying areas. Lowland areas not only include flood target zones, but also areas with great potential for the development and construction of various infrastructures and certain fields of human life, for example, trade, settlement, agriculture, and industry (Mardiatno, 2021). Floods cause environmental damage including components of the physical, biological, or artificial environment, as well as components of the human environment. But due to the destruction of all environmental components, humans become victims of the most painful components because they receive the greatest damage to other environmental components (Wangge, 2014). So, it can be concluded that flooding is an increase in the volume of river water that exceeds the normal average limit that exceeds the capacity of the drainage area so that it overflows and inundates the surrounding area.

Cause of Flood

Floods can be caused by high rainfall that exceeds the average normal rainfall, causing the volume of water in rivers to increase and overflow on embankments or embankments. Judging from the morphological conditions, flooding is caused by the various reliefs of the landscape and the flow of many rivers. Deforestation is exacerbating this situation, and land use changes from open land to built-up land around rivers, narrowing rivers and causing land subsidence, which can lead to flooding. Based on the location or activity, there are several main causes of flooding. According to Koedati and Sugiyanto (2002:7), the occurrence of floods is caused by human activities such as:

1. Changes in water catchment conditions, such as urban expansion, deforestation, inappropriate agriculture, and other land use changes, will increase flood runoff causing flooding problems. Changes in land use have contributed significantly to improving the quality and quantity of floods.
2. Slum areas, and slum settlements along riverbanks can be a barrier to mobility. The problem of slum settlements was identified as the main cause of flooding in urban areas.
3. Indiscriminate disposal of garbage causes blockages in various waterways, especially in residential areas.
4. Damage to flood control structures and inadequate planning of flood control systems.

In addition to human activities, natural conditions are also one of the causes of floods. Natural conditions are divided into two, namely natural conditions that are static (fixed) and natural conditions that are dynamic as described below:

1. Natural conditions that are static (fixed)
   a. The topography is flat or concave including floodplains.
   b. Conditions of river flow, for example, the slope of the canal is sloping, tortuous, the appearance of blockages or in the form of a bottle (bottle neck), and the presence of river deposits in the form of islands (ambal river).
2. Dynamic Natural Condition

   a. Excessive extraction of groundwater causes the soil to sink or sink, causing the groundwater level to fall.
   b. High rainfall
   c. There is a backflow or damming that is often found at the mouth of a large river or river meeting.

Flood Control

According to Kodoatie, and Sugiyanto (2002), flood control has two methods, namely non-structural and structural methods.

1. Flood Control Structural Method
   Structural flood control is an effort to minimize the impact of flood disasters which is carried out through the construction of physical infrastructure.

2. Flood Control Non-Structural Method
   Non-structural flood control is an effort to reduce the impact of flood disasters without building physical infrastructure for flood control, for example making urban spatial planning policies and so on.

Flood Vulnerability

Flood-prone areas are areas whose conditions have caused or led to uncontrolled flooding. Flood vulnerability is a condition that indicates whether an area is prone to inundation or is flooded (Dibyosaputro, 1988 Kurnianto, 2010). Each area with different physical conditions has different vulnerabilities. Some areas are very prone to flooding, and some areas are not at risk of flooding. Areas with frequent or high potential for natural disasters depend on the severity of the causes of flooding.

According to Prasetyo (2009), factors that affect flood-prone areas are relatively flat topography and poor spatial planning. These areas are mainly located in big cities and river banks. Rachmat and Pamungkas (2014) found that distance to the river and topographical conditions indicate that this has a major impact on flood vulnerability. In addition, land use affects the absorption of rainwater by the soil.

Floods can be caused by all kinds of causes, one of which is the physical factor of the area. Areas that have the potential for flooding are classified into three, namely:

1. Flood Plain Area
   Flood plain area or floodplain area is a low-lying area located on the left and right of the river, causing the flow to the river to be slow and causing the area to be prone to flooding due to overflowing river water and local rain in the area.

2. Riverfront Area
   The river border area is an area along the left and right of the river, including artificial rivers. The existence of this area is about 100 meters on either side of a large river and about 50 meters on either side of a small river (tributary).

3. Basin Area
   The Basin area is a relatively large area, both in the lowlands and highlands (upstream) which can become flood-prone areas. Riverbanks must be managed and maintained as well as possible in order to avoid disasters and flood problems.

4. Analysis and Discussion

In this study using scoring analysis from several existing maps of Pesanggrahan District with the following scoring provisions:

1. Contour
   On the contour map, elevations 10 to 69 will be given a value of 1 because they are at the lowest and most potentially flooded because water is most likely to flow into this area, 70 to 133 will be given a value of 2 and the highest 134 to 167 will be given a value of 3.

2. Land Use Map
   From the land use map itself, it will be seen the percentage of green open land use in the village, if there is no green open space it will be given a value of 1, if 1% to 10% will be given a value of 2 and 11% to 20% will be given a value of 3 .

3. Drainage

Drainage will be seen whether the sub-district has a final disposal site such as rivers, lakes, and the like. If the area has a landfill, it will be given a score of 3, if there is primary road drainage but there is no final disposal, it will be given a value of 2, and if it does not have both, it will be given a value of 1.

The authors are encouraged to render the numbers according to the International rules, specifying the dot as a decimal separator and the comma as a thousands separator.

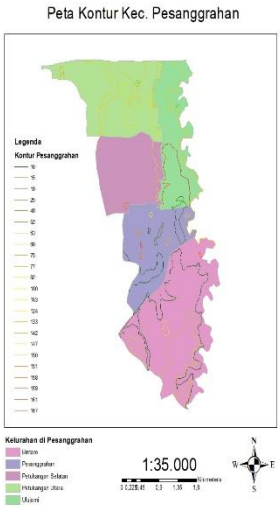

Fig 1. Contour map of Pesanggrahan sub-district

The first map is a contour map (fig.1), from the contour map we judge that the lowest sub-district is the sub-district with the smallest value and vice versa, in this study we use a color spectrum from the highest red to the lowest green to make it easier to read. From the contour map, it can be seen that the lowest areas are Bintaro Village and Pesanggrahan Village with a range of 10 to 60 masl which we give a value of 1 and North Petukangan Village has the highest altitude with a range of 100-150 masl and will be given a value of 3.

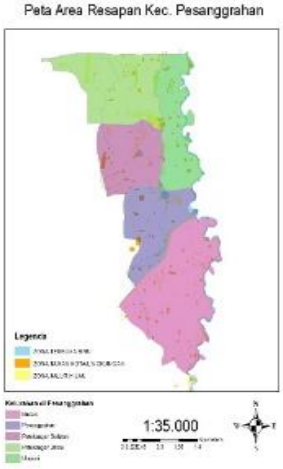

Fig 2. Map of the absorption area of Pesanggrahan sub-districtt

From the land use map itself (fig.2), all sub-district tend to be the same. Has residential and residential areas that dominate, slightly mixed, and also commercial areas. Each sub-district cannot be given a perfect score because the green zone in each sub-district does not reach 20% as planned.

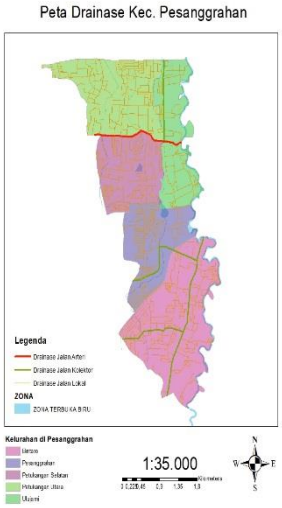

Fig 3. Pesanggrahan district drainage map

In the drainage map (fig.3), it is seen from the type of drainage and also whether there is an end to the drainage flow. From the map, all drainages in each sub-district tend to be the same and have been fulfilled, only that in some sub-district there are rivers which are assumed to be the final disposal of water flows. In short, a sub-district that has a river in its area has a value of 3 because the passage of water to the final disposal is faster and does not cause flooding due to settled water. The village that has a river in its area is Bintaro Village, Pesanggrahan, Ulujami. The rest of the other sub-district will be given a score of 2 because the drainage facilities are adequate. The following is a table of scoring analysis:

sub-district	Scoring			Total
	Conture	Land Use	Drainase	
Bintaro	1	2	3	6
Petukangan Utara	3	2	2	7
Petukangan Selatan	2	2	2	6
Pesanggrahan	1	2	3	6
Ulujami	3	2	3	8

6. Conclusions and suggestions

It should be noted in advance that the results of this analysis are based on several assumptions taken by the researcher. The first is that the condition of the drainage canal is fine and there are no obstacles such as damage and congestion. The second is that the land use map is completely like the existing state where the green zone in the map reflects the green zone in the existing state of the Pesanggrahan District area.

From the results of the scoring analysis, it can be seen that the sub-district with the lowest level of vulnerability to flooding is the Ulujami sub-district, this sub-district besides having the highest elevation

among other sub-district, water will flow into the sub-district which tends to be lower than this sub-district as well. The presence of a river in this village makes the flow of water faster to the final disposal, namely the river. Some sub-districts with low scores are Pesanggrahan and Bintaro Villages, these villages have rivers in their area but with the lowest elevation, this village has the potential to flood if the drainage channel is blocked or the volume of water exceeds what can be accommodated. Suggestions that can be taken from this research for the government are to prepare several villages that are considered more prone to flooding, such as Bintaro and Pesanggrahan villages whose drainage conditions must always be checked because these two villages are a little far from the last disposal, the water flow is required to be smooth and not there are hiccups along the way of the water flow.

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Study of Flood Vulnerability in Pesanggrahan District, South Jakarta

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Abstract

Pesanggrahan Sub-district is located in South Jakarta Administrative City, DKI Jakarta Province, Pesanggrahan Sub-district is crossed by Pesanggrahan River which divides sub-districts and crosses several villages that are included in Pesanggrahan District. In the rainy season, floods often occur due to overflowing water in this Pesanggrahan river and resulting in material and non-material losses. The purpose of this study is to determine the level of flood vulnerability that has occurred, especially in areas that have not been affected in order to avoid the risks that occur. The benefit of this research is to input mitigation efforts that will be carried out in the event of a flood. The research variables used in this study are the area of the flood ranging from the river, elevation, slope, and land use. The research method is using GIS technique to superimpose or map overlay, scoring, and weight using Geographic Information System (GIS) software. The expected result is the creation of a classification of the level of flood vulnerability and its extent. The planned mitigation directives are directives related to river body improvement, and utilization of river commensurate space intended for the government, and the community. This research is one of the personal research roadmaps and is in accordance with the faculty research roadmap. This research is included in the building and environmental disaster mitigation research cluster, the leading field of the green urban environment, and the national research master plan on disaster management. The planned output is scientific work published in reputable international journals and Intellectual Property Rights.

Keywords: Flood Vulnerability, Geographic Information System, Disaster Mitigation, River Basin Area, Land Use.

1. Introduction

1.1 Sub Introduction

The Pesanggrahan River flows from the Bogor Regency, Depok City, West Java Province, and Tangerang City, Banten Province until it enters the South Jakarta, West Jakarta, and North Jakarta areas in the DKI Jakarta Province. This river passes through Tanah Cereal District, Bojong Gede District, Sawangan District, Limo District, Kebayoran Lama District, Pesanggrahan District, Kembangan District, Kebon Jeruk District, until finally to Cengkareng. Djoharam et. al (2018) stated in their research that the Pesanggrahan River is a strategic river in its designation as mandated in DKI Jakarta Governor Decree No. 582/1995 namely for fisheries and the South Tangerang City Government plans to utilize water from the Pesanggrahan River as raw material for drinking water for consuming. The existing land uses along the Pesanggrahan River include residential, industrial, vacant land, and green open space activities.

Pesanggrahan District experiences regular flooding, especially during the rainy season, this flood is caused by local rain or flooding from upstream areas. This flood caused losses to the community including the interruption of daily activities, cessation of transportation, and damage to public facilities and infrastructure. The DKI Regional Government noted that the last flood occurred in 2021 and hit 22 urban villages which caused 840 residents to evacuate (Republika, 2021). Pesanggrahan sub-districts are among those experiencing flooding as a result of overflowing the Pesanggrahan river which inundated the river border area along the river channel. The pattern of settlements that are close to rivers with high density increases the potential for this disaster risk.

There are flood events that occur every year and sometimes in cycles of several years causing quite high floods. For this reason, a study is needed to determine the level of flood vulnerability in the area. This knowledge of flood vulnerability which is

equipped with regional zoning will be very helpful in disaster mitigation so that this research can assist local governments in preventing it as early as possible (Taki, 2021).

The purpose of this study was to identify the level of vulnerability to flooding in Pesanggrahan District, South Jakarta administrative city, DKI Jakarta City, with theoretical limitations on flooding and the level of vulnerability. The discussion limits include scoring the DKI Jakarta, especially for areas that have not been affected and have the potential for flood risk. Regional boundaries are the administrative area of Pesanggrahan Sub-district, level of flood vulnerability, environmental planning related to faculty research on building and environmental disaster mitigation towards a green urban environment and leads to the Trisakti University research master plan, namely green Jabodetabek.

2. Methodology

The source of data used in this research is secondary data. The data needed in this study include 1. SAS Planet Image Data in the Pesanggrahan District; 2. SRTM DEM data from USGS; 3. Indonesian Earth Map (RBI) scale 1:25000 Pesanggrahan District DKI Jakarta.

The data analysis technique used Geographic Information System with overlay and scoring analysis. Overlay analysis is combining two or more different maps to produce a combined map unit that contains new information. This analysis serves to identify vulnerable areas based on the level of vulnerability to flood disasters. The data is overlaid using ArcGIS software to produce a map of the level of vulnerability to flood disasters in Pesanggrahan. Scoring analysis is the assignment of a score to a map polygon to provide a level of proximity, relatedness, or the severity of a certain impact on a phenomenon spatially. This analysis is carried out to assign a value based on the magnitude of its influence on flood vulnerability

3. Literature Study

3.1 Flood

Based on the Ministry of Public Works and Public Housing in Gunawan (2010), the problem of flooding in urban areas is mainly caused by the dense population that occupies the floodplain of a river. In this area, the flat topography and rapid development hinder the establishment of an effective drainage system. The particular flood problem in urban areas in Indonesia is caused by an ineffective urban drainage system.

The development of urban drainage is difficult to implement due to the flat topography, extensive urban development in floodplain areas, high levels of rain and extensive watertight areas, and damage to reservoir areas (Syarifudin, et al, 2017). In general, flooding is an event or condition in which a plain area is inundated or submerged due to an excessive increase in the volume of water. In other words, flooding is an event that occurs when overflowing water flows inundate or submerge land. Flooding is defined as runoff that exceeds the normal water level and cannot be absorbed by the plains or riverbeds, resulting in flooding in the lowlands around the river.

Heavy rainfall is usually the cause of floods. The increase in rainfall is not matched by good infiltration and runoff, the amount of water exceeds the allowable level and causes runoff. Nugroho (2015) said that in the water cycle, the distribution of inputs in the form of rainwater is different, namely the flow of stems (steam fall) water that passes (throughfall), and rainwater that is directly on the ground surface, then separated into runoff, infiltration, and evaporation. Water escape and stem flow are closely related to land use, while infiltration and runoff depend on the parameters of soil type and slope.

According to Darwis (2018), flooding is an event of inundation of arid land caused by river runoff that flows beyond the capacity of the drainage area and inundates the surrounding area. When the water flow exceeds the capacity of the aqueduct, and when the river water enters the surrounding area, flooding will usually occur. Meanwhile, Nurrahmah (2015) argues that "flood disasters are events that overflow the river flow due to water exceeding the river's storage capacity so that it overflows and inundates land or lower areas around it." If the area affected by the overflow is an area used by the community, and there is damage that causes suffering and loss to the community, then the flood is considered a natural disaster.

Natural floods usually affect sunken or flat areas, which usually include low-lying areas. Lowland areas not only include flood target zones, but also areas with great potential for the development and construction of various infrastructures and certain fields of human life, for example, trade, settlement, agriculture, and industry (Mardiatno, 2021). Floods cause environmental damage including components of the physical, biological, or artificial environment, as well as components of the human environment. But due to the destruction of all environmental components, humans become victims of the most painful components because they receive the greatest damage to other environmental components (Wangge, 2014). So, it can be concluded that flooding is an increase in the volume of river water that exceeds the normal average limit that exceeds the capacity of the drainage area so that it overflows and inundates the surrounding area.

Cause of Flood

Floods can be caused by high rainfall that exceeds the average normal rainfall, causing the volume of water in rivers to increase and overflow on embankments or embankments. Judging from the morphological conditions, flooding is caused by the various reliefs of the landscape and the flow of many rivers. Deforestation is exacerbating this situation, and land use changes from open land to built-up land around rivers, narrowing rivers and causing land subsidence, which can lead to flooding. Based on the location or activity, there are several main causes of flooding. According to Koedati and Sugiyanto (2002:7), the occurrence of floods is caused by human activities such as:

1. Changes in water catchment conditions, such as urban expansion, deforestation, inappropriate agriculture, and other land use changes, will increase flood runoff causing flooding problems. Changes in land use have contributed significantly to improving the quality and quantity of floods.
2. Slum areas, and slum settlements along riverbanks can be a barrier to mobility. The problem of slum settlements was identified as the main cause of flooding in urban areas.
3. Indiscriminate disposal of garbage causes blockages in various waterways, especially in residential areas.
4. Damage to flood control structures and inadequate planning of flood control systems.

In addition to human activities, natural conditions are also one of the causes of floods. Natural conditions are divided into two, namely natural conditions that are static (fixed) and natural conditions that are dynamic as described below:

1. Natural conditions that are static (fixed)
   a. The topography is flat or concave including floodplains.
   b. Conditions of river flow, for example, the slope of the canal is sloping, tortuous, the appearance of blockages or in the form of a bottle (bottle neck), and the presence of river deposits in the form of islands (ambal river).
2. Dynamic Natural Condition

   a. Excessive extraction of groundwater causes the soil to sink or sink, causing the groundwater level to fall.
   b. High rainfall
   c. There is a backflow or damming that is often found at the mouth of a large river or river meeting.

Flood Control

According to Kodoatie, and Sugiyanto (2002), flood control has two methods, namely non-structural and structural methods.

1. Flood Control Structural Method
   Structural flood control is an effort to minimize the impact of flood disasters which is carried out through the construction of physical infrastructure.

2. Flood Control Non-Structural Method
   Non-structural flood control is an effort to reduce the impact of flood disasters without building physical infrastructure for flood control, for example making urban spatial planning policies and so on.

Flood Vulnerability

Flood-prone areas are areas whose conditions have caused or led to uncontrolled flooding. Flood vulnerability is a condition that indicates whether an area is prone to inundation or is flooded (Dibyosaputro, 1988 Kurnianto, 2010). Each area with different physical conditions has different vulnerabilities. Some areas are very prone to flooding, and some areas are not at risk of flooding. Areas with frequent or high potential for natural disasters depend on the severity of the causes of flooding.

According to Prasetyo (2009), factors that affect flood-prone areas are relatively flat topography and poor spatial planning. These areas are mainly located in big cities and river banks. Rachmat and Pamungkas (2014) found that distance to the river and topographical conditions indicate that this has a major impact on flood vulnerability. In addition, land use affects the absorption of rainwater by the soil.

Floods can be caused by all kinds of causes, one of which is the physical factor of the area. Areas that have the potential for flooding are classified into three, namely:

1. Flood Plain Area
   Flood plain area or floodplain area is a low-lying area located on the left and right of the river, causing the flow to the river to be slow and causing the area to be prone to flooding due to overflowing river water and local rain in the area.

2. Riverfront Area
   The river border area is an area along the left and right of the river, including artificial rivers. The existence of this area is about 100 meters on either side of a large river and about 50 meters on either side of a small river (tributary).

3. Basin Area
   The Basin area is a relatively large area, both in the lowlands and highlands (upstream) which can become flood-prone areas. Riverbanks must be managed and maintained as well as possible in order to avoid disasters and flood problems.

4. Analysis and Discussion

In this study using scoring analysis from several existing maps of Pesanggrahan District with the following scoring provisions:

1. Contour
   On the contour map, elevations 10 to 69 will be given a value of 1 because they are at the lowest and most potentially flooded because water is most likely to flow into this area, 70 to 133 will be given a value of 2 and the highest 134 to 167 will be given a value of 3.

2. Land Use Map
   From the land use map itself, it will be seen the percentage of green open land use in the village, if there is no green open space it will be given a value of 1, if 1% to 10% will be given a value of 2 and 11% to 20% will be given a value of 3 .

3. Drainage

Drainage will be seen whether the sub-district has a final disposal site such as rivers, lakes, and the like. If the area has a landfill, it will be given a score of 3, if there is primary road drainage but there is no final disposal, it will be given a value of 2, and if it does not have both, it will be given a value of 1.

The authors are encouraged to render the numbers according to the International rules, specifying the dot as a decimal separator and the comma as a thousands separator.

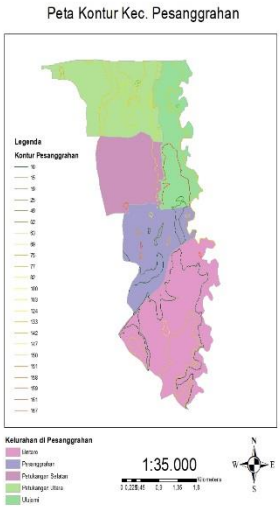

Fig 1. Contour map of Pesanggrahan sub-district

The first map is a contour map (fig.1), from the contour map we judge that the lowest sub-district is the sub-district with the smallest value and vice versa, in this study we use a color spectrum from the highest red to the lowest green to make it easier to read. From the contour map, it can be seen that the lowest areas are Bintaro Village and Pesanggrahan Village with a range of 10 to 60 masl which we give a value of 1 and North Petukangan Village has the highest altitude with a range of 100-150 masl and will be given a value of 3.

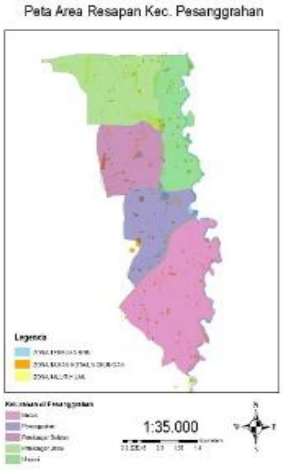

Fig 2. Map of the absorption area of Pesanggrahan sub-districtt

From the land use map itself (fig.2), all sub-district tend to be the same. Has residential and residential areas that dominate, slightly mixed, and also commercial areas. Each sub-district cannot be given a perfect score because the green zone in each sub-district does not reach 20% as planned.

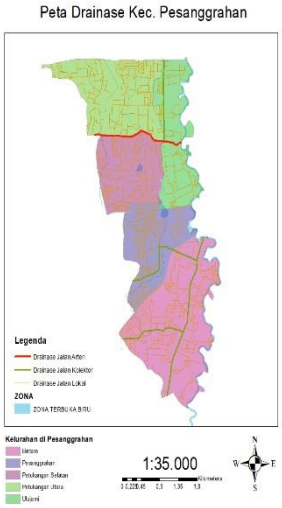

Fig 3. Pesanggrahan district drainage map

In the drainage map (fig.3), it is seen from the type of drainage and also whether there is an end to the drainage flow. From the map, all drainages in each sub-district tend to be the same and have been fulfilled, only that in some sub-district there are rivers which are assumed to be the final disposal of water flows. In short, a sub-district that has a river in its area has a value of 3 because the passage of water to the final disposal is faster and does not cause flooding due to settled water. The village that has a river in its area is Bintaro Village, Pesanggrahan, Ulujami. The rest of the other sub-district will be given a score of 2 because the drainage facilities are adequate. The following is a table of scoring analysis:

sub-district	Scoring			Total
	Conture	Land Use	Drainase	
Bintaro	1	2	3	6
Petukangan Utara	3	2	2	7
Petukangan Selatan	2	2	2	6
Pesanggrahan	1	2	3	6
Ulujami	3	2	3	8

6. Conclusions and suggestions

It should be noted in advance that the results of this analysis are based on several assumptions taken by the researcher. The first is that the condition of the drainage canal is fine and there are no obstacles such as damage and congestion. The second is that the land use map is completely like the existing state where the green zone in the map reflects the green zone in the existing state of the Pesanggrahan District area.

From the results of the scoring analysis, it can be seen that the sub-district with the lowest level of vulnerability to flooding is the Ulujami sub-district, this sub-district besides having the highest elevation

among other sub-district, water will flow into the sub-district which tends to be lower than this sub-district as well. The presence of a river in this village makes the flow of water faster to the final disposal, namely the river. Some sub-districts with low scores are Pesanggrahan and Bintaro Villages, these villages have rivers in their area but with the lowest elevation, this village has the potential to flood if the drainage channel is blocked or the volume of water exceeds what can be accommodated. Suggestions that can be taken from this research for the government are to prepare several villages that are considered more prone to flooding, such as Bintaro and Pesanggrahan villages whose drainage conditions must always be checked because these two villages are a little far from the last disposal, the water flow is required to be smooth and not there are hiccups along the way of the water flow.

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