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Mitigation Policy of Flood Disaster in Sungai Penuh Town Province of Jambi, Indonesia

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Abstract

This research is based on the weak role of government in reducing the risk of flood disaster in Sungai Penuh Town appropriately, thus efforts are needed to avoid and decrease this situation, in other word mitigation of flood disaster is needed. The purpose of this study are analyzed the characteristics of area based catastrophic flooding, flood hazard, and flood risk and formulate mitigation policy and direction of flood disaster. The type of research is combined or mixed method. This study using quantitative Method used in determining volcano hazard, the level of vulnerability of the community, volcano risk and the use of qualitative Method used in determining the direction and mitigation policies towards mitigation of flood disaster. Findings research shows two characteristics area are good area that didn't hazard of flood covering 4872 ha and bad area that cause the flood covering 30403 ha, with three levels of flood hazard are high flood hazard covering 3145 ha, medium flood hazard covering 1726 ha, and low flood hazard covering 30403 ha and three levels of flood risk are flood risk high covering 4872 ha, flood risk medium covering 6395 ha, and flood risk low covering 24008 ha. The high flood harmful for environment and agriculture, due this situation, this research is needed mitigation policy of flood disaster which set up zoning on any flood hazard zone, normalization downstream/ estuaries of river, doing and improving the coordination of government in the cross-sectoral of town and regency, developing the early warning system, and socialitation and provide training/ non-agricultural skills to the society.

Keywords: Policy, Mitigation, Flood Disaster, Hazard, Risk

Introduction

Sungai Penuh Town has beautiful natural scenery with a cool climate, but also prone to natural disasters. In topography and morphology, Sungai Penuh Town is a depressed area, located in the fracture of the ocean, the morphology of wavy are medium and strong, with the lowest point of 500 meters above sea level and the highest point 1800 meters above sea level, with a slope of 14% -55%. This topography makes Sungai Penuh Town full highly vulnerable to landslides and flooding. Meanwhile on the other hand there is a swampy area which has always been the area of flood inundation during the rainy season (BPBDs, 2011; Hermon, 2012a; Hermon, 2012b).

Sungai Penuh Town always become flooded every rainy season arrives and always threatens almost all districts in Sungai Penuh Town. The main factors that led to the occurrence of floods in the Sungai Penuh Town, is the high rainfall and lasts longer in the upper watershed Batang Bungkal and Ampuh River resulted in flooding in the downstream flow of the river due to the lack of absorption and lack of good watershed Lake Kerinci and conditions surrounding community settlements in watersheds that are lower than the normal limit

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water discharge their this happens every rainy season. High rainfall also wreak Batang Merao River so during the rainy season every year, resulting in seasonal flooding along the Batang Merao River. While the seepage of rain in the upper reaches is poor so that water flows directly into the watershed surrounding that directly flows into Batang Bungkal River across the Sungai Penuh Town and causing widespread flooding, so the negative impact on physical structures, bridges, homes located around the banks of the Batang Bungkal River (Bappeda, 2012; Hermon, 2014a; Hermon, 2014b; Hermon, 2017; Hermon, 2018a).

Flood in 2013 hits three villages, they are Tanjung Village and Tanjung Muda Village Hamparan Rawang District and Tanjung Bungo Village Tanah Kampung District, according to Village Heads, Tanjung is the worst flooding since last 20 years with the impact is the water level has reached 2 meters and stagnant water for 16 days (Tribun Jambi, 2013). In early 2016 flood happen that most serious occurred in the village of Koto Dumo and Koto Padang Tanah Kampung District (Metro Sakti, 2016), resulting in thousands of homes submerged by floodwaters reaching one meter, but floods also caused disturbing access to Sungai Penuh Town because the roads are impassable (Soraklintera, 2016). Not only resulted in thousands of homes submerged and damaged infrastructure, the floods that occurred in the beginning of 2016 also resulted in 247 ha of paddy crop failure (Department of Agriculture, 2016; Hermon *et al*, 2018a).

The flood disaster can also be triggered by human behavior that are not friendly to the environment and the activities of people living along the river, so it cannot be avoided if there was a flood then there is always the losses that arise, both in terms of human life, environmental changes, economy and infrastructure. As well as floods that occurred in the village of Lawang Agung Pondok Tinggi District caused by the contractor drainage projects, flood that occurred in the beginning of 2016, the biggest flood in the history of Sungai Penuh Town in the decade 2014 - March 2016 (Portal Buana Online News, 2016; Hermon, 2017; Hermon, 2018b).

Several rows of flood that occurred in several districts in the Sungai Penuh Town, many of public opinion which says that less responsive and slow efforts of the government in handling the flood. It indicates the weakness of the government's role in reducing the risk of floods in the Sungai Penuh Town, therefore it should be an attempt to avoid the occurrence of disasters and reducing the risk of floods, in other words the need mitigation of flood disaster. Mitigation of flood disaster is a series of efforts to reduce the flooding risk, either through physical development or awareness and increase capacity to deal with the threat of floods. Mitigation measures can be done through the mapping of areas that have high levels of flood hazards and also necessary mitigation policy of flood formulation (Paimin *et al*., 2009 in Hermon, 2012).

Method

Tutorial flood-mitigation policies conducted through analysis of secondary data, followed by in-depth interviews through informants by the Government of Sungai Penuh Town (BPBDs, Department of Public Works, the Environment Agency, Department of Agriculture), private sector (NGOs), experts (Higher Education), and the community. This is done for the formulation of policy alternatives, while the policy priorities were analyzed by using AHP (Analytical Hierarchy Process). The research location is in the Sungai Penuh Town and data used in this study are (1) primary data obtained directly from the field by observing the characteristics of land-based flood and the level of hazard of flooding (landform, slope of land either side of the river, damming by branching river/tide, meandering (P), the average slope of the watershed, rainfall and land use); (2) supporting secondary data (the number of fatalities and economic losses due to floods) obtained from the relevant agencies such as BAPPEDA, BPS, and BPBD.

Results and Discussion

The astronomical, situational of Sungai Penuh Town between 101˚14'32" BT - 101˚27'31" BT and 02˚01'40" LS - 02˚14'54" LS. While geographically, Sungai Penuh Town are within the scope of Kerinci Regency in the western part of the Province of Jambi directly adjacent to the Province of West Sumatra and Bengkulu. Sungai Penuh Town generally located at an altitude between 500 - 1000 meters above sea level. Slope varies from flat to very steep/ precipitous. Namely fluvial landform, volcanic, denudational, and karst.

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The type of soil is alluvial, andosol, latosol, and podzolic. The average daily temperature of Sungai Penuh Town is 22.5°C. Relative of air humidity per month by 83%. The average rainfall 1618 mm/yr.

The flood disaster is an event that is threatening and disrupting the lives and livelihood caused by overflowing rivers. Mapping areas that have high levels of flood hazard needs to be done so that the government can take appropriate policy in overcoming it. Sungai Penuh Town is one part of the Province of Jambi. Sungai Penuh Town area included in the Sub-Watershed Batanghari. The main river is contained in the Sungai Penuh Town is a Ning River, Pengasah River, Air Sesat River, Air Sempit River, Terung River, Air Hitam River, Batang Sangir River (± 3 km), Air Bungkal River (± 9 km), and Batang Merao River (± 12 km). The main rivers above are included in Sub-Watershed Batanghari, which is a series of watershed from Kerinci Regency.

Based on the indicators of rainfall in the study area is about 1618 mm/yr. This allows the occurrence of floods is not too worried mean in terms of rainfall there is nothing to worry about. Based on data from BMKG Meteorological Station Depati Parbo Kerinci in 2015, the highest rainfall in the area of research is in November with an average of 297.3 mm/month, followed in December with an average rainfall of 279.8 mm/month, while the lowest rainfall in the area of research that takes place in October with an average of 9.2 mm/month, followed in succession in September that with an average of 16 mm/month. Based on rainfall data above, it can be predicted likelihood of potential flooding in the area of research, namely in November and December, while other months predicted no potential flooding.

Calculation of land characteristics Sungai Penuh Town indicates that there are two levels of land-based characteristics of the floods in the Sungai Penuh Town, they are: (1) the level of the characteristics of good land, and does not support the flooding that covering an area of 3146 ha (8.9%) due to the origin of land forms (1) denudasional contained in the three sample points are D1 (eroded mountains), D2 (eroded hills) and D6 (foot of the slopes); (2) karst with sampling points is K4 (the rest of the karst hills); and (3) volcanic with two sample points that V3 (mountain slope) and V5 (plains foot of the mountain). the slope of land either side of the river ranges from 8-28% (very smooth). Hardly any damming by branching river only by a subsidiary of the main river. Meandering sinisity is 1.1 with an average slope of watershed categorized as very bad in supporting flood (8%-28%) with the use of land mostly consists of hills; (2) the level of bad land characteristics, and support the occurrence of floods that covering an area of 30403 ha (86.2%) due to the origin of the fluvial land forms found in five samples of research that are F1 (alluvial), F2 (swamp back), F3 (floodplains), F4 (natural levees), and F6 (alluvial fan). Land slopes either side of the river ranges from 2% - 8% (hampered). Damming of the main river, with an average slope of the watershed with flat category (8%) with the use of the land consists of settlements and fields. This is same as the opinion of Paimin (2009) in Hermon (2012) states that the characteristics of the flooded area is often in the form of land forms alluvial plains, valleys alluvial, swamp with a slope of land either side of the river <2% has the potential to receive the overflow of river water in the form of puddle.

Flood hazard level in the Sungai Penuh Town indicates that there are three levels of flood hazard, they are (1) **high** flood hazard level covering an area of 4872 ha (13.8%); (2) **medium** flood hazard level covering an area of 6395 ha (18.1%); and (3) **low** level of flood hazard covering an area of 24008 ha (68.1%),. High flood hazard level caused by landform origin fluvial processes which are at three points, they are F1 sample (alluvial), F2 (swamp back) and F3 (floodplain). Land slopes left and right tributaries inhibited (2%). Damming by the main river, with an average slope of the watershed with flat category (8%) with the use of the land consists of urban settlements. Not much different from the characteristic of land-based flood, the level of high flood hazard contained in the three sample points are categorized high flood hazard based on Paimin (2009) in Hermon (2012) states that the characteristics of the area is often flooded a form of plains alluvial, alluvial valleys, swamps with a left-right slope of the river <2% has the potential to receive the overflow of river water in the form of puddles.

There are three categories of flood risk in the area of research they are three: (1) **high** flood risk level covering an area of 4872 ha (13.8%). In this zone the possibility of property's loss around >100 million and over 10 deaths; (2) **medium** flood risk level covering an area of 6395 ha (18.1%). In this zone the possibility of property's loss is about 100 million by and <10 deaths; (3) **low** flood risk level covering an area of 24008 ha (68.1%). In this zone the possibility of property's loss is about <10 million without any deaths.

Law No. 24 of 2007 on disaster management chapter 1 verse 9 states that mitigation is a series of efforts to reduce disaster risk, either through physical development, awareness or increase the ability of people

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in the face of hazard. As same as, RTRW Sungai Penuh Town 2011 - 2013 also explains that the physical and environmental carrying capacity Sungai Penuh Town is located in areas prone of floods, landslides, earthquakes and disaster needed approaches of disaster mitigation to avoid these problems.

According to Zubaidah *et al* (2005), floods despite pose a risk is relatively lower than the volcanic eruptions, earthquakes and tsunamis, but has a frequency of relatively higher, so when accumulated this disaster also caused much loss than three disasters other. One way to minimize the risk of flooding is to predict when an area will potentially flooded. According to Imam (2007; Hermon, 2014b; Hermon, 2015; Hermon 2016a; Hermon, 2016b; Hermon *et al*, 2017; Hermon *et al*, 2018), mitigation is generally carried out in order to reduce losses due to the possibility of a disaster, whether it be deaths/ or loss of property which will affect the lives and human activity. To define a mitigation plan or strategy which precise and accurate, it is necessary to do risk assessment. Not all potential natural hazard would pose a risk of disaster. If an event that has the potential hazard occurred in an area vulnerable to the condition, so the area at risk of disaster.

From the calculation of the flooding risk level, indicates the risk level is high enough to threaten the community settlement and agriculture, it is necessary for landing and mitigation policies. The criteria for policy direction and mitigation which done in this research include aspects of land-based characteristics of floods, flood hazard level, and the level of flood risk. Based on these criteria drawn up various alternative policies, which then obtained a policy priority (Oktorie, 2017)

From twelve policy alternatives can be taken five policy priorities based on the calculation of the ratio Consistency with the requirements of data should be consistent or <0.1. Figure 1 shows the values of Consistency ratio is 0.011. That is, the policy hierarchy in this study is consistent and can be used.

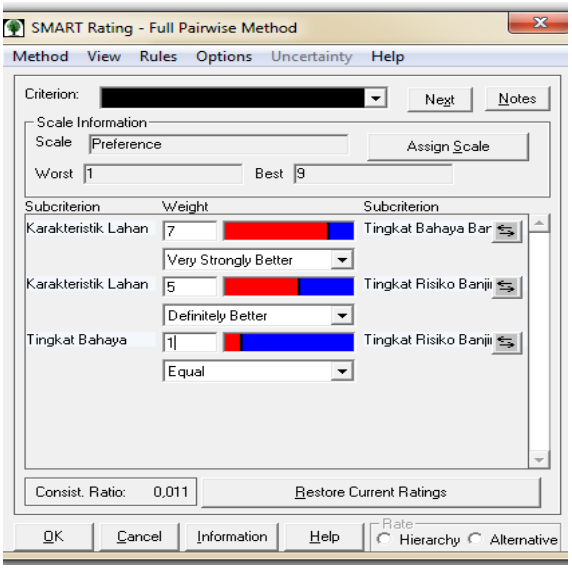

Figure 1. Consistency ratio (<0,1)

The nature of the consistency of the policy is 0.011 or <0.1, so it can proceed with setting policy priorities. Based on the interviews conducted with BPBD, BLH, PU, Department of Agriculture, and public figures, from twelve policy alternatives can be taken five policy priorities. Figure 3 shows that the policy priority is to set up zoning on any flood hazard zone, normalization downstream/ estuaries of river, doing and improving the coordination of government in the cross-sectoral of town and regency, developing the early warning system, and socialization and provide training/ non-agricultural skills to the society.

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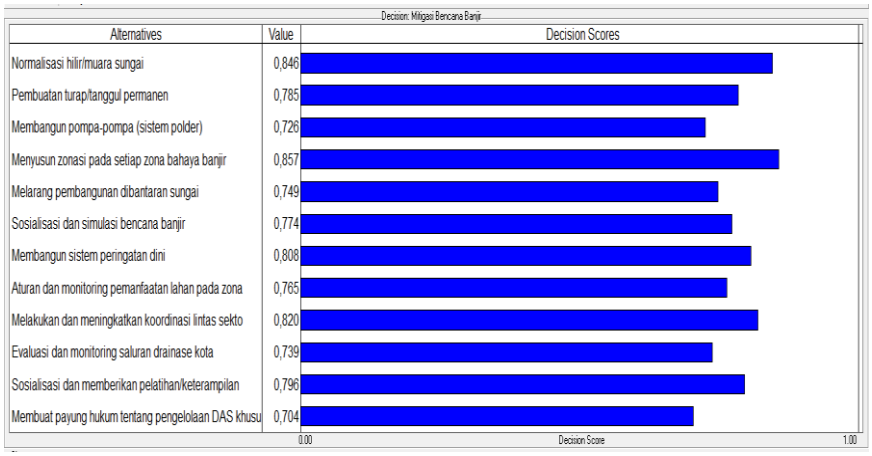

Figure 2. Priorities The Mitigation Policy of Flood Disaster

These policy priorities can be accomplished with the implementation and implications of each policy. The implementation of each priority of the policy are:

a. Set up zoning on any flood hazard zone
   1. Socialization of flood hazard zoning properly to the public.
   2. Implement strict supervision and control, and consistently at every level of the flood zone.
   3. Prepare to evacuate the hazard zone of high flood disaster such as shelter, boats and other rescue tools.
   4. Socialisation to the public of increased vigilance in any zone on the hazard of flooding.

b. Normalization downstream/ estuary of river
   1. Dredging in the downstream who have experienced silting.
   2. Conservation of riparian area by planting adaptive flooding.
   3. Restore the upstream area by planting, especially in the area of water resources.
   4. Improve clean program (PROKASIH).
   5. Continuing production of the check dam in upstream.
   6. Conduct regular monitoring of the river basin management.
   7. Evaluation and monitoring of existing irrigation development.

c. Doing and improving the coordination of government in the cross-sectoral of town and regency
   1. Establish a forum basin (as a comprehensive container).
   2. Provide counseling and formed a village disaster preparedness and climate village program.
   3. Socialization of building design.
   4. Control of land use and planning where to place vital facilities are vulnerable to flooding in the safety area.
   5. Evaluation and monitoring in the upstream watershed in Kerinci regency, periodic and measurable.
   6. Coordinate between education and health care centers located in flood hazard areas.

d. Developing the early warning system
   1. Provide training on flood alert such as how the storage/ warehousing supplies, a place of rest /sleep in a safe place (a high area).
   2. Enforce an early warning system based on local wisdom or community.
   3. Socialization SOP/ standard procedure flood early warning system.

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4. Build a network of communities along the river.
5. Create understanding flood warning scheme with the community.
6. Conduct monitoring of early warning system on a regular basis.

e. Socialization and provide training/ non-agricultural skills to the society.

1. Increasing the quality of human resources through training activities diklat (education and training) or bimtek (technical assistance) in all fields.
2. Empowerment potential of the village needs to be done in a sustainable manner by photographing the potential already owned and could be developed continuously.
3. Socialization of appropriate planting schedules which adjusted to approximate high rainfall.

In addition to flood control, according Regulation The Minister of Interior No. 33 In 2006, five policy priorities above is also in line with the directives of flood control according RTRW Sungai Penuh Town 2011-2031 that the direction of the flood control including the development of reservoir water body, normalizing the flow of the river around Sungai Penuh Town, control of the region in areas prone to flooding, and improving the quality of the drainage area. To avoid the annual flooding caused of high elevation of the riverbed elevation than the road and farmland elevation, it is necessary to develop a major polder system in puddle area located around flooding area.

Instruction flood-mitigation policies that have been formulated based on research as a whole resembles that have been formulated in the RTRW Sungai Penuh Town 2011 - 2013. However, there are several points that distinguishes it is the direction of the flood control contained in Sungai Penuh Town RTRW 2011-2013 only focus to the physical aspects of flood prone areas, while for the social aspects of the mitigation of floods is still not a priority.

Conclusion

Based on the results of the research, Sungai Penuh can be categorized into two categories based on the level of flood land characteristics, they are (1) Zone A or **Good** Zone is covering an area of 30403 ha (86.2%), means that the characteristics of the Good land in supporting non-occurrence of floods; (2) Zone B or **Bad** Zone is covering an area of 4872 ha (13.8%), means that support the flood disaster. The level of flood hazard in the Sungai Penuh Town indicates three levels of flood hazard, they are (1) **high** flood hazard level is covering an area of 4872 ha (13.8%); (2) **medium** flood hazard level covering an area of 6395 ha (18.1%); and (3) **low** flood hazard level is covering an area of 24008 ha (68.1%). There are three categories of the flood risk level in the area of research; (1) **high** flood risk level is covering an area of 4872 ha (13.8%). In this zone the possibility of property's loss reaches> 100 million, and over 10 deaths; (2) **medium** flood risk level of flood risk is covering an area of 6395 ha (18.1%). In this zone the possibility of property's loss reaches 100 million, and <10 deaths; (3) **low** flood risk level covering an area of 24008 ha (68.1%). In this zone the possibility of property's losses <10 million without any deaths. To mitigate the worst effects of the floods, need to apply several alternative policies based on land characteristics of floods, flood hazard level and the level of flood risk. Based on these alternatives that became one of his priorities was to set up zoning on any flood hazard zone (0.857), normalization downstream/ estuaries of river (0.846), doing and improving the coordination of government in the cross-sectoral of town and regency (0.820), developing the early warning system (0.808), and socialization and training/ non-agricultural skills to the society (0.796).

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