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Smart Disaster Governance in Reducing Flood Disaster Risk in Pati Regency based on Geospatial Analysis

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Abstract

Hydrometeorological disasters are disasters that often occur in Indonesia and the frequency of these disasters has increased and has an impact on human safety. So, the need for disaster management that can assist in disaster risk reduction. The existence of a smart city concept can help in changing disaster governance to be smart and can help in increasing community resilience to disasters. One of the districts that often experience disasters and has implemented the smart city concept is Pati Regency. Disaster events in Pati Regency in 2016-2020 experienced an increase of approximately 148 incidents. Judging from the increase in disaster events, there is a need for clear disaster management in reducing risk at each stage (pre, during and after the disaster). The application of the smart city concept in Pati Regency is expected to help with this. So far, there has been no previous research related to smart disaster management in Pati Regency. So, this research needs to be done because in disaster risk reduction it is necessary to have intelligent disaster management. The purpose of this study was to determine the parameters of smart disaster management and priority locations in reducing the risk of flood disasters in Pati Regency. This study uses quantitative methods with scoring techniques to obtain intelligent disaster management parameters.

Keywords: disaster management; smart city; smart disaster management

1. Introduction

Currently, hydrometeorological disasters are disasters that frequently occur in the world. Hydrometeorological disasters are catastrophic phenomena that occur in the atmosphere, water or ocean. These disasters are closely related to climate change and extreme weather, causing the frequency of disasters to increase and have an impact on human safety (Buchori, Pramitasari, et al. 2018; Buchori, Sugiri, et al. 2018). One country that often experiences disasters, especially hydrometeorological disasters, is Indonesia. Geographically, Indonesia's position is in an area of volcanic activity and tectonic movement of the Asian Continental Plate and the Australian Continental Plate. Based on geographical and climatological conditions, Indonesia has a very high disaster potential and varies greatly from the aspect of the type of disaster (Buchori, Sugiri, et al. 2018; Sejati, Buchori, and Rudiarto 2019). According to data from BNPB (National Board for Disaster Management) in 2010 the number of disaster events in Indonesia was 1,945 times and in 2021 it will increase to 5,402 natural disasters.

One of the concepts aimed at overcoming various urban problems such as environmental damage that results in disasters is smart city (Zhu, Li, and Feng 2019). With the help of information communication technology and other modern technologies, cities can emphasize infrastructure protection and disaster management such as continuous monitoring, data fusion, disaster warning, decision making, and security

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planning (Kummitha and Crutzen 2017; Han and Hawken 2018; Sharif (RS) and Pokharel (SP) 2021). There are 6 dimensions included in the smart city concept, including smart economy, smart governance, smart living, smart people, smart mobility, and smart environment (Giffinger 2007).

One of the districts that often experience disasters and has implemented the smart city concept is Pati District. Pati Regency, one of the districts in Central Java Province which directly borders the Java Sea, has the potential for disasters such as extreme increases and decreases in temperature, extreme increases and decreases in rainfall, and so on (Suroso and Firman 2018). Disaster incidents in Pati Regency in 2016-2020 experienced an increase of approximately 148 incidents based on data from the Pati Regency BPBD. Judging from the increase in disaster incidents, there is a need for clear disaster management in reducing risk at every stage (pre, during and post disaster). It is hoped that the implementation of the smart city concept in Pati Regency can help this. This research focuses on intelligent disaster management in efforts to reduce disaster risk. In existing conditions, there is no good governance and there is still overlap between stakeholders regarding disaster risk reduction at every stage. So, this research needs to be carried out because in reducing disaster risk there is a need for an intelligent disaster management system both in the pre-, during and post-disaster stages (A. A. Shah et al. 2019).

There has not been much research related to disaster management, especially involving the smart city concept and was carried out in Pati Regency. In article Shahat, Hyun, and Yeom (2020) discusses the conceptual framework for integrative disaster management by utilizing IoT. The research Crow and Albright (2019) discusses the relationship between local and central governments after a disaster. Meanwhile, research Dash and Punia (2019) discusses governance in flood disaster preparedness. In research Munene, Swartling, and Thomalla (2018) discusses adaptive governance to change development and disaster risk through the framework. Based on research Brink and Wamsler (2018) discussing collaborative governance for climate change disasters. Meanwhile, research Viale Pereira et al. (2017) discusses collaboration and participation in smart governance in Brazil. While research that has been carried out in Pati Regency related to disasters is about disaster risk (Kristanto, Paripurno, and Rianto 2015; Prayitno 2017), identification of the level of community preparedness for disaster risk (Wijayanti 2021), patterns of community resilience (Nurwahyudi and Maryono 2018), and analysis of local rainfall characteristics as a hydrometeorological disaster mitigation strategy (Kartono, Purwanto, and Suripin 2020).

Based on previous research articles, it can be seen that there has been no research related to the parameters of intelligent disaster management in reducing disaster risk, the existing research has its own focus, such as some which only discuss the intelligent disaster management framework, some which discuss disaster governance. of course, and some discuss smart governance. Likewise, with research conducted in Pati Regency, there has been no research related to intelligent disaster management in reducing disaster risk. So, this research needs to be carried out and focuses on the parameters of smart governance in disaster risk reduction in Pati Regency.

2. Data and Methods

This research took the study area in Pati Regency. Pati Regency is one of the regencies in Central Java Province. Pati Regency has a varied morphological structure consisting of the slopes of Mount Muria, lowlands and limestone mountains. Pati Regency consists of 21 sub-districts, 401 villages and 5 sub-districts. The area of Pati Regency is 1503.66 km2 or 150.368 ha with the government center located in Pati District. The total population of Pati Regency in 2022 is 1,361,068 people. To better understand the general picture of Pati Regency, you can look at Figure 1 below.

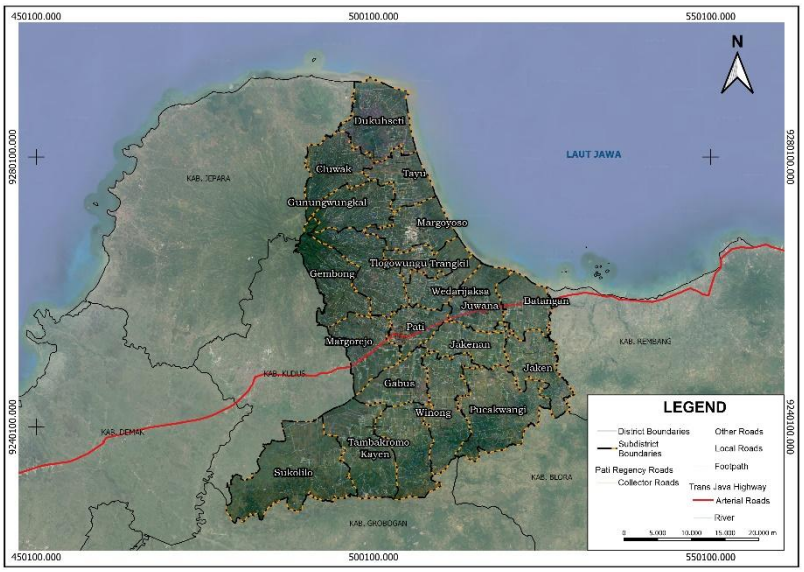

Figure 1 Pati Regency Administrative Map
Source: geospatial information agency, 2022

This research uses a quantitative approach to achieve research objectives. A quantitative approach was taken based on GIS (Geographic Information System). Quantitative research using GIS spatial analysis tools can make it easier for researchers to assess priority areas affected by flood disasters to be handled. Apart from that, quantitative research is also used to determine priority parameters for smart governance in reducing flood disaster risk. The proposed research stages include preparation, data collection and data analysis. The data used in this research includes primary and secondary data.

The preparation stage of the research was carried out by examining literature related to smart disaster governance in reducing the risk of flood disasters in Pati Regency based on geospatial analysis. The literature review activity aims to map out the extent of novelty and the variables that will be used in this study. Furthermore, the list of data requirements will be detailed based on the variables that have been obtained from reviewing the documents.

The second stage is data collection. Data collection was carried out primary and secondary. Primary data collection was carried out by means of observation and FGD (to see the priority parameters in intelligent disaster management and validate the priority locations for flood disaster management). Meanwhile, secondary data collection was carried out through literature review and document review. The population in this study are stakeholders related to disasters in Pati Regency such as OPD (regional apparatus organizations)/related agencies/organizations, the community, private sector, media, and universities. OPD related to BPBD (Regional Disaster Management Agency), Bappeda (Regional Planning Agency), Social Service, DPUTR (Public Works and Spatial Planning Service), Public Housing Service for Settlement Areas, Health Service, Communication and Informatics Service, Environment Service, Department Maritime Affairs and Fisheries, Transportation Department, BBWS (River Area Management Center) Pemali Juwana, BPDASHL (River Watershed and Protected Forest Management Center) Pemalijratun (UPT (Task Implementation Unit) Ministry of Environment and Forestry Pemali-Jratun), Perhutani (State Forestry Public Company) , Village Community Empowerment Service, Forest Service II Pati Branch, TNI (Indonesian National Army)/Indonesian Republic Police, PMI (Indonesian Red Cross), NGO (Non-Governmental Organization). The private sector has provided assistance for disaster management. Media that has reported on disasters, and universities that have conducted research related to disasters in Pati Regency.

The sample is part of the population that has the same characteristics and can represent that population. The sample used in this study were stakeholders related to the disaster in Pati Regency, such as related OPDs/agencies/organizations, the community, the private sector, the media, and universities. These stakeholders have been described in the previous population. The sampling technique used in this research is saturated or census sampling technique, in which all members of the population are used as samples.

The final stage is data analysis which is divided based on targets. In the first analysis related to the analysis of priority locations for flood disaster management using a spatial analysis tool GIS (Geographical Information System). The data used to analyze the risk of flood disasters was obtained from the Inarisk portal. The second analysis is related to stakeholder analysis and their role in disaster management. The analysis technique used is quantitative descriptive analysis. To identify stakeholders and their roles in disaster management, it is seen based on the strategic plan and disaster management plan documents. The third analysis is an analysis of smart disaster governance parameters in reducing flood disaster risk. The analysis technique used is scoring analysis using a Likert scale. The Likert scale is a research scale for measuring the attitudes and opinions of respondents. The Likert scale has a scale of 1-5 with the selection of Strongly Agree (SS) to Strongly Disagree (STS), below are the levels.

1. Strongly Agree (SS)
2. Agree (S)
3. Undecided (RG)
4. Disagree (TS)
5. Strongly Disagree (STS)

The score 1 – 5 above shows the views of stakeholders regarding the parameters of intelligent disaster management in reducing disaster risk. A score of 1 indicates that the respondent strongly agrees that the parameter has been demonstrated or that the parameter has been implemented very well. A score of 3 indicates that the respondent is unsure or does not know enough about these parameters. A score of 5 indicates that these parameters have not been implemented properly or have not even been implemented.

3. Result and Discussion

Disaster risk is the potential for damage caused by a disaster such as death, injury, damage or loss of property, infrastructure damage, and environmental damage over a certain period of time (BNPB, 2019). Disasters can occur at any time, but when communities and policy makers have the capacity and readiness to face these threats, disaster risks can be reduced (Mukaromah, Suharini, and Tjahjono 2020). One form of flood disaster mitigation is by determining priority locations for flood management through a flood disaster risk map.

Determining priority locations for flood disaster management is very important for disaster mitigation so it needs to be considered in spatial planning. Spatial planning issues are very important for areas that are prone to disasters (Putera, Valentina, and Rosa 2020). A spatial planning process that does not pay attention to nature can have an impact on disasters (Haris, Sitorus, and Tjahjono 2022). So determining priority locations for handling flood disasters needs to be done to minimize losses that occur due to disasters.

Priority locations for handling flood disasters in Pati Regency are carried out using disaster risk analysis. The level of flood disaster risk can be seen based on the level of danger, level of vulnerability and level of capacity. The preparation of flood disaster risk analysis uses 3 scoring classes, namely high value, medium value, value and low. The disaster risk assessment is prepared based on an index that refers to the 2012 Regulation of the Head of the Disaster Management Agency of the Republic of Indonesia No. 2 concerning General Guidelines for Disaster Risk Assessment. Flood disaster risk analysis is obtained through calculating the threat index, vulnerability index and capacity index which can be accessed through the InaRisk portal.

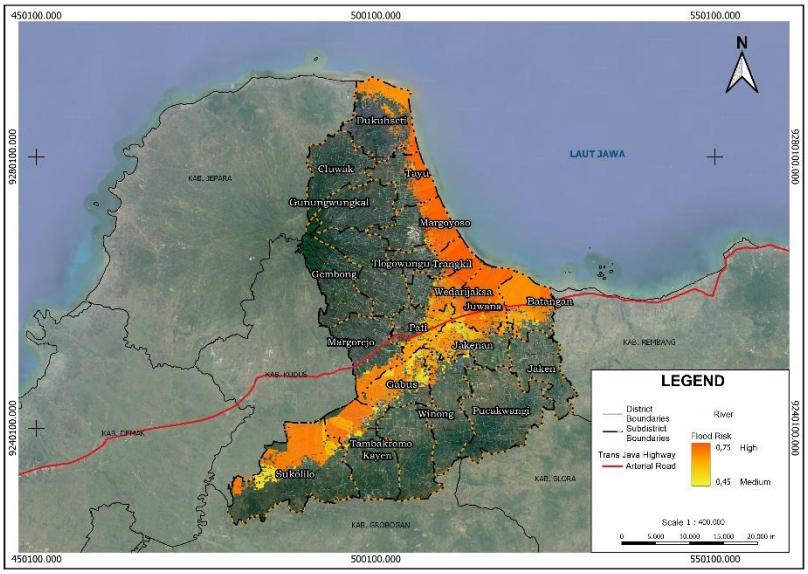

Figure 2 Flood Disaster Risk Map in Pati Regency

Source: Inarisk, 2023

Based on the flood disaster risk map on Figure 2 above, areas with a high index are in 130 villages out of 406 villages throughout Pati Regency. The most villages with a high index are in Juwana District, namely 19 villages. Flood disasters in Pati Regency often occur in the southern region, namely Juwana, Jakenan, Gabus, Tambakromo Districts due to the frequent overflow of the Silugonggo River or Juwana River and in the northern part, namely Tayu District due to the overflow of the Tayu River around the estuary. Other areas that have a high risk of flooding include Dukuhseti, Margoyoso, Batangan, Kayen, Margorejo, Pati, Sukolilo, Trangkil, Wedarijaksa and Winong sub-districts.

The flood disaster in Pati Regency occurred due to river conditions experiencing shallowing, sedimentation, narrowing of cross-sectional area, coupled with high rainfall. There are also rivers in Pati Regency that are experiencing physical changes, such as the river body narrowing at the downstream end of the river. Especially in coastal areas such as Juwana District, the river conditions are silting up due to the large number of boats parked. There are people who live in flood-prone areas, and many villages/districts have not received CSR assistance from the private sector. In disaster management, there is a need for pentahelix disaster management, namely collaboration between government, private sector, academics, media and society. The main goal of disaster management is the integration of interrelated processes that can provide an efficient way to analyze, monitor and/or predict disasters (S. A. Shah et al. 2019). So there is a need for collaboration between stakeholders in reducing the risk of flood disasters in Pati Regency.

BPBD is the main stakeholder in disaster management in Pati Regency which has functions/roles such as coordinating with other stakeholders in disaster management; providing command and direction of human resources, equipment, logistics from other regional apparatus; and as executor. In addition, OPD/agencies/organizations related to disasters such as Bappeda (Regional Planning Agency), Social Service, DPUTR (Public Works and Spatial Planning Service), Public Housing Service for Settlement Areas, Health Service, Communication and Informatics Service, Environment Service, Department Maritime Affairs and Fisheries, Transportation Department, BBWS (River Area Management Center) Pemali Juwana, BPDASHL (River Watershed and Protected Forest Management Center) Pemalijratun (UPT (Task Implementation Unit) Ministry of Environment and Forestry Pemali-Jratun), Perhutani (State Forestry Public Company) , Village Community Empowerment Service, Forest Service II Pati Branch, TNI (Indonesian National Army)/Indonesian Republic Police, PMI (Indonesian Red Cross), NGO (Non-Governmental Organization) have their respective roles which are divided into pre-disaster, emergency response and post-disaster. The main roles that OPD/agencies/organizations have during the pre-disaster period are policy makers, facilities and infrastructure providers, coordination with other OPDs/agencies/organizations. The main roles that OPDs/agencies/organizations have during the emergency response stage are analysis of the number of victims, preparing logistics and public kitchens, preparing equipment for emergency response, initial repair of vital infrastructure, provision of evacuation sites, security of government assets. The main

roles that OPDs/agencies/organizations have in the aftermath of a disaster include preparing rehabilitation and reconstruction plans, social and economic recovery, providing social assistance, repairing damaged facilities and infrastructure.

Apart from OPD/agencies/organizations, stakeholders related to disaster management need the participation of the community, business world, academics and the media. Communities are the initial actors in disaster management as well as victims of disasters, so they must be able to deal with disasters within certain limits and must be aware of protecting the environment. The private sector has a role in dealing with disasters, such as providing emergency assistance such as social, economic and infrastructure assistance. Academics have a role in disaster management such as conducting training for volunteers and the community, making studies related to disasters. The media has a very important role in building community resilience, such as providing information related to disasters.

Stakeholders also play a role in determining the parameters of intelligent disaster management in reducing the risk of flood disasters in Pati Regency. Because in disaster risk reduction it is necessary to have an intelligent disaster management system both at the pre, during and post-disaster stages (A. A. Shah et al. 2019). Determination of these parameters is carried out by means of FGD with relevant stakeholders. This dialogue between stakeholders enables bottom-up integration and disaster risk reduction measures (Gaillard et al. 2013).

Figure 3 Focus Group Discussion with Stakeholders

Source: Author Documentation, 2023

Based on the results of FGDs with relevant stakeholders on Figure 3 above, produce smart disaster management parameters in reducing the risk of flood disasters. There are 13 parameters of intelligent disaster management in disaster risk reduction. The 13 parameters are easy to access, there is monitoring, connectivity, real-time data, there is an early warning system, informative (easy to understand/clear), there is stakeholder participation, flexible and transparent, awareness of disasters, responsive in disaster management (effective and efficient), control over the implementation of disaster governance, preparedness (stakeholder capacity for disasters), post-disaster response and recovery. These parameters can be used as a reference in implementing smart disaster management for policy makers or the Pati Regency government to be able to reduce disaster risks, especially floods.

4. Conclusion

The risk of a flood disaster is the potential loss caused by flooding in an area within a certain period of time in the form of death, injury, loss of sense of security, displacement, damage or loss of property, disruption of community activities, environmental damage and others. So, it is necessary to make efforts to reduce the risk of flood disasters through intelligent disaster management. In this study, before determining the parameters of intelligent disaster management in reducing the risk of flood disasters, it is necessary to identify priority locations in flood disaster management.

The results of the flood disaster risk analysis show that there are areas with a high index in 130 villages out of 406 villages throughout Pati Regency. The most villages with a high index are in Juwana District, namely 19 villages. Other areas that have a high risk of flooding include Dukuhseti, Margoyoso, Batangan, Kayen, Margorejo, Pati, Sukolilo, Trangkil, Wedarijaksa and Winong sub-districts. In reducing the risk of flood disasters in Pati Regency, there needs to be collaboration and the role of related stakeholders.

Stakeholders involved in reducing the risk of flooding in Pati Regency are the OPD/agencies/organizations concerned, the community, the private sector, the media, and universities. Where each stakeholder has their respective important roles both at the pre-disaster, disaster response, and post-disaster stages. These stakeholders also play a role in determining the priority parameters of smart disaster management for flood disaster reduction in Pati Regency. There are 13 parameters of intelligent disaster management in disaster risk reduction, namely easy access, monitoring, connectivity, real-time data, early warning system, informative (easy to understand/clear), stakeholder participation, flexible and transparent, awareness of disasters, responsiveness in disaster management (effective and efficient), existence of control in the implementation of disaster management, preparedness (stakeholder capacity for

disaster), post-disaster management and recovery. This parameter can be used as input for the government in creating a smart disaster management system to be able to reduce disaster risks, especially floods.

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