



## Effectiveness of Flood Management through Pump Houses Based on Geographic Information Systems in the City of Surabaya

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### **Abstract**

In East Java, based on the records of the East Java Regional Disaster Management Agency (BPBD), it was noted that from January 1 to March 19, 2021, there have been 258 flood disasters. Eleven of them were flash floods and three tidal floods occurred. Likewise, in the city of Surabaya, flooding is caused by high rainfall. The purpose of the study was to find out the extent of the policy formulation of the construction and development of pump houses in solving flood problems in the city of Surabaya. This type of research is qualitative descriptive research. Research Results The formulation of the pump house development policy in flood management in the city of Surabaya has gone through the correct stages. The Commission for the Development of the Surabaya City Dprd identified flooding problems through various activities: recesses, seminars, workshops, musrenbang at the village/kelurahan and sub-district levels. Flooding is still a crucial problem that needs to be solved and the availability of a large budget. Flood management in the city of Surabaya includes multiplying and developing pump houses, building channels, repairing and elevating sluices and increasing green open space. Establishment of pump house development policy. As stated in Surabaya Mayor Regulation Number 49 of 2016 and the technical basis in question is the Surabaya Drainage Master Plan (SDMP) 2018-2038. Suggestions and recommendations. 1) It is expected that flood management will be carried out thoroughly / holistically. It needs collaborative cooperation/synergy of all my interests, both government, private sector as partners and the community. 2) Flood risk reduction should be combined structurally with the technical engineering of disaster-resistant buildings and culturally, namely increasing knowledge and attitudes so as to build resilient communities; 3) In the development of pump houses in the future by using applications with webmap-based geographic information system (GIS) technology to detect the condition of pump houses and flood-prone areas using several parameters; and 4) In the future, the city of Surabaya has a flood management bylaw and a priority scale for flood management in the form of a roadmap.

**Keywords:** *Policy Formulation; Geographic Information Systems; Webmap; Flood Relief; Pump House*

### **Introduction**

Rain is a gift of Almighty God to his people. Most of the rain is very much expected for humans on the face of the earth. Farmers really hope that it will rain so that the crops can thrive. Some people rain to lower the heat and others rain also has other benefits. But excessive rain and not offset by adequate

channels resulted in flooding. This means how to manage rain appropriately is critical, as humans cannot definitively lower or stop the rain. In other words, how human efforts in managing or controlling rain and its consequences must be pursued. Because if it is wrong or wrong in controlling water problems, in turn, natural disasters arise, namely floods.

In general, disasters are events or series of events that threaten and disrupt people's lives and livelihoods caused, either by natural and / or non-natural factors or human factors, resulting in human casualties, environmental damage, property losses, and psychological impacts. (PerKa No. 2 of 2012:2012). Meanwhile, natural disasters are the result of an imbalance of natural elements, namely between water, soil, plants, and other natural elements. This imbalance of nature is often triggered by human actions and behavior, citing development for the welfare of citizens. But what often happens is the opposite, not only floods but also landslides or droughts that cause forest fires. Although there are natural disasters that are really affected and caused purely by natural forces, such as storms, earthquakes, and erupting mountains. In addition to these aspects of natural disasters, technological failures, transportation accidents, and disease outbreaks are other disasters that also have the potential to occur in Indonesia. Several events related to this non-natural disaster were recorded that caused quite a lot of casualties and losses. These disasters are not caused by nature alone but also non-natural and a combination of various threat risks, conditions of vulnerability, inability, or weakness in acting to reduce the potential negative consequences that exist.

Natural disasters due to floods, landslides, and droughts, almost every season hit Indonesia. In flood disasters, the events and processes are strongly influenced by natural factors in the form of abnormal rainfall, even influenced by tides (for tidal floods). Flood disasters can be anticipated, because these events are very clear signs, namely when the rainy season comes, and rainfall is high. When rainfall is high, the river is no longer able to hold rainwater and eventually overflows, so flooding occurs. Floods can be a disaster for humans if they damage infrastructure and cause casualties and property losses. How to anticipate the arrival of flood disasters can be done with various actions, for example making river embankments, straightening river meanders, installing water level measuring instruments in the river body, and installing sirens as a sign when the river water exceeds the normal limit of the water level.

Handling flood hazards is not only carried out by the government but also by other actors such as the private sector and the community. The importance of the community's role in controlling water damage such as flood hazards has the support of laws and regulations, namely Law No.7 of 2004 concerning Water Resources

Community responses in reducing flood risk are carried out by actions through disaster mitigation programs from the government as well as community activities themselves. Flood risk reduction is a whole series of activities from beginning to end (one cycle) to implement disaster management, carried out through 3 (three) stages as follows: 1) Pre-disaster stage which is carried out when there is no disaster and when it is under threat of potential disasters. At this stage, disaster prevention and mitigation are carried out to reduce and overcome disaster risks and preparedness is carried out before a disaster occurs; 2) Emergency response stage designed and implemented in the event of a disaster; and 3) The deep post-disaster stage after a disaster or known as the rehabilitation and reconstruction stage.

In East Java, based on the records of the East Java Regional Disaster Management Agency (BPBD), it was noted that from January 1 to March 19, 2021, there have been 258 flood disasters in the East Java region. Eleven of them were flash floods and three tidal floods occurred. This year's floods are more frequent than in 2020 in the same time span, namely January 1 – March 19, which was recorded to have occurred 206 times. Twelve of them are flash floods and the other four are floods and landslides. This number is known [suarasurabaya.net](http://suarasurabaya.net) from the [smartpb.bpb.jatimprov.go.id](http://smartpb.bpb.jatimprov.go.id) page Various flood mitigation efforts have been carried out in East Java Province, including short-term measures carried out by BPBD East Java and local governments including tools and personnel to evacuate residents, establishment or provision of refugee camps, provision of refugee consumption and health services.

Meanwhile, long-term flood management is carried out by local and central governments, in the form of pump house installations or can also use the term sluice; normalization and strengthening of cliffs and *Floodways*. (Source: <https://www.suarasurabaya.net>. Specifically, for flood management through the construction of pump houses is the focus of this research. This is because pump houses are a flood mitigation strategy that has begun to be developed in regencies / cities in East Java Province in general and the City of Surabaya in particular.

In the city of Surabaya, flooding is caused by high rainfall. Heavy rains that continue to pour over most areas of Surabaya City cause rivers to overflow and cause flooding in several areas. Based on Indonesian Disaster Data and Information, the National Disaster Management Agency for Floods in the City of Surabaya occurred on 1). December 18, 2013, there were no casualties; 2). January 1, 2012, no casualties; 3). March 28, 2011, no casualties; 4). March 26, 2011, no casualties. 5). February 1, 2011, no casualties; 6). December 1, 2010, no casualties; 7). November 1, 2010, no casualties; 8). March 1, 2010, no casualties; 9). March 11, 2009, no casualties; 10). March 6, 2009, no casualties; c11). December 12, 2008, no casualties; 12). March 6, 2005, no casualties. (Source: Compilation of Data from Indonesian Disaster Data and Information, National Disaster Management Agency). One of the efforts to prevent flooding is to build a pump house even though the results have not been maximized. With conditions like this, policy-making actors in the development of pump houses are expected to use the right information as a basis for consideration. One of them is the design of an application with webmap-based geographic information system (GIS) technology to detect the condition of pump houses and flood-prone areas using several parameters. The purpose of this study is to produce technology products as a consideration in the formulation of unidirectional disaster mitigation policies and support the Topic of Excellence of PT through the Dr. Soetomo University Surabaya Research Strategic Plan in the field of disaster management and the environment theme of regional application of webmap prototypes to find out disaster-prone areas to support National Research Priorities. The overall research results are a description of the formulation of pump house development policies in the city of Surabaya and building a webmap application to provide spatial information on the distribution of pump houses and floods (hotspots) based on the distribution of pump houses, the characteristics of pump houses, and the location of flood areas. Spatial analysis to determine the classification of flood-prone areas based on area of inundation area, duration of inundation, height of inundation of high, low, and medium categories using artificial intelligence (AI) methods. The contribution of the research results provides information to policy-making actors and related agencies as one of the considerations in the development of pump houses as an effort to overcome flood disasters.

## ***Theoretical***

### **Public Policy Concept**

There are many opinions about the definition of a policy. Smith and Larimer (2009:3) in their book entitled "The Public Policy Theory Primer" put forward various opinions about policy. Policy is whatever governments choose to do or no to do. (Dye, 1987:1). Whether or not a policy is carried out is a form of public policy. Anything that is or is not done by the government to be in the public or public interest is part of public policy.

Meanwhile, Eyestone (1971:18) argues that policy is the relationship of governmental units to its environment. The relationship between units in government institutions is a form of top-down sourced policy. Every superior has policies that must be implemented by subordinates, both institutionally and personally. The policy takes the form of a correlation between elements and institutions.

Wilson in Kadji (2015) posits that the policy is actions, objective and pronouncements of governments on particular matters, the steps they take (or fail to take) to implement them, and the explanations they give for what happens (or does not happen) (or the actions, objectives and statements of

governments on certain matters, the steps they take (or fail in decision-making) to carry them out, and explanations they give for what happened (or did not happen).

From some of the definitions and opinions above, it can be concluded that policy is a decision made by an authorized official for the public interest that is arranged in such a way as to be implemented and accounted for as a logical consequence in actions and statements by the government.

Conceptually, public policy comes with a specific goal, which is to organize a common life to achieve the agreed common goals (mission and vision). In this case, public policy is interpreted as a path or tool to achieve the goals to which it aspires. If the ideal of the Indonesian nation is to achieve a just and prosperous society based on Pancasila and the 1945 Constitution, then the ideal public policy for Indonesia can be illustrated by the following picture:

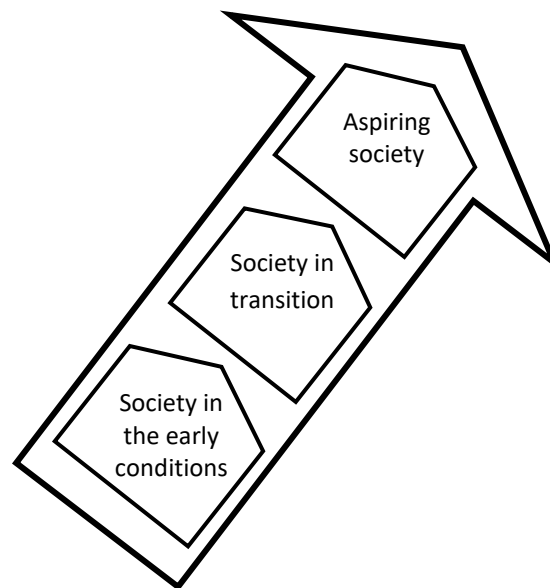


Figure 1. The Ideal of Public Policy  
Source: Nugroho (2009:130)

We can put "public policy" as "management" of the achievement of national goals". We can conclude that: 1) Public policy is easy to understand because its meaning is "things that are done to achieve national goals" and 2) Public policy is easy to measure because the measure is clear, that is, the extent to which progress towards achieving ideals has been taken. However, this does not mean that public policy is easy to make, easy to implement, and easy to control, because public policy concerns political factors.

According to Nugroho (2009:98), public policy objectives can be distinguished from the resource side, namely 1) Distributing state resources to society, including allocative, realistic, and redistribution, versus absorbing or absorbing resources into the state. 2) Regulative and versus deregulative. Regulative policies are regulating and restrictive, such as tariff policies, industrial protection policies, human rights policies, and so on. Deregulative policies are liberating, such as privatization policies, tariff removal policies and negative investment revocation policies. 3) dynamization versus stabilization. A dynamization policy is a policy that moves national resources to achieve certain desired progress. Stabilization policies put the brakes on too precise dynamics so as not to damage the existing system, whether political, security, economic, or social systems. 4) Policies that strengthen the country versus strengthen the market. Policies that strengthen the state are those that encourage greater the role of the

state, while policies that strengthen the market or the public are policies that encourage greater public roles or market mechanisms than the role of the state.

In practice, each policy contains more than one policy objective, which are different. Public policy always contains a multi-purpose, which is to make it a fair and balanced policy in encouraging the progress of common life.

Public policy teaches us; life together must be regulated. It is not merely governed but governed by rules that apply to everything and apply bindingly to all. Each violator will be sanctioned according to the weight of the violation he committed, and sanctions are imposed in front of the community by the institution that has the task of imposing sanctions. Those rules are simply understood as public policy.

In the book *Public Policy: Theory and Process* (Winarno: 2007:16), in general the term "policy" or "policy" is used to designate the behavior of an actor (e.g., an official, a group, or a government agency) or several actors in a particular field of activity. This kind of policy definition can be used and is relatively adequate for the purposes of ordinary talks but becomes less adequate for more scientific and systematic talks regarding public policy analysis. Basically, there are many limitations or definitions of public policy in the political science literature. Each of these definitions gives a different emphasis. This difference arises because each expert has a different background and point of view. While on the other hand, the approaches and models used by experts will ultimately also determine how the public policy is to be defined.

Conceptually, the definition of public policy in question also provides an understanding of the public policy process, the factors associated in the public policy process, and the importance or meaning of public policy.

### Policy Process

The public policy process is a complex process because it involves many processes and factors that must be studied. Therefore, some political experts who are interested in reviewing public policy divide the processes of public policymaking into several stages. The stages of public policy according to Dunn (2000:24-25) in Kadji (2015) are as follows:

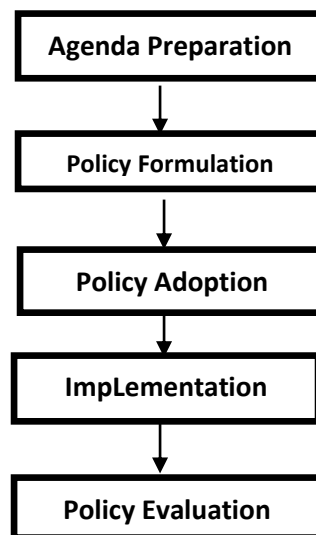


Figure 2: Stages of Public Policy  
Source: Dunn (2000:24-25)

### (1) Agenda Preparation Stage

The elected and appointed officials put the issue on the public agenda. Previously these issues competed first to be able to fit into the policy agenda. In the end, some issues made it onto the policy agendas of policymakers. At this stage one issue may not be touched upon at all, while another issue is set to be the focus of discussion, or there is also a problem for certain reasons postponed for the same time.

### (2) Policy Formulation Stage

Issues that go on the policy agenda are then discussed by policymakers. These problems are defined to find the best solution to the problem. The solution comes from various policy alternatives. Similarly, to the struggle of a problem to fit into the policy agenda, in the formulation stage of each policy, alternatives compete to be selected as policies taken to solve the problem. At this stage, each of the actors will "play" to propose the best problem solving.

### (3) Policy Adoption Phase

Of the many policy alternatives offered by policymakers, in the end one of these policy alternatives was adopted with the support of the legislative majority, a consensus between agency directors or judicial decisions.

### (4) Policy Implementation Phase

A policy program will only be an elite record if the program is not implemented. Therefore, policy program decisions that have been taken as an alternative to problem solving must be implemented, namely implemented by administrative agencies and government agencies at the lower level. The policies that have been taken are implemented by administrative units that mobilize financial and human resources. At this stage of implementation various interests will compete. Some policy implementations have the support of implementors, but others may be opposed by implementers.

### (5) Policy Evaluation Stage

At this stage the policies that have been implemented will be assessed or evaluated, the extent to which the policies created have been able to solve the problem. Public policy is essentially made to achieve the desired impact. In this case, solving the problems facing society. Therefore, measures or criteria are determined that form the basis for assessing whether public policy has achieved the desired impact.

Another policy process model developed from approaches in systems theory. The formal model of the policy process is from "policy ideas", "formalization and legalization of policies", "implementation", only then towards performance or achieving the *diharapkan\_* achievements obtained after an evaluation of *kebijakan\_* performance as shown in the following figure:

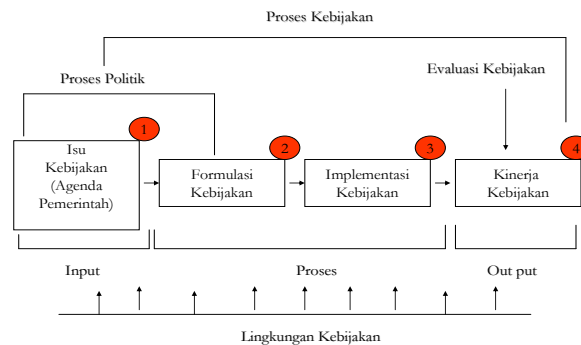


Figure 3: The Ideal Policy Process  
Source: Nugroho (2009:389)

### Policy Formulation

According to Dunn in (Pramono;2015) at the Policy Formulation stage, the problems that enter the policy agenda are then discussed by policymakers. These problems are defined to find the best solution to the problem. The solution comes from various policy alternatives. Similarly, to the struggle of a problem to fit into the policy agenda, in the formulation stage of each policy, alternatives compete to be selected as policies taken to solve the problem. At this stage, each of the actors will "play" to propose the best problem solving.

Meanwhile, according to Thomas R. Dye (in, Kadji, 2015) policy formulation is an effort by the government to innervate public life as a solution to every problem in society. Interventions can coerce the public because the government is given authoritative authority.

Policy formulation is one of the important stages in the formation of public policy. As Charles Lindblom and several other experts wrote, in understanding the policy formulation process we need to understand the actors involved or actors as well as in the process of forming the policy, both actors who are official and actors who are not official. As expressed by Charles Lindblom, that to understand who exactly formulated the policy must first be understood the nature of all the cast as well as (participators), what parts or roles they perform, the authority or form of power they have, and how they relate to each other and supervise each other. Of the various types of casts as well, each cast according to Lindblom has a special role that includes ordinary citizens, organizational leaders, members of the House of Representatives, leaders of legislative institutions, party activists, party leaders, judges, civil servants, technical experts, and business managers.

Policy Formulation is also referred to as the stage that also determines public policy, in this stage the boundaries of the policy itself are formulated. For this reason, it must be realized that some of the essentials of public policy, are: **First**, that public policy is aimed at intervening in the life and public interest within the framework of increasing public capacity itself. **Second**, the limited capabilities of human resources. Not a few good public policies end up being unable to be implemented because they are not supported by the availability of adequate human resources. **Third**, institutional limitations, to the extent of the quality of professional and proportionate management practices within government agencies and community institutions, both in the for-profit and non-profit fields. **Fourth**, is a classic but no less important limitation, namely the limitation of funds or budget. The policy cannot be carried out if there are no funds. And **fifth**, is a limitation of a technical nature, namely about the technical ability to formulate the policy itself. Therefore, to produce policies that have a tif effect a leader according to Kadji, (2015) must have:

- 1) Power Introspection, looking deeply at the circumstances and powers of the ser ta authority of the officials who will carry out the terse but policy,
- 2) Power Retrospection, looking at things that have happened to study identical problems in the past, and
- 3) Feasibility, looking ahead and configuring the desired state based on existing data, concepts and realities.

Excellent public policy is a public policy that can solve problems that exist in the middle of the public, for that the formulation or formulation of policies carried out by the policy elite must go through scientific stages and involve elements of society that are of mutual interest. Subarsono (2011) as a public policy expert argues that problem formulation can be viewed as a process consisting of four stages, namely: problem search, problem defining, problem specification, problem recognition.

The essence of the public policy cycle is policy formulation because it is from here that it will be established or formulated substantively public policy as an alternative to solving societal problems. Not necessarily all public policy issues can be accommodated by the government as public problems that must be solved through public policy and processed through a series of actions. Budi Winarno in Mulia (2019) concluded from the opinions of several experts that in policy formulation there are four stages that are implemented systematically, namely:

1) **The First Stage, The Formulation of the Problem**

Exploring and formulating problems is the most fun step in policy formulation. To be able to formulate a policy properly, public problems must be well recognized and defined.

2) **Second Phase, Policy Agenda**

Not all public issues will be on the policy agenda, they will compete. Only certain issues will eventually make it onto the policy agenda. Public issues that fall into the policy agenda will then be discussed by policymakers.

3) **Third Stage, Selection of Policy Alternatives to Solve the Problem**

At this stage, policymakers will deal with various alternative policy options that will be taken to solve the problem. Policymakers will be faced with a battle of interests between the various actors involved in policy formulation. In this condition, policy choices will be based on compromises and negotiations that occur between interested actors.

4) **Fourth Stage, Policy Setting**

After one of the many policy alternatives offered, it is decided to be taken as a way of solving the problem, then at the last stage in policy making is to establish the chosen policy so that it has binding legal force (Mulia, 2019).

## **Disaster Management**

The definition of disaster according to W. Nick Carter in Nurjanah in Arifin et al (2018:13) is "an event, natural or man-made, sudden or progressive, which impacts with such severity that the effected community has to respond by taking exceptional measures". (Arifin, 2018)

Meanwhile, according to the International Strategy for Disaster Reduction (ISDR-Badan PBB) a natural disaster is an event, caused by nature or due to human actions, occurring suddenly or slowly, thus causing the loss of human souls, property, environmental damage, this event occurs beyond the ability of the community with all its resources. Syahputra Adisanjaya Suleman et al, Proceedings of KS: Research & PKM, Volume 4, Number 1, Pp.1-140. (Suleman & Apsari, 2017)



In accordance with the mandate of Law No. 24/2007 Article 10, the government established the National Disaster Management Agency (BNPB). This non-departmental institution established through Presidential Regulation Number 8 of 2008 concerning the National Disaster Management Agency applies as a leading sector in handling natural disasters that occur in Indonesia. Along with the spirit of decentralization of government and regional autonomy, the problem of disaster handling and management is also the responsibility and authority of local governments. Thus, it is necessary to synchronize coordination between the central and regional governments in disaster mitigation as mandated by Law Number 24 of 2007 in Article 5 that the Government and Regional Governments are responsible for the implementation of disaster management. For this purpose, provisions for the establishment of the Regional Disaster Management Agency (BPBD) were also stipulated. This is expressly stated in Law Number 24 of 2007 Article 18.

Based on the provisions, each province is required to form a Provincial BPBD. Districts/cities can form BPBD based on workload criteria, financial capabilities, and needs. If the Regency/City Government does not form a BPBD, then disaster management is accommodated by the appropriate Regional Apparatus Work Unit (SKPD). Thus, it can be said that BPBD is a non-departmental government agency that carries out disaster management tasks in both provinces and regencies/cities. This means that local governments are responsible and have authority in the implementation of countermeasures in their areas. (Sri Heryati, 2020:141) (Kusnan & Suryaman, 2020)

To implement disaster management, it is carried out through 3 (three) stages as follows:

- 1) Pre-disaster stage that is carried out when there is no disaster and when it is under threat of potential disasters
- 2) The emergency response stage is designed and implemented when a disaster occurs.
- 3) The post-disaster stage is deep after the disaster.

The following is an illustration:



Figure 4: Disaster Management

Source: Yogi Cahyo Ginanjar, S.T. – First Expert Policy Analyst in <https://bpbd.babelprov.go.id/proses-penanggulangan-bencana>

A more detailed explanation related to disaster management from the figure above includes:

- 1) **Pre-Disaster Stage.** At this stage, 2 (two) stages are further divided, namely:
  - a) **Prevention and Mitigation Stage.**

The disaster prevention and mitigation stage can be carried out structurally or culturally (non-structurally). Structurally, efforts made to reduce *vulnerability* to disasters are technical engineering of disaster-resistant buildings. Meanwhile, culturally, efforts to reduce *vulnerability* to disasters are by changing paradigms, increasing knowledge and attitudes so that a resilient society is built. Cultural mitigation includes making people care about their

environment to minimize the occurrence of disasters. Activities that can generally be carried out at this stage include:

- (1) Create a map or floor plan of an area that is highly prone to disasters
- (2) Creation of disaster alarms
- (3) Making buildings resistant to certain disasters
- (4) Providing in-depth counseling and education to people in disaster-prone areas.

#### **b) Preparedness Phase**

At this stage nature shows a sign or signal that a disaster is imminent. So, at this stage, all elements, especially the community, need to be prepared and always ready to face the disaster. At this stage there is the Renkon process which stands for Contingency Plan. Contingencies are a circumstance or situation that is expected to occur soon but may not happen either. Contingency Plan means a process of identifying and preparing a plan that is based on such contingency or indeterminate circumstances. A contingency plan may never be activated if the expected circumstances do not occur. In general, activities at the preparedness stage include:

- (1) Drawing up a plan for the development of a warning system, maintenance of supplies and training of personnel.
- (2) Develop search and rescue measures and evacuation plans for areas that may be at risk from recurrent disasters.
- (3) Carrying out these readiness measures is carried out before a disaster event occurs and is aimed at minimizing casualties, service disruptions, and damage when a disaster occurs.

### **2) Emergency Response Phase**

This stage is when disaster strikes. Activities at the emergency response stage that generally apply to all types of disasters include:

- a) Save yourself and those closest to you.
- b) Don't panic.
- c) To be able to save others, you must be safe.
- d) Running or staying away from the disaster center does not need to carry any things.
- e) Protect yourself from objects that may injure yourself.

### **3) Rehabilitation and Reconstruction Phase**

This stage is often also called the recovery stage. Activities that can be done are:

#### **a) Emergency Assistance**

- (1) Setting up an aid command post
- (2) Coordinate with the Disaster Management Implementation Coordinating Unit (SATAKORLAK PBP) and other aid providers.
- (3) Set up shelter tents, soup kitchens, health posts and coordination posts.
- (4) Distribute medicines, groceries, and clothing.
- (5) Search and place the victims in tents or evacuation posts.
- (6) Assisting medics for treatment and grouping victims.
- (7) Search, evacuate, and grave the dead.

#### **b) Damage Inventory**

At this stage, data collection is carried out on various damages that occur, both buildings, public facilities, agricultural land, and so on.

**c) Recovery**

At this stage, recovery or restoration of environmental conditions that were damaged or chaotic due to disasters as before. This recovery is not only carried out in the physical environment, but victims affected by the disaster are also given recovery both physically and mentally.

**d) Rehabilitation**

- (1) Starting to design a regional spatial plan (master plan) ideally by giving confidence and involving all components of the community, especially disaster victims. Included in this activity is the mapping of disaster areas.
- (2) Began to develop a disaster management system that is part of the environmental management system
- (3) Search and preparation of land for fixed settlements
- (4) Relocation of victims from shelter tents
- (5) Starting to repair or build houses for disaster victims
- (6) At this stage, physical improvement of public facilities begins to be carried out in the medium term
- (7) Start conducting practical job training and creating jobs
- (8) Repair or construction of schools, worship facilities, offices, hospitals, and markets began to be carried out
- (9) The function of the command post began to be focused on facilitation or mentoring activities.

**e) Reconstruction**

Reconstruction activities are carried out with medium-term and long-term programs for physical, social, and economic improvements to restore people's lives to better conditions than before.

**f) Resume Monitoring**

Regions that have experienced a disaster are more likely to experience the same event again. Therefore, it is necessary to carry out continuous monitoring to minimize the impact of the disaster.

**SIG-Multidimensional Spatial Data and Decision Analysis**

The type of decision-making in GIS involves several alternatives and several interconnected evaluation criteria. Many spatial problems in the real world give rise to multi-criteria decision making (MCDM) [10] GIS techniques and procedures have an important role in decision making to automate, manage, and analyze various spatial data for decision making. Spatial multi-criteria decision analysis as a process that combines and converts geographic data into the resulting decisions. The purpose of GIS is to provide spatial decision support. Multi-criteria decision-making procedures determine the relationship between "input map" and "output map" (Vitianingsih et al., 2017)

GIS-based multi-criteria decision analysis can be thought of as a process that combines and transforms spatial data into resulting decisions. Two considerations critical to spatial MCDA are the GIS ability for data acquisition, storage, search, manipulation and analysis, and MCDM's ability to combine geographic data and decision-makers' preferences to determine alternative values (Malczewski, 2004) A combination of MCDM Model and data mining is used to determine the weight of the parameters used (T. Emha, 2009)

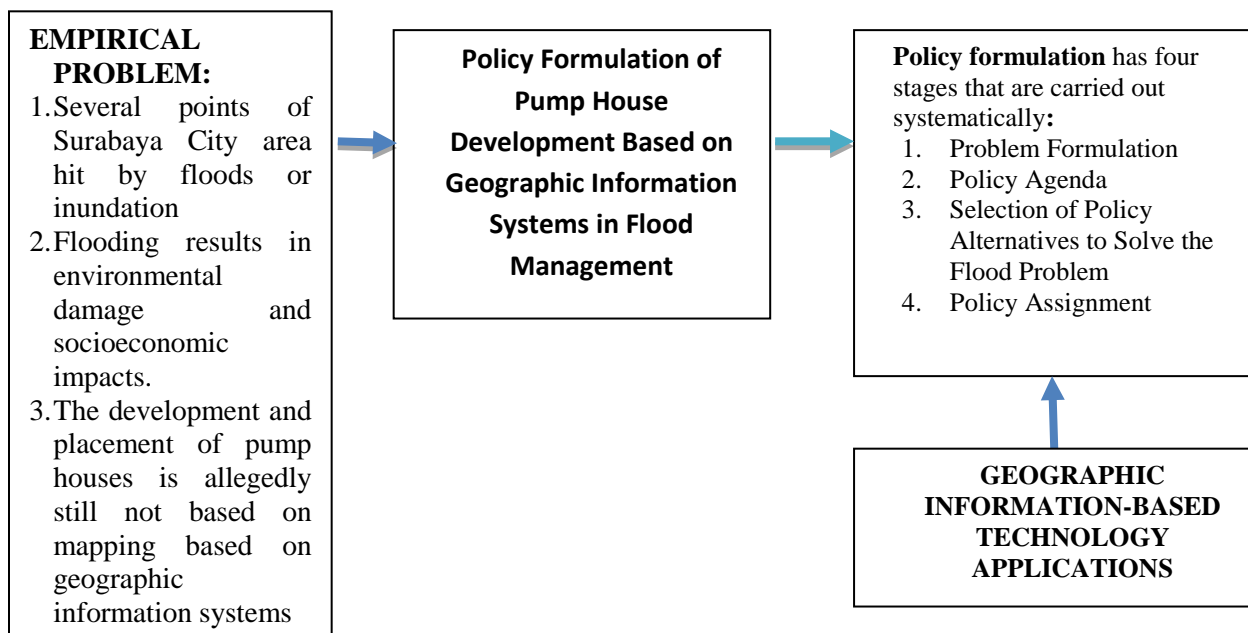
**SIG-Spatial Data Mining**

Data mining is a term used to describe the discovery of knowledge in a database. (T. Emha, 2009) In simple terms, data mining leads to the process of extracting and analyzing knowledge from large amounts of data (Agarwal, 2014). Data Mining is a process of finding meaningful relationships, patterns,

and tendencies by examining in large sets of data stored in storage using pattern recognition techniques such as statistical techniques, mathematics, pattern recognition and machine learning, resulting in a new, more useful information and knowledge (Larose & Larose, 2014) Data mining functions include description, estimate, prediction, classification, grouping, and association functions.

## Methodology

The proposed research framework refers to Figure 4. The preliminary study conducted in this study was by conducting an empirical study by looking at several points of the Surabaya city area hit by floods or inundation. Flooding causes environmental damage and has socioeconomic impacts, so the development and placement of pump houses is suspected to be still not based on mapping based on geographic information systems. Describing policy formulation there are four stages: 1) Problem Formulation; 2) Policy Agenda; 3) Selection of Policy Alternatives to Solve the Flood Problem; and 4) Policy Assignment. Application of technology based on pump house mapping information system as one of the policy considerations for developing pump houses in the city of Surabaya.



Picture 5. Research Framework  
Source: Processed Researcher

## 1) Types of Research

Research on the formulation of pump house development policies in flood management using a descriptive-qualitative approach. Because this type of research is generally carried out on research in the form of case studies that focus attention on a particular unit of various phenomena. This research is exploratory so that it can deeply understand various social variables.

## 2) Research Focus and Location

This study tries to describe the formulation of pump house development policies in the city of Surabaya through 4 stages, namely: 1) Problem Formulation; 2) Policy Agenda; 3) Selection of Policy Alternatives to Solve the Flood Problem; and 4) Policy Assignment. Furthermore, he recommends a geographic information system as the basis for the policy of building pump houses in Surabaya in the future. The type of research that is considered appropriate to the design of this study is descriptive

research. The location of this research is in the Department of Water Resources and Highways (DSDABM), and sixty-four (64) pompo houses in the city of Surabaya.

### 3) Data Collection Techniques

Data were collected through observation, in-depth interviews, documentation studies and Focus Group Discussions (FGDs). Observations were made to observe early and go directly to the field to see the effectiveness of flood management through the construction of pump houses in the city of Surabaya. Documentation studies are carried out not limited to only documents in physical form, but also documents in the form of digital files, such as photos, videos, presentation slides, application programs, databases, coding systems (coding) and operating systems (operating systems). Meanwhile, FGD is used with the aim not only to explore problems from various broader and deeper perspectives, but also as a means of verifying data and information obtained from observation and interview methods.

### 4) Informant

In contrast to quantitative research that prioritizes representation and uses the term respondent in determining samples, in qualitative research the priority is flexibility, scope of information span and using the term informant. An informant is an interviewee, requested information by the interviewer. An informant is a person who is estimated to master and understand data, information, or facts from an object of research.

The informant determination technique in this study is Purposive sampling. Purposive sampling is the sampling of data sources with certain considerations/objectives. This consideration, for example, the person who is considered to know best about what we expect, or perhaps he as a ruler so that it will make it easier for the researcher to explore the social object / situation under study.

Purposive sampling is the sampling of data sources with certain considerations/objectives. This consideration, for example, the person who is considered to know best about what we expect, or perhaps he as a ruler so that it will make it easier for the researcher to explore the social object / situation under study. Several informants have been predetermined. The informant that the researcher interviewed was later referred to as a key informant.

The informants specified in this way are:

- a) Deputy Speaker of the Surabaya City Parliament
- b) Secretary of the Department of Water Resources and Highways (DSDABM)
- c) Vice Chairman of the Indonesian Association of Disaster Experts

### 5) Data Analysis Techniques

Data analysis techniques use the appropriate approach (Miles & Huberman, 2017: 12) in Dull at all (Dull & Reinhardt, 2014) as follows :

- a) Collect data and information generated through observation methods, in-depth interviews, FGDs, and analysis of texts, documents, and digital files.
- b) Identifying and revising the data and information obtained by simplifying, abstracting, and transforming the data obtained in the field continuously during the research process aims to sharpen, classify, direct, discard the unnecessary, and organize the data.
- c) Describes and describes patterns and relationships in the form of narratives, matrices, tables, schemas, diagrams, graphs, or images.
- d) Draw conclusions and verification. At this stage seeks to find meaning, noting the regularity, patterns, configuration, and causal relationships.

Research methods used in designing software for research activities using the System Development Life Cycle (SDLC), (Kendal & Kendal, 2011)

## **Results**

### **1) Policy Formulation of Pump House Development in Flood Management in the City of Surabaya**

Stages in the policy formulation proposed by Budi Winarno consisting of 1) problem formulation; 2) policy agenda, 3) selection of policy alternatives; and 4) Policy setting. In this sub-chapter, researchers will describe these stages in the policy formulation process for the construction and development of pump houses in the city of Surabaya.

As is known that the construction of pump houses as mandated by the Drainage Master Plan 2018-2038 has the intention of being one of the efforts to solve the flood problem in the city of Surabaya. The pump house is expected to be an important element to prevent flooding in Surabaya. This is because the pump house can anticipate the rainy season with high rainfall for 24 hours. Because this infrastructure is monitored and maintained for 24 hours as well. The existence of pump houses as of 2020 the number of pumps is 204 which are in 59 pump house points and equipped with 111 generators. (Source: [www.cermati.com/artikel/terbukti-jitu-begini-cara-atasi-banjir-di-surabaya-ala-risma](http://www.cermati.com/artikel/terbukti-jitu-begini-cara-atasi-banjir-di-surabaya-ala-risma), retrieved 29 November 2021). The current pump house has grown  $\pm$  64 pump houses (2022). The existence of this pump house is spread in various areas of Surabaya. Both in secondary and primary channels and outlets that lead directly to the klaut. The function of the facility is important, namely ensuring that there are no obstacles while accelerating the discharge of rainwater overflow to the boezem or sea. For more details how the policy formulation of the construction and development of pump houses is outlined at the following stages:

#### **a) Dimensions of Problem Formulation**

Various efforts to identify problems regarding flooding have been pursued, especially by Komisi C for the development of the Surabaya City DPRD. Among others, the recess period activities were held at six points in Rungkut, and Gunung Anyar Districts carried out by Deputy Chairman of Commission C of the Surabaya DPRD Aning Rahmawati in Surabaya. In addition, as an effort to prepare the Flood Management Raperda which is being negotiated at the Regional Regulation Formation Agency (Bapemperda) of the DPRD, so that really based on actual data on the conditions in the field, a special study of flood management in the city of Surabaya is carried out.

Actual data related to problems that cause floods is a necessity so that the steps taken are not wrong, let alone policy formulation errors. This will result in a cycle of disaster management, especially the pre-disaster stage including what must be done in the disaster prevention and mitigation stage and the preparedness stage will also not solve the flood.

Another effort to explore this flood problem is the activities of official meetings such as: seminars, mursrebang workshops at the village / kelurahan and sub-district levels as a forum for dprd members. Identify flooding problems and other problems for example: Physical development of road infrastructure, welfare, and education

The problem of flooding varies depending on its geographical location, soil contours and the surrounding environment. Of course, this will result in each area that the cause of flooding will be different. Based on the identification of flood conditions in the city of Surabaya, among others, it is caused: 1) Waterways that are clogged with garbage such as occurred on Jalan Mojopahit and several other locations; 2) Sluices/pump houses that are unable to accommodate the heavy rain; 3) Sluices that rely solely on gravity; and 4) The impact of tides or tidal water; and 5) Reduced catchment areas due to

faster land conversion. Tidal flooding is a flood caused by sea level rise, until the tide inundates the land. This flood is caused by the occurrence of sea tides that are higher than the land height.

### **b) Dimensions of the Policy Agenda**

There are many problems that need to be taken immediately in the city of Surabaya, including: reducing poverty, realizing a child-friendly city, improving health services, ease of population administration, handling congestion, providing convenient public transportation modes, fostering MSMEs and small and medium-sized industries, reducing the risk of floods and other disasters. All problems want to be solved and the community will receive benefits so that a prosperous, safe, peaceful, and clean life can be realized. It's just that with a limited budget, all these problems will be seen on the scale of priorities. This is what causes if not all public problems in the city of Surabaya are included in the policy agenda.

Specifically, the problem of flooding in the city of Surabaya is still an important agenda in the policy agenda. This can be seen by the formation of existing policies and policies that will be made, for example: Surabaya City Regional Regulation Number 12 of 2014 concerning the Surabaya City Regional Spatial Plan for 2014-2034 Article 36 (5) and the Surabaya Drainage Master Plan 2018-2038 or still in the process of making, namely the Flood Management Bylaw. Policies that have been made can also be in the form of direct action as an effort to prevent and mitigate disasters and preparedness in the form of improving and modifying the physical environment as well as awareness and increasing the ability to face disaster threats. All of which are attached to the tupoksi Sumber Daya Air dan Bina Marga (DSDABM) mainly as well as other agencies or Regional Apparatus Organizations (OPD) such as: The Cleanliness and Green Open Space Service (DKRTH), the ranks of the police and TNI, Sub-district, Lurah and other OPDs within the Surabaya City Government.

In addition, the budget provided by the Surabaya City government as an effort to overcome floods through the Flood Control Program and is only run by one public organization under the authority of the Surabaya City Government, namely the Surabaya City Water Resources and Highways Agency (DSDABM), which used to be called the Bina Marga and Pematuan Public Works Office (DPUBMP), shows that the budget used to overcome floods has occupied the top 3 positions in recent years. Likewise, this year's 2022 budget reaches 541.1 billion. Even next year's plan will be raised to 867 billion. Among them is to support the urban drainage system in Surabaya. This includes the construction of primary, secondary, and tertiary channels supported by 67 pump houses and 77 water storage bozems.

### **c) Policy Alternative Selection Dimensions for Troubleshooting**

For the selection of alternative policies that arise from the Ranpenda initiatives of members of the DPRD, commissions, joint commissions and Bapempeda proceed in accordance with the predetermined mechanism. There was not long and tough debate between the Party factions in the DPRD in Surabaya City. Finally, it was found that the problem of flooding to zero flood cities could not be done partially, it had to be done holistically/ thoroughly it had to be able to connect and collaboratively. Various alternatives to solve the flood problem in the city of Surabaya based on the identification of the problem are as follows: 1) Multiply and develop pump houses. The construction of pump houses continues to be carried out at several points and spreads evenly in areas prone to inundation or other areas in anticipation of inundation especially during heavy rains and seawater overflowing. In addition, development is also carried out for existing pump houses by adding power supplies, generators, and CCTV; 2) Build channels. Included is the culvert box. This water channel continues to be connected until it reaches its downstream, namely to the sea. Box culvert is a square or city precast concrete that serves for drainage channels/culverts. Currently the construction of the culvert box  $\pm$  300 kilometers; 3) Repair and elevation of the sluice. This sluice because it borders the sea needs to be elevated, so that when the sea is high tide

does not enter the land; 4) Expand Green Open Space. Of course, the implementers of the program are attached to the tupoksi of the Dinas / OPD in the City of Surabaya, namely DSDABM and DKRTH.

#### **d) Policy Assignment Dimensions**

At the last stage in policy formulation is to establish a policy so that it has binding legal force. Flood control policies from various alternative legal bases that are most importantly used as a reference for the Surabaya City Government in implementing flood management are Surabaya City Regional Regulation Number 12 of 2014 concerning the Surabaya City Regional Spatial Plan for 2014-2034 and Surabaya Mayor Regulation Number 49 of 2016 concerning the Position, Organizational Structure, Job Description and Functions and Work Procedures of the Public Works Office of Bina Marga and Surabaya City Planning, Surabaya City Regional Regulation Number 7 of 2002 concerning the management of green open space. In addition to referring to the legal basis, the Surabaya City Government, especially the Bina Marga and Pematusan Public Works Office (DPUBMP), which is now called DSDABM, also refers to the technical basis in carrying out various flood mitigation activities. The technical basis in question is the Surabaya Drainage Master Plan (SDMP) 2018-2038.

From the results of the interview, it can be concluded that the policy formulation for the development of pump houses in flood management in the city of Surabaya has gone through the correct stages including: 1) problem formulation, 2) Policy Agenda, 3) Selection of Policy Alternatives to solve flood problems and 4) Establishment of pump house development policy. The following is a more detailed discussion of the 4 stages of foemulation of the policy of building and developing pump houses.

At the stage of formulating the problem of flooding. To identify the formulation of flood problems, the Surabaya City DPRD Development Commission identifies flood problems through various activities ranging from recesses, seminars, workshops, musrenbang at the village / kelurahan and sub-district levels. In addition, the DPRD also seeks to become actual data on flood problems by pouring 1 billion funds in 2022 specifically for flood management studies in 5 rayons of Surabaya City. It is hoped that this will be able to complete the study of more than 50% of the 117 inundation points in the city of Surabaya. The way to identify the problem is in accordance with what was conveyed by Thomas R. Dye that the spirit of policy formulation is the government's effort in this case the Surabaya City Government intervenes in public life as a flood solution in this case which is a problem in the community of the Surabaya City area. Charles Lindblom said that in formulating policies it is necessary that actors be involved in policy formulation. In the formulation of this flood management policy, those involved are council members, executives in the mayor, related OPDs and all stakeholders. The flooding problems that can be identified are caused by 1) Waterways, 2) Water Gates / Pump Houses that have not worked optimally, 3) The impact of sea or tidal tides, and 4) Reduced catchment areas.

Policy agenda. Not all issues are on the policy agenda. There are so many problems in Surabaya. As a Metropolis City, Surabaya cannot be denied that the surrounding regions / regencies / cities place great hopes in the fields of economy, education, trade, and industry. Of course, Surabaya must improve both infrastructure and other infrastructure. If there is a flood in the Metropolis, it will have a significant impact on social, economic growth. For this reason, the problem of flooding is still a crucial issue and is on the public agenda. As stated by Budi Winarno that only certain issues can finally be included in the public agenda. This can be seen by the policy of Surabaya City Regional Regulation Number 12 of 2014 concerning the Surabaya City Regional Spatial Plan for 2014-2034 Article 36 (5) and the Surabaya Drainage Master Plan for 2018-2038 or is still in the process of making, namely the Flood Management Bylaw. In addition, the budget allocated for flood management always occupies the position of the top three program budgets in the Surabaya City Government equivalent to education and the management and construction of roads and bridges is proof that flooding is a very important problem to obtain a quick and appropriate and effective solution.



Selection of Policy alternatives to solve the problem. There is no battle of interests between actors involved in the formulation of flood management policies in the city of Surabaya. As stated by Budi Winarno, in determining alternative choices for flood management, compromise and negotiation between actors who take advantage of the disaster are needed. For this reason, there is a discourse from Commission C for the Development of the Surabaya City DPRD so that the city government compiles a priority scale for flood management in the form of a roadmap/ road map. So that in handling floods, the stages that must be carried out from year to year and carried out in synergy, comprehensively / holistically and collaboratively. The alternative is currently a solution in structural flood management. In disaster management, which was conveyed by Yogi Cahyo Ginanjar in the structural disaster management process, this is an effort to reduce vulnerability to disasters by engineering disaster-resistant buildings. In handling floods in the city of Surabaya, among others, it is multiplying and developing pump houses. The pump house itself is a place used by the water pump to move or increase the water discharge and regulate the amount of water that can be discharged by the pump. In other words, the pump house is one of the media that can be used to anticipate floods and to accelerate the flow of water. Data in 2020 pump houses in the city of Surabaya as many as 59 then developed  $\pm$  64 in 2022, four of which are still in the construction stage up to 40%. Namely the pump house of Pahlawan, Karah, Kebonsari and Gadukan. In addition, another alternative to flood management in the city of Surabaya is by building channels, repairing, and raising sluices and increasing green open space. The hope in the future is to reduce the risk of flooding not only structurally but combined culturally, including making people care about their environment to minimize the occurrence of disasters.

Policy Assignment. Of all the alternative policies for handling flood disasters, the main basis for the pump house development policy is stipulated in Surabaya City Regional Regulation Number 12 of 2014 concerning the Surabaya City Regional Spatial Plan for 2014-2034 and Surabaya Mayor Regulation Number 49 of 2016 concerning the Position, Organizational Structure, Job Description and Functions as well as Work Procedures of the Public Works Office of Bina Marga and Surabaya City Planning. In addition to referring to the legal basis, the Surabaya City Government, especially the Bina Marga and Pemasukan Public Works Office (DPUBMP), which is now called DSDABM, also refers to the technical basis in carrying out various flood mitigation activities. The technical basis in question is the Surabaya Drainage Master Plan (SDMP) 2018-2038.

## **2) Geographic Information-Based Technology Application Model in the Placement and Development of Pump Houses in the City of Surabaya**

Flood management through pump houses continues to be improved in effectiveness by developing and placing pump houses based on geographical information or based on mapping flood-prone areas. This is so that the achievements so far have been in the form of narrowing inundation areas, rapid receding of inundation when rainfall rises, and the lower inundation is more optimal and the dream of the city of Surabaya to be free from flooding becomes a reality. The city of Surabaya can dispel floods because of various efforts made by cross-agencies/agencies, so there must be harmonious coordination between agencies/agencies so that the achievements so far will continue to be improved, namely the City of Surabaya is free from floods.

The mapping of the distribution of pump points in Figure 5.8 and detailed information on pump points in Figure 5.9 can be used as the basis for policy making by the Water Resources and Highways Agency (DSDABM) in the development of new pump houses and the placement of pump house construction in the city of Surabaya in the following year by looking at supporting parameters.

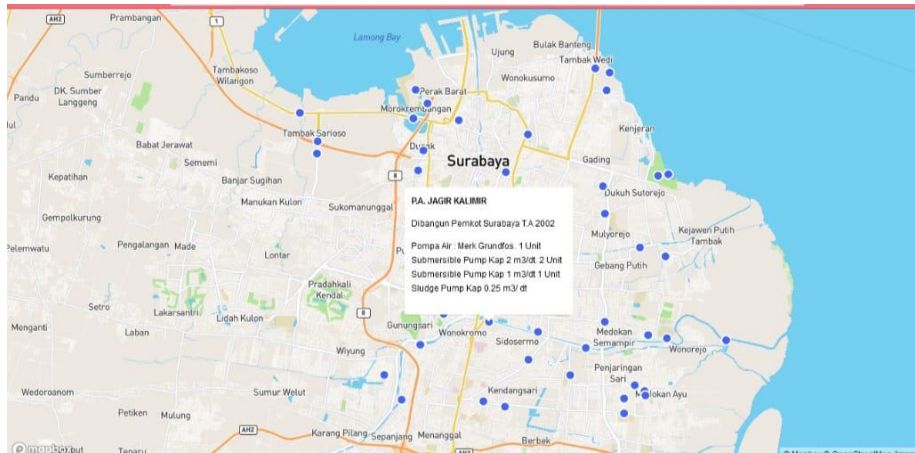


Figure 6 Detailed Information on the Distribution of Pump Points in Surabaya  
 Source: (access: <https://titikrumahpompasurabaya.com/Home>)

The addition of a new pump point house as a development effort can be done by the admin as the process in Figure 7 to Figure 8.

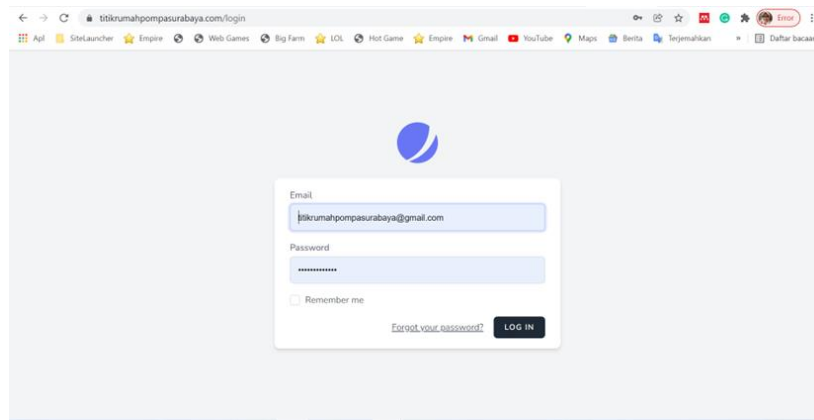


Figure 7 Data Management Regulation by Admin  
 Source: Data Processed

#	Nama	Lokasi	Pembuatan	Tahun Pembuatan	Pompa Air	PLN	PDAM	Keterangan
54	P.A. JAMBANGAN		Pemkot Surabaya	2013	Merk 2 unit Submersible Pump Kapasitas 1.5 m3/det Sludge Pump 1 unit Kap. 0.25 m3/det	PLN 1200 VA		
53	P.A. KALIKERTING	J. Pacar Kembang X/1	Rehab Tahun 2004 (Dibangun Pemkot Surabaya)	1976	Merk Grundfos. 1 Unit Sludge Pump Kap. 0.25 m3/det. 1 Unit	PLN 105 kVA, GENSET Merk MAN 400 kVA	Ada	

Figure 8 Data Regulation for insert, update, and delete  
 Source: Data Processed

Figure 9 Adding New Pump Point Data  
Source: Data Processed

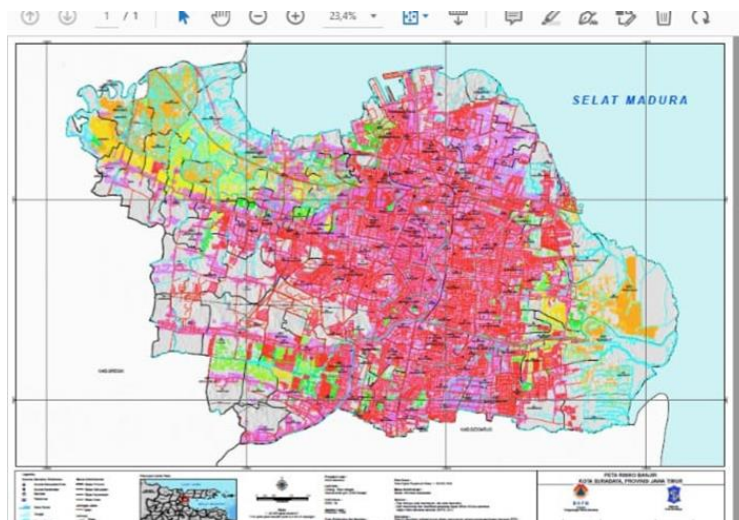


Figure 10: Surabaya City Flood Risk Map  
Source: National Disaster Management Agency

Furthermore, based on disaster risk data for the City of Surabaya and strengthened by looking at the data on inaRISK (bnpb.go.id) 18, October 2022 shows that of the 64 (sixty-four) pump houses spread across the city of Surabaya, there are 22 (twenty-two) around the pump houses that still have a high risk for flooding, namely: P.A. Keputran, P.A. Simolawang, P.A. Kutisari, P.A. Mulyosari, P.A. Gunungsari, P.A. Kalikepiting, P.A. Kalidami, P.A. Gunungsari, P.A. Dupak Bandarejo, P.A. Semolowaru, P.A. Tidar, P.A. Boezem Kalidami, P.A. Balong/Margomulyo, P.A. Boezem Wonorejo, P.A. Mulyosari, P.A. Medokan Semampir, P.A. Jemursari, P.A. Wonorejo II, P.A. Greges, P.A. Yakaya, P.A. Avoor Wonorejo Hilir and P.A. Karah. So, it can be recommended that around this pump house be built and developed the next pump house.

The formulation of the pump house development policy in flood management in the city of Surabaya has gone through the correct stages including:

- a) Problem formulation. To identify the formulation of flood problems, the Surabaya City DPRD Development Commission identifies flood problems through various activities ranging from recesses, seminars, workshops, musrenbang at the village / kelurahan and sub-district levels. In addition, the DPRD also seeks to become actual data on flood problems by pouring 1 billion funds in 2022 specifically for flood management studies in 5 rayons of Surabaya City.

- b) Policy Agenda, flooding is still a crucial problem that needs to be solved. In addition, the budget allocated for flood management always occupies the position of the top three program budgets in the Surabaya City Government equivalent to education and the management and construction of roads and bridges is proof that flooding is a very important problem to obtain a quick and appropriate and effective solution.
- c) Selection of Policy Alternatives to solve the flooding problem. There is no battle of interests between actors involved in the formulation of flood management policies in the city of Surabaya. Determining alternative options for flood management requires compromise and negotiation between actors. In handling floods in the city of Surabaya, among others, it is multiplying and developing pump houses. In addition, another alternative to flood management in the city of Surabaya is by building channels, repairing, and raising sluices and increasing green open space.
- d) Establishment of pump house development policy. Alternative policies for handling flood disasters are mainly the basis of the pump house development policy of Surabaya Mayor Regulation Number 49 of 2016 concerning the Position, Organizational Structure, Job Description and Functions as well as Work Procedures of the Public Works Office of Bina Marga and Surabaya City Planning. In addition to referring to the legal basis, the Surabaya City Government, especially the Bina Marga and Pemasukan Public Works Office (DPUBMP), which is now called DSDABM, also refers to the technical basis in carrying out various flood mitigation activities. The technical basis in question is the Surabaya Drainage Master Plan (SDMP) 2018-2038.

### Suggestions and Recommendations

To realize the effectiveness of achieving flood mitigation goals in the city of Surabaya, researchers recommend:

- 1) Completion to zero flood city requires comprehensive/holistic flood management. It needs collaborative cooperation/synergy of all my interests, both government, private sector as partners and the community.
- 2) The hope in the future is to reduce flood risk not only structurally, namely efforts made to reduce vulnerability to disasters with technical engineering of disaster-resistant buildings, but culturally combined, namely efforts to reduce vulnerability) to disasters is to change paradigms, increase knowledge and attitudes so that a resilient society is built. Cultural mitigation includes making people care about their environment to minimize the occurrence of disasters.
- 3) Flood management through pump houses continues to be improved in effectiveness by developing and placing pump houses based on geographic information systems or based on mapping flood risk areas. This is so that the achievements so far have been in the form of narrowing inundation areas, rapid receding of inundation when rainfall rises, and the lower inundation is more optimal and the dream of the city of Surabaya to be free from flooding becomes a reality.
- 4) In the development of pump houses in the future by using applications with webmap-based geographic information system (GIS) technology to detect the condition of pump houses and flood-prone areas using several parameters
- 5) In the future, the city of Surabaya has a flood management bylaw and a priority scale for flood management in the form of a roadmap. This is so that disaster management has a stronger legal system so that in the implementation stage it is also easier to establish harmonization between stakeholders.

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