Analysis of Hydro Climatological Disaster Management for Resilient City in Surabaya

Nina Awalia Safitri, Subagyo Adam and
Moses Glorino Rumambo Pandin

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ANALYSIS OF HYDRO CLIMATOLOGICAL DISASTER MANAGEMENT FOR RESILIENT CITY IN SURABAYA

NINA AWALIA SAFITRI[1], SUBAGYO ADAM[2] AND MOSES G. R. PANDIN[3*]
[1]Postgraduate School Airlangga University
[2]Faculty of Social and Political Science Airlangga University
[3]Faculty of Humanities Airlangga University
Jl. Airlangga No.4 - 6, Airlangga, Gubeng, Surabaya, East Java 60115

Email: nina.awalia.safitri-2018@pasca.unair.ac.id

Abstract: This research examines how the city of Surabaya manages hydro climatological disaster risks with disaster management. Behind the success story of Surabaya in managing the urban risk of flooding in early January 2020 in just three hours, how the disaster management work not only by increasing the capacity but also reduce the hazard and vulnerability by the city. Surabaya already has a system to elaborating strategy for disaster management with a cycle model of pre-disaster, emergency response and post-disaster as a city resilient effort.
This research uses descriptive qualitative method with a case study approach to investigate an urban disaster problem that has occurred in Surabaya. This research was designed from January 2020 as a preliminary study and research implementation in May to July 2020. Focus research on stakeholders directly involved in the preparation of efforts or strategies for disaster management represented by the Disaster Management and Community Protection Agency (BPBLINMAS) and the City Planning and Development Agency (BAPPEKO) in Surabaya through interviews, observations (direct and indirect) and document studies.
The results found in this research are the level of hydro climatological disaster risk in Surabaya is high but the threat can be reduced by managing vulnerability and increasing capacity. Surabaya has chosen to manage hydro climatological risks by conducting socialization, education and simulations to improve community preparedness to face the risk of hydro climatological disasters. Structural and non-structural mitigation is also carried out as an effort to reduce the impact of disasters. In the event of a disaster, the city government, through related institutions as a partners of the city government. Until the post-disaster with rehabilitation and reconstruction stage, six strategies that have a dual function in the development and improvement of the welfare of citizens.

Keywords: Disaster Management, Hydro Climatology, Resilient City.

Abbreviations: [].

Introduction

Background

UN Habitat reported 55% of the world's population lives in urban areas, a proportion estimated to increase to 68% by 2050. Projections show that urbanization, a gradual change in the residence of the human population from rural to urban areas, combined with overall growth in the world's population can add 2.5 billion more people will arrive in urban areas by 2050, with almost 90% of this increase occurring in Asia and Africa (UN, 2016). Cities face increasingly global 21st century difficulties and challenges. From the effects of climate change, migrant population growth, inadequate infrastructure, cyber-attacks and pandemics (World Economy

Forum, 2019). Cities in Asia are among the most vulnerable to the effects of climate change, such as hurricanes, storm surges and heat waves. Unfortunately, these cities also suffer from chronic pressures such as traffic congestion, pollution, flooding, and rubbish that are not collected (Stephane Hallegatte, 2016).

In addition to the chronic stresses of the problem, when a disaster occurs, urban areas and their populations are also more vulnerable to shocks, leading to increased vulnerability, uncertainty, and city risk (Narieswari, 2019). Basically, a disaster is a combination of aspects of disaster threat, vulnerability, and capability that are triggered by an incident. Disaster situation is very dependent on human actions in facing and overcoming it (Pakes, 2019). Understanding the aspects of disaster also includes several disaster parameters such as hazards, vulnerabilities, vulnerabilities and risks that need to be managed so that the damage and adverse effects of a disaster can be reduced. The solution must aim to prevent damage to the social order because of insecurity and tension (Heleen de Coninck, 2019).

According to reports (Pamungkas, 2014) Surabaya faces various risks in water supply and wastewater systems, flooding in coastal areas, and diseases due to decreased air quality. The level of vulnerability is increasing especially for people living in slums (located in the northern part of the city of Surabaya), along rivers and coastal areas. Slum settlements, lack of access to services, lack of economic opportunities and governance, so that children are often marginalized. Rapid urbanization and development have an impact on increasing climate risks in various areas in the city of Surabaya (Perdinan, 2017). In recent years, the impact of flooding has multiplied due to rising sea levels, coastal erosion and land subsidence. The average death toll from floods is indeed lower compared to other natural disasters such as earthquakes or landslides, but the material and non-material losses incurred are far greater (Katherina, 2016). Therefore, this study will examine by analyzing hydro climatological disaster management in the city of Surabaya with some urban dynamics that bring the city of Surabaya into a resilient city. Cycle models in disaster management can help cities explore the strengths and weaknesses of their systems. Also how this study will advance new knowledge or new ways of understanding and matching in helping expand knowledge and understanding of urban disaster management. Thus the stress and shock of each city can be managed as an effort so that the city is able to take mitigation and adaptation measures in the face of change and can continue to survive in the future.

The Theory

The Concept of Disaster

Terminology of disaster according to UNSDRR is a serious disruption to the functioning of a community or community that results in extensive human, material, economic, or environmental losses and exceeds the ability of the affected community or community to cope with their own resources. Disasters are a combination of aspects of disaster threat, vulnerability, and capability that are triggered by an incident. Disaster situation is very dependent on human actions in facing and overcoming it. Understanding of disaster aspects also covers several disaster parameters such as danger, vulnerability, vulnerability and risk (UNISDR, 2015).

Risk

Is an opportunity from the emergence of adverse effects or the possibility of loss in terms of death, injury loss and confusion damage caused by the interaction between the threat of disaster and vulnerability (UNISDR, 2015). Risk relates to a combination of the likelihood (probability) of an event and its negative consequences.

Hazard

Is an event or physical condition that has the potential to cause damage to humans such as injuries, damage to property and infrastructure, environmental damage, disruption to economic

activities or any loss and loss that can occur (UNISDR, 2015).Dangers occur because of interactions between nature, humans, technological systems, as well as the characteristics of the area of origin that is experiencing danger (van, 2018).

Susceptibility

It is a geological, biological, hydrological, geographical, socio-cultural, political, economic and technological condition or characteristic of a region for a certain period of time which reduces the ability to prevent, reduce, achieve readiness, and reduce the ability to respond to the adverse effects of certain hazards (International Strategy for Disaster Reduction, 2009)

Vulnerability

Is the result of conditions and processes that are affected by hazards originating from nature, technological disasters, or certain extreme condition? The dimensions of vulnerability include social vulnerability, economic vulnerability, and environmental vulnerability (van, 2018).

Urban Challenges

100 Resilient Cities classifies urban problems into two clusters, namely taking into account the various shocks and stresses experienced by the city. On the other hand, acute shocks are sudden and sharp events that threaten a city while chronic stress is a slow-moving disaster that weakens the fabric of the city. usually the challenges facing the city are often not just shock and stress. Most cities face a combination of these challenges, which can contribute to increasingly threatening the city's resilience. Under such a large population concentration, urban problems become increasingly difficult and complicated to deal with. In addition to the chronic stresses of the problem, when a disaster occurs, urban areas and their populations are also more vulnerable to shocks, leading to increased vulnerability, uncertainty, and city risk (Narieswari, 2019).

Disaster Management

Disaster management is a series of activities carried out in the framework of efforts to prevent, mitigate preparedness, emergency response, and recovery related to disaster events. Disaster management is carried out with the aim of reducing losses and risks that may occur and accelerating the recovery process after a disaster occurs. Disaster management consists of two stages, ex-ante (before a disaster occurs) and ex-past (after a disaster). Ex-ante consists of mitigation, prevention, and preparedness. The ex-past stage was in the form of emergency response, rehabilitation and reconstruction. The disaster management strategy can be technical or engineering as well as non-technical or statutory regulations (Sudibyakto, 2017).

Materials and Methods

This research uses descriptive qualitative method with a case study approach, which is a social research to investigate; understand, and research an urban disaster problem that has occurred in Surabaya. The case study approach referred to in this research is to describe the results of the research and try to find a comprehensive picture of a situation. The choice of this approach is because the reason for the phenomenon to be studied is a case that requires in-depth descriptive assessment, which is knowing an overview of disaster management analysis for urban resilience in Surabaya. Phenomenon refers to facts, events, or circumstances that can be studied or observed but with questionable causes or explanations. In this sense, a phenomenon that forms the subject of analysis that can include anything that can be observed or considered to exist but is not fully understood. In social and behavioural sciences, this case usually focuses on human interactions in complex physical, social, economic, cultural, or political. This research was designed from January 2020 as a preliminary study and research implementation in May to July 2020. Focus of research on stakeholders directly involved in the preparation of disaster management efforts or strategies represented by BPBLINMAS and BAPPEKO in Surabaya through interviews, observations (direct and indirect) as well as study documents.

Results and Discussion

Hydro Climatological Disaster Risk Analysis

Hazard Analysis

Surabaya City was identified as an area that had Disaster Risks such as earthquakes, tidal floods, abrasion and inundation, fires, and whirlwinds. In the study of the Indonesia Disaster Risk Index (IRBI) in 2018 the city of Surabaya ranked 139 out of 514 districts / cities throughout Indonesia, with a score of 166.80. From 2015-2018 the Surabaya City multi-threat disaster risk index has been classified as a city with a high risk (score 166.80) (IRBI, 2018). Flood and whirlwind events dominated with 14 and 9 events in the last 10 years, followed by drought and fire. This results in the potential for standing water from the overflow of river and channel water discharge in the rainy season and tidal floods, especially the north coast of Surabaya.

Figure 1. Rob Flood Risk Map of Surabaya City
Source: Bappeko Surabaya, 2018.

If there is rain with high intensity and a long time Surabaya is also prone to inundation at several points scattered throughout the city. Causing a puddle that disrupts the activities and activities of residents. The severity of events due to inundation is classified based on the duration of inundation and the frequency of occurrence at the same location. This is as illustrated in the map below;

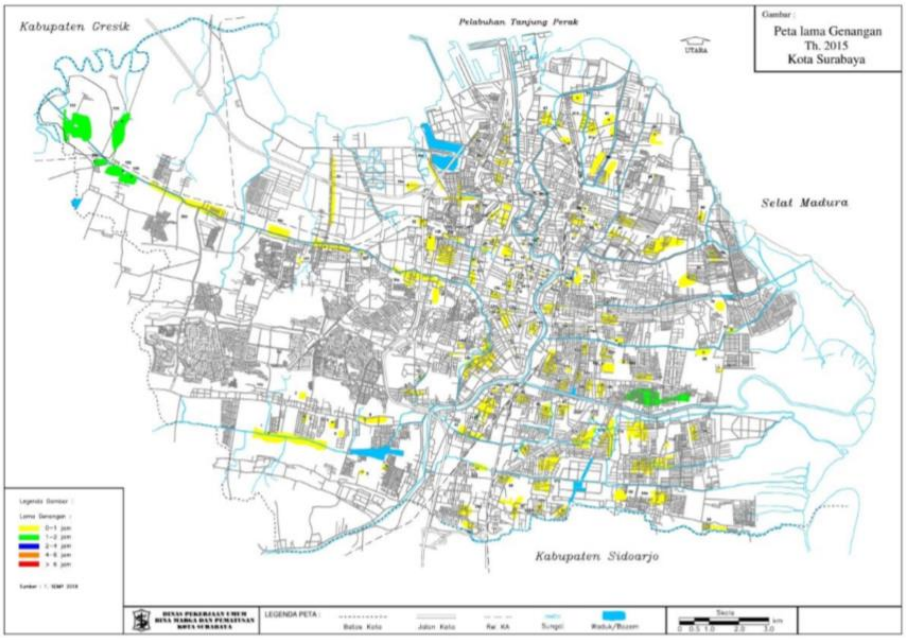

Figure 2. Map of Surabaya City Inundation Distribution

Source: Bina Marga Public Works Office and Surabaya City Administration, 2015

There are 5 areas (rayon) namely in Wiyung rayon, there are 31 priority monitoring points with a height of ± 15 cm inundation and a length of inundation ± 0.3 hours with a total of flooded area is 54.50 ha. The Tandes rayon contained 58 monitoring points with a height of ± 50 cm inundation and a length of inundation ± 3 hours with a total of flooded area is 45,21 ha. Next is the Inundation in Gubeng rayon, there are 69 monitoring points with a height of ± 40 cm inundation and a length of inundation ± 3 hours with a total area of flooded area of 6,60 ha. The Jambangan Rayon there are 52 priority monitoring points with a height of ± 60 cm inundation and a length of inundation ± 3 hours with a total of flooded area is1,43 ha. And the last one is Rayon Genteng. In this rayon there are 36 monitoring points with a height of inundation ± 50 cm and a length of inundation ± 3 hours with a total of flooded area is 0,70 ha. So that the total number of areas prone to inundation reaches 246 monitoring points and covers 108,44 ha.

Table 1. Results of Monitoring in Priority Handling of Surabaya City inundation 2018

No.	Inundation Location	Jumlah Titik	Area (ha)	Height (cm)	Length of Inundation (hour)
1.	Rayon Wiyung	31	54,50	15	0,3
2.	Rayon Tandes	58	45,21	50	3
3.	Rayon Gubeng	69	6,60	40	3
4.	Rayon Genteng	36	0,70	50	3
5.	Rayon Jambangan	52	1,43	60	3

Source: Surabaya Drainage Masterplan 2018-2038

Vulnerability Analysis

Physical and Environmental Vulnerability

The city of Surabaya is between 07^{o} 21 'South Latitude and 112^{o} 36' – 112^{o} 54 'East Longitude. Being the capital of East Java Province, the area is low land with a height of 3-6 meters above sea level, except in the south there are two gentle slopes with a height of 25-50 meters above

sea level. Based on the Surabaya City Spatial Plan, the Surabaya City an area of approximately 33,451.14 Ha with a sea area as far as a third of the territory of the East Java Province. A tropical area with Climate and weather conditions because it is located in that has two seasons, namely the rainy season and the dry season throughout the year that alternates. Surabaya has an average rainfall of 172 mm / year. The average humidity is 75-76.8%., With temperatures ranging from a maximum of 30 ° C and a minimum of 25 ° C.

The city of Surabaya is located downstream of the Brantas River which empties into the Madura Strait. Several large rivers that function to carry and channel floods originating from upstream flow across the city of Surabaya. The Surabaya river with an average of 26.70 m^3 / second, Kali Mas with an average of 6.26 m3 / second and Jagir river with an average average 7.06 m^3 / second. As a downstream area, the city of Surabaya itself is an area of overflow of water from rivers that cross and causes flooding in the rainy season.

Economic Vulnerability

The city of Surabaya, as the provincial capital, has benefited greatly from the existence of supporting economic infrastructure such as Purabaya Terminal, Tanjung Perak Port, Juanda International Airport and Gubeng Train Station, which have a quite strategic role and are taken into account in determining the direction of economic development policy in East Java Province. Economic power and all existing economic activities are one of the main drivers of the economy of East Java.

Vice versa, the growth of the City of Surabaya also affects the development of the city / district around it, sectoral and spatially. Surabaya City has a strategic area that has the potential to be developed in a sustainable manner to support the existence of future urban area development, including; Strategic Areas to Support Economic Growth. Then the Regions that will be developed to encourage economic growth are: The Warehousing and Industrial Area of Margomulyo. In terms of accessibility because it is located close to the port of Tanjung Perak and the Sidoarjo-Surabaya-Gresik Toll Road, the Industrial Area and the Margomulyo Warehousing are strategic areas to be optimized and developed with an orientation to the smart and clean industry supported by adequate infrastructure.

For the tourism strategy area of Tunjungan and surrounding areas in Bubutan District. Tunjungan as a commercial and office centre area, as well as an area that is one of the city centres, it is very potential to continue to be developed because it has a history and experienced a golden period in the decade 1940 to the late 1970s with the characteristics of shopping-street and shopping arcade, so it is known and become one of the Surabaya city icon with the jargon *"Rek Ayo Mlaku - Mlaku nang Tunjungan*".

Next is potential sectoral of Suramadu-Kenjeran Beach Bridge Area and Waterfront City Area in Bulak District. The existence of Suramadu Bridge and Kenjeran Beach is expected to be able to increase the potential and role of Surabaya City, as a regional centre. In addition, this region has potential as a regional scale trade and service area. Of course this potential will not be optimal if the threat of hydro climatological disaster occurs in the city of Surabaya.

Socio Cultural Vulnerability

Variables of social and cultural vulnerability include population awareness, elderly population groups and children, women's groups and poverty levels of the population. Population density becomes a consideration of social vulnerability because the more congested an area will greatly affect the social vulnerability of the community. The high population density illustrates the high opportunity for casualties and property that threaten the survival of the community. Based on data from the Central Statistics Agency, from a population of 39.5 million in 2018 in East Java, Surabaya is the region with the most population with a population of 3,094,732 or 7.83% of the total. This figure has always increased from previous years.

Old Age and Toddler Population (Old population (> 65 years) and under five years old (<5 years)) which reaches 17.32% of the total population or around 420 thousand elderlies and 112 thousand toddlers and children. As well as the disabled group, this group is one of the variables of social vulnerability because during a disaster and in the process of evacuation, the elderly and toddlers are considered to have lower ability, so that the elderly and toddlers have a dependency on the productive age population.

While the ratio of the number of women in the composition of the population in Surabaya which reached the composition of the male population was 1,541,738 people. While the female population reached 1,552,994 inhabitants. by sex, illustrates the relatively low ability in the evacuation process. This is based on the condition of women who are generally rated lower than the physical condition of men. With this condition, the female population will be more vulnerable than the male population, therefore the female population variable is included in social vulnerability.

Surabaya City developed as a Metropolitan City. The strategic position of Surabaya as the centre of community economic activity makes it always dynamic. Being the centre of activity is tantamount to being a place to migrate for people from various regions. The population will obviously increase with the charm of the city of Surabaya, which promises all kinds of conveniences. The city of Surabaya must remain a safe and comfortable home for its residents. The development of residential areas is very fast which results in changes in land use and the unavailability of a good drainage system that causes inundation areas that arise and influence on community activities, government and economic activities, causing obstacles to traffic.

Capacity Analysis

Capacity is the ability of regions and communities to take action to reduce threats and potential losses from disasters in a structured, planned and integrated manner. In city resilience, there are several parameters including Health and Welfare, every person who lives and works in the city has access to what they need to survive and develop. Then the community's economy through a process that promotes effective leadership, inclusive decision making, empowered stakeholders, and integrated planning. Infrastructure and environmental capacity, which are man-made and natural systems that provide critical services, protect and connect city assets that enable the flow of goods, services and knowledge. As well as leadership and strategies in the social financial system that enable urban populations to live peacefully, and act collectively. Although the economic turmoil during 2018 is very dynamic, the achievement of economic growth in Surabaya City is always quite high at 6.19% which is higher than the economic growth of East Java and National. The location of the City of Surabaya which is quite strategic for trade, exports and imports is relatively conducive to producing a fairly stable and vibrant economic climate.

Table 2. Economic Growth of Surabaya City in 2015-2019

Economic growth	Realization (%)				Target 2019
	2015	2016	2017	2018	
Surabaya	5,97	6,00	6,13	6,19	6,1-6,6
East Java	5,44	5,57	5,45	5,50	5,51-5,53
Nasional	4,88	5,03	5,07	5,17	8

source: BPS Surabaya City, 2018.

The city of Surabaya also has services for emergencies at the 112 Surabaya Command Centre. Not only to monitor the hydro climatology events of this emergency service, it also responds to citizen reports with fast time under 10 minutes. This facility is supported by the application of smart government with the collaboration of the Surabaya intelligent transport system, 1200 cctvs that are scattered in points prone to emergency events and pump houses for monitoring and mitigation as well as an early warning system. Services 112 Surabaya Command Centre

responds to 24-hour emergencies and serves various types of public complaints including accidents, natural disasters, fires, and animal rescue in the city of Surabaya. It includes 8 DPOs in the city of Surabaya which include the Social Service, Police, Cleaning agencies and Green Open Space (DKRTH), civil service police Unit (Satpol PP), fire department (PMK), Public Works Agency, Department of Transportation (Dishub) and Public Relations and other related agencies.

the level of Public Understanding of Disasters is also very necessary in anticipating the threat of flooding. In this case, the basis for determining variables is based on the existing practical concept of disaster vulnerability. With the condition of many people who do not understand the characteristics of the disaster that will occur it will increase the high vulnerability of the community in dealing with floods.

At present the involvement of various levels of society ranging from medical personnel in each District Health Canter, Students in 10 Surabaya Public Middle Schools, voluntary organizations, and Dasawisma as an effort to represent vulnerable groups namely women and the elderly are also involved in prevention and preparedness activities. At least 2,313 people have been involved in activities in 2019.

Analysis of Disaster Management

Pre-disaster

Since 2017 Surabaya has formulated the preparation of a study that includes a list of questions, field monitoring, evaluation and preparation of a pre-disaster prevention data evaluation report. Collection and management and analysis of potential hazard or threat data. Collection of various references and rules on disaster as a reference material, field review to find out the situation that exists when a disaster occurs which can then be used to develop the concept of technical guidelines for disaster prevention and disaster risk reduction. So in preparing the concept of reports and evaluations about pre-disaster prevention activities for disaster risk reduction, there are eight activities that aim to educate the public with information about disaster risks and threats, especially the risk of hydro climatological disasters in Surabaya. Disaster Management Education for Dasawisma, Indonesian Youth Red Cross Forum (FORPIS), Disaster Early Awareness Training, Establishment of Disaster Preparedness Village, Establishment of Disaster Response Schools, Development of Potential Disasters, and Capacity Building for Officers.

Some disaster stakeholders are also involved in the activity. Among them is when PPGD material in the formation of disaster resilient Schools involving PMI. When delivering material to officers in anticipation of climates, weather and water rescue involving BMKG and BASARNAS Instructors. Likewise, when delivering material and simulating disasters in disaster-prone areas involving Firefighters (PMK) and handling emergencies due to wild animals in collaboration with Instructors from the Surabaya Zoo (KBS).

Analysis of Emergency Response Management

Disaster management and emergency models are known as cycles that need to be carried out in their entirety. Although a special institution for disaster management and emergency has been formed in the city, it does not mean that community participation is neglected. Community involvement as a mobilizer and encourage the community to take an active role in determining security and safety in disaster management. So that the synergy between the community, related stakeholders brings up new solutions to become a resilient community. The focus of emergency response management in the city of Surabaya is a system that bridges the efforts of the Surabaya City Government to respond quickly to emergency complaints from the public through the Surabaya Command Centre's standby command post on the second floor of the former Siola building. The Command Centre has effectively served public emergency

complaints through the complaint number 112. The number can be accessed 24 hours and is toll free. When residents called number 112 and submitted their reports, officers immediately contacted the relevant Regional Work Unit (SKPD) to immediately follow up on the report by sending officers to the location.

This Control Centre can also cut the flow of bureaucratic disaster management. If all this time, the agency that handles emergency problems such as the Fire Service or the National Unity Agency or has its own command post. With this Command Centre, the SKPD will be synergized in one room to monitor the condition of the city for 24 hours and receive public reports. Data collected from 2018 to July 2020 recorded 6,211 complaints through the 112 command center. With details of 1,726 emergency events in 2018, the number increased to 3,113 events in 2019 and 1,372 emergency events were recorded until July 2020.

Post-Disaster Management

Surabaya has recorded a record of controlling floods and inundation due to high rainfall along with tides in just 3 hours in early January 2020. Previously, a major flood occurred in the city of Surabaya last recorded in 2017 with the most affected areas in west Surabaya due to the overflow of Lamong river. After that Surabaya City is prepared to anticipate with several efforts including by continuing to increase the city's capacity in structural and non-structural mitigation. For example, by expanding primary, secondary and tertiary waterways. Including adding a box culvert network which until now the number of new channels in the Surabaya region reached 293.87 kilometres. The number will continue to be added until downstream to the sea. Among the main works is the Manukan culvert box project in West Surabaya.

Construction of embankments in the Lamong River which reaches 8 km in length and improvement of water gate height so that flood control during high tides can be pressed so that it does not enter the land. Flooding also teaches that water catchment pockets are important, so that the Surabaya municipal government increased the number of reservoirs (*boozem*) now to 72 reservoirs with an area of 1,446,925 m2 with water capacity reaching 6,008,139 m3. Construction of pump houses and other supporting infrastructure was also increased. There are at least 204 pump houses in 59 flood and flood-prone points accompanied by 111 units of generators if at any time the electricity supply is not functioning due to flooding.

Besides that, the dredging of rivers and canals also continues. The results of river and channel sedimentation if calculated according to the data of the Surabaya Public Works and Pematusan Public Works Office (PUBMP) in 2019 were recorded at 2.9 million m3. Utilization of sedimentation land is then used to build parks, fields, tombs and reservoir revitalization. So that if the use of the dredging is used for construction and public facilities can save the budget of 13-75 billion Rupiah per year.

The addition of green open space in Surabaya since the last 10 years is being actively promoted, until now the total number of green open space in Surabaya is 7,290.53 ha2 or reaching 21.79% of the total area of the city of Surabaya. The purpose of this activity is to increase green space and planting trees in all areas of Surabaya can be a means of flood control. In addition to rehabilitation and reconstruction efforts that have been carried out to control floods and floods, the city of Surabaya has also issued regulations on the prohibition of building buildings in catchment areas and other flood control.

Figure 3. Command Centre 112 Surabaya City
Source: BAPPEKO, 2018

Conclusion

Hydro-climatological disaster management in Surabaya uses the pre-disaster, emergency and post-disaster cycle models. Pre-disaster city government did prevention by mitigating and increasing citizen preparedness through awareness raising and awareness training. For emergency response the Surabaya government relies on an integrated command centre 112 service system by involving all relevant stakeholders in disaster management. Whereas in the post disaster phase the strategy carried out in the principle of build back better is by rehabilitation and reconstruction including the revitalization of various structures to prevent floods and inundation.

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Appendix

ANALYSIS OF HYDRO CLIMATOLOGICAL DISASTER MANAGEMENT FOR RESILIENT CITY IN SURABAYA

NINA AWALIA SAFITRI[1*], SUBAGYO ADAM[2] AND MOSES G. R. PANDIN[3]
[1]Postgraduate School Airlangga University
[2]Faculty of Social and Political Science Airlangga University
[3]Faculty of Humanities Airlangga University
***Corresponding author email:**
nina.awalia.safitri-2018@pasca.unair.ac.id

Author's contribution

Nina Collected the data, Conceived and designed the analysis took the lead in writing the manuscript with support from Subagyo and Moses. Subagyo supervised research progress, and Moses was involved in planning and helped oversee the project. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare absence of conflicting interests with the funders.

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