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Participatory mapping for urban fire risk reduction in high-density urban settlement

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Abstract

Surabaya is a densely populated city prone to urban fires. Fire outbreaks occur annually causing billions of dollars of damage. Kelurahan Nyamplungan is part of Ampel strategic socio-cultural area. The Kelurahan experienced recurring fires with severe physical damage. High fire risk level in Kelurahan Nyamplungan is caused by high level of vulnerability and the low community capacity. Fire risk reduction through participatory mapping is an alternative to vulnerability reduction and capacity enhancement of communities through community involvement. This public outreach attempt generated fire risk maps through overlay analysis and public perception of fire risk in their neighborhood. Most of the Kelurahan fall under level 4, meaning it has high fire risk. At the end of the participatory mapping activity, public awareness towards urban fire safety increased. The community now acknowledges their need of fire safety equipment and vigilance in activities that could potentially cause a fire outbreak.

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Keywords: Urban fire risk; participatory mapping.

1. Introduction

Urban area identical to the area of dense habitation so prone to fire. Fires accounted for 15 percent of the total disasters in Indonesia, especially in urban areas with high population density. Fires in the city of Surabaya occurred repeatedly each year. Recorded in the year 2012 as many as 573 events occurred, while in 2013 decreased to 397

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events. 2014 fires again increased as many as 596 events. Fires that continue to occur each year are physically affect billions of rupiah each month. Event fires in the region Ampel village, Village Nyamplungan a repeated occurrence. In 2013 a fire in Nyamplungan settlement involving four units PMK. In March 2014 a fire occurred in the township Nyamplungan lead to 3 homes sold and involves one major FMD unit. The next information on Month 6 September 2014 a fire engulfed a house in the settlement Nyamplungan plot that involves 12 units PMK. The basic thing to be risk factors of fire occurrence is suspected behavioral patterns of society, both the case of a short circuit or LPG cylinder blast. In the Village Nyamplungan with dense residential areas, the condition is exacerbated by the difficulty of fire fighting efforts because of the condition of houses huddled.

The frequency of fires are frequent in Sub Nyamplungan shows a lack of public awareness of fire-related hazards in their environment. The recurring incident also showed during this community rely on firefighters in fire pemadamam process. Whereas the efforts undertaken outage firefighters can be optimized when getting help and support from the community[I]. This shows that the community preparedness in the face of the threat of fire is needed in support of the performance of firefighters and minimize losses due to fire. Surabaya City Government's efforts in reducing the risk of fire in the township Ampel is through the optimization of firefighters (PMK) and the reconstruction or rebuilding of public facilities were burnt (RTR Strategic Region Old City 2012). However, these efforts have not considered optimal because of the efforts of fire management is done inclined after the incident and has not been actively involving the community as those prone to the risk of catastrophic fires, participated undertake preventive measures and responses related to the potential for catastrophic fires in the neighborhood. This suggests the need for a participatory approach attempts to encourage people to participate actively and independently in kesiapsiaan fire and disaster mitigation. To improve the preparedness of the public, is necessary to formulate an urban fire disaster contingency plans that integrate local knowledge society, as well as experience in handling FMD fire disaster.

2. Literature Review and Methods

According Suprapto [5] the fire hazard is the fire that is not desired. Fire events occur starting with the fire burning then no longer be able to control and threaten the safety of life and property. Persitiwa these fires have some process until the fire is extinguished. According Mantra [4] are some of the developmental process in the event of fire flames which consist of:

1. Phase ignition / explosion. This stage is characterized by the emergence of fire caused by heat energy of the material in space.
2. Stage Fire growth has begun to develop in accordance with the quantity of fuel available. This stage is the most good for evacuation.
3. Stage Flashover. A phase transition from the growth phase to the phase of full combustion. This stage is very fast, the temperature usually ranges between 300º C - 600º C.
4. Phase Combustion Full. At this stage, the heat that is released is the greatest because the fire has spread to the entire space. The temperature can reach 1200º C.
5. Phase ebb. At this point all material was burned and the temperature has begun to fall and the firing rate also declined.

According to the General Guidelines for Disaster Risk Assessment for Disaster Management Plan by BNPB [6] there is a calculation based risk assessment 3 variables:

Hazard

The indicators used to map fire hazard and residential buildings is the frequency of the number of fires, economic losses, the number of dead and seriously injured casualties. Defined danger zone at the fire hazard map based classes and weights for each parameter. Expressed in the following equation:

Table 1. Hazard Assessment Indicators

Parameter	Weight (%)	Class			Score
		Low	Medium	High	
Fire incident frequency	60	<2% (1-2 times)	2-5% (3 times)	>5% (>3 times)	Class/Max Value Class

economic losses	6	<1 M	1-3 M	>3 M
The number of dead	20	-	1 person	>1 person
The number of victims seriously injured	6	<5 persons	5-10 persons	>10 persons

Source: General Guidelines for Disaster Risk Assessment BNPB, 2015

Vulnerability

Index vulnerability level of fire can be seen in three types of vulnerabilities that social vulnerability, the vulnerability of physical and economic vulnerability.

a. Social vulnerability

Indicators used for social vulnerability is the population density, sex ratio, the poverty ratio, the ratio of people with disabilities and the ratio of the age group. Index of social vulnerability is obtained from the average weight of the population density (60%), vulnerable groups (40%), which consists of the sex ratio (10%), poverty ratio (10%), the ratio of the cacaat (10%), and age group (10%).

b. Economic vulnerability

The indicators used for economic vulnerability is the area of productive land (paddy fields, plantations, agricultural land and pond) in rupiah and GDP. Village of Nyamplungan do not possess the land productive, but productive lands that contribute GDP Surabaya namely land use as trade and services and public facilities such as hospitals.

c. Physical vulnerability

Indicators used for physical vulnerability is the density of buildings, availability of building / public facilities, and the presence of critical facilities (flammable buildings).

Table 2. Indicators of Social Vulneraility Assessment

Parameter	Weight (%)	Class			Score
		Low	Medium	High	
Population density	60	0-0.59 person/m²	0.059-0.1 person /m²	>0.1 person /m²	Class/Max Value Class
Sex ratio (10 %)	40	<20%	20-40%	>40%	
Poverty ratio (10 %)					
Ratio of Disabled Persons (10%)					
Ratio of Age Group (10 %)					

Source : General Guidelines for Disaster Risk Assessment by BNPB , 2015

Table 3. Indicators of Economic Vulneraility Assessment

Parameter	**Weight (%)**	**Class**			**Score**
		Low	Medium	High	
GDP	100	<100 jt (Housing, General Facility)	100-300 jt (Industry)	>300 jt (Commercial)	Class/Max Value Class

Source : General Guidelines for Disaster Risk Assessment by BNPB , 2015

3) Physical Susceptibility

Indicators used for physical susceptibility is the density of buildings, availability of building / public facilities, and the presence of critical facilities (buildings flammable).

Table 4. Physical indicators Susceptibility Assessment

Parameter	**Weight (%)**	**Class**			**Score**
		Low	Medium	High	
Building density	40	Low	Medium	High	Class/Max Value Class
Land Use	40	Commercial, Industry	General Facility	Housing	
Critical facilities	20			Flammable building	

Source : General Guidelines for Disaster Risk Assessment by BNPB , 2015

The third is based on the vulnerability map, it can be formulated assisted vulnerability maps with ArcGIS software, the resulting vulnerability map. Equation to produce a fire disaster vulnerability maps according to the General Guidelines for disaster risk assessment by BNPB (2015), namely:

*Fire vulnerability = (40% * social vulnerability) + (30% economic vulnerability) + (30% physical vulnerability)*

Social Capacity

Capacity index is obtained by resistance level area at a time. The indicators used to map HFA capacity is an indicator that consists of:

Table 5. Capacity Assesment Indicator

Parameter	Weight (%)	Class			Score
		Low	Medium	High	
Rules and institutional disaster management Early warning and disaster risk assessments disaster education Reduction of basic risk factors Construction of preparedness on the entire line	100	<0,33	0,33-0,66	>0,66	Class/Max Value Class

Source : General Guidelines for Disaster Risk Assessment by BNPB , 2015

However, in other circumstances, can be measured also if there are areas with awareness of disaster indicated by the presence of a basic risk reduction through the development of early preparedness. From the three variables above the next step is to assess the disaster risk.

Risk

Disaster risk assessment carried out by reviewing and determining the level of threat, vulnerability level, and the level of capacity. By combining the map of threats, vulnerabilities, and capacities that have been generated before, then obtained a map of the risk of catastrophic fires. Formulation of risk obtained from the overlay using ArcGIS software with equal weighting between the level of hazard, vulnerability, and capacity. The following is a table of variables between risk weighting to produce a risk map.

Table 6. Risk Assesment Indicator

Parameter	**Weight (%)**	**Class**			**Score**
		Low	Medium	Tinggi	
Threat	33,33	Score 1 Threats Low	Score 2 Threats Medium	Score 3 Threats High	Class/Max Value Class
Susceptibility	33,33	Score 1 Susceptibility Low	Score 2 Susceptibility Medium	Score 3 Susceptibility High	
Capacity	33,33	Score 1 Capacity Low	Score 2 Capacity Medium	Score 3 Capacity High	

Source : General Guidelines for Disaster Risk Assessment by BNPB , 2015

3. Result

Kampung Nyamplungan is geographically located on the city of Surabaya, East Java. Nyamplungan included in one of the villages in the District Customs Cantikan, North Surabaya. Village wide Nyamplungan approximately 53 Ha (see Picture 1). The frequency of occurrence of fire in the village Nyamplungan until the last 5 years found several cases of fire events. Location of fire is further identified by dots historical event. Over the last 5 years, the incidence of fires in the Village Nyamplungan be around housing residents are in RW IV, RW VI dan RW VII (see Figure2).

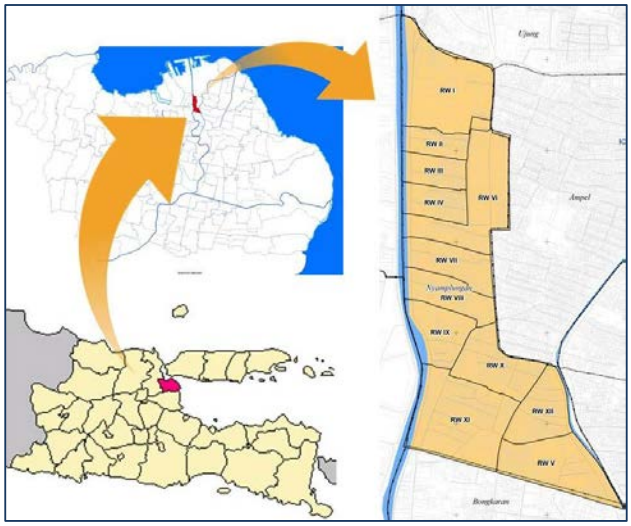

Fig. 1. Delineation of Kampung Nyamplungan, North Surabaya, East Java.

Disaster risk assessment carried out by reviewing and determining the level of threat, vulnerability level, and the level of capacity. By combining the map of threats, vulnerabilities, and capacities that have been generated before, then the fire disaster risk map obtained in the Village Nyamplungan. Under fire risk maps have been produced, most of the village Nyamplungan have a moderate level of risk. That is, most of the village Nyamplungan have a risk of fire alarming impact that the need for management plans in order to cope with these risks. Disaster risk map Nyamplungan fire in the village can be seen on the Picture 3.

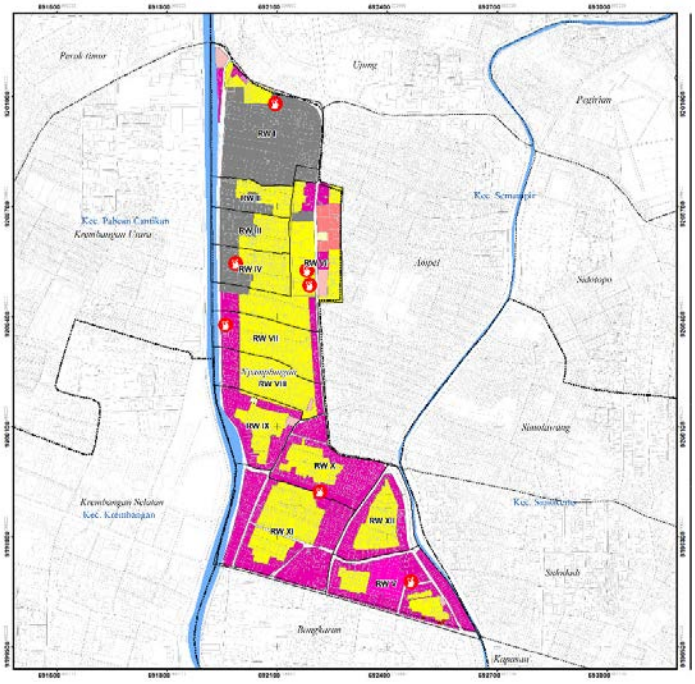

Fig. 2. Location of fire hazard in the last 5 years in Kampung Nyamplungan

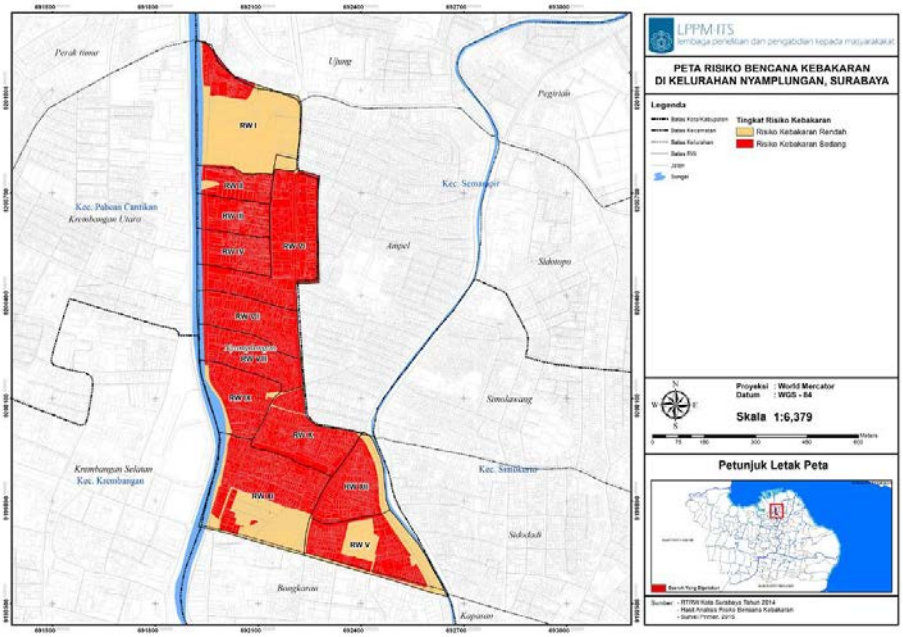

Fig. 3. Fire Risk Mapping in Nyamplungan, Surabaya

4. Conclusions

Based on the results of the Urban Fire mapping through considerations of three variables: fire hazard, vulnerability, and capacity, the urban fire risk in kampung Nyamplungan can be concluded that the resulting map of the risk of fire in the area of community-based information level of vulnerability and vulnerability to disaster areas are classified into low- and moderate-risk areas. Based on this research it will be essentials to continue and enrich with the knowledgeable perception of stakeholders as well as the exploration of the need for a means of supporting infrastructures in the region mitigation efforts and prepare the existence of a fire disaster mitigation efforts through the formulation of a plan region based mitigation potential of environmental resources and community of Kampung Nyamplungan.

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