The Level of Social Vulnerability of Flood Disaster in Tangerang City Area of Banten Province

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A B S T R A K

Penelitian ini bertujuan untuk mengetahui tingkat Kerentanan Sosial Bencana Banjir di wilayah Kota Tangerang dengan menggunakan metode SoVI (Social Vulnerability Index). Penelitian ini mengguakan 6 indikator sebagai penilai tingkat Kerentanan Sosial bencana banjir dalam unit kelurahan. Setiap unit kelurahan dihitung secara kuantitatif menggunakan teknik PCA (Principal Componen Analysis) dan dilakukan pembobotan pada masing-masing indikator. Masing-masing bobot mengambarkan keterkaitan setiap indikator/ variabel dengan tingkat kerentanannya. Hasil Penelitian ini menunjukan terdapat 5 Kategori tingkat kerentanan. Tingkat Kerentanan sosial dengan kategori sangat rendah terdapat pada 4 Kelurahan yaitu: Pasar Baru, Nambo Jaya, Panunggangan Timur, dan Sukarasa. Kategori rendah terdapat pada 16 kelurahan diantaranya: Kunciran Jaya, Pakojan, dan Kelapa Indah. Kategori sedang terdapat pada 27 kelurahan diantaranya Nerogtog, Cipete, dan Babakan. Kategori tinggi terdapat pada 15 kelurahan diantaranya Gebang Raya, Kunciran, dan Piang. Kategori sangat tinggi terdapat pada 7 kelurahan diantaranya: Kunciran Indah, Petir, dan Cipondoh Indah.

Keywords:
Social Vulnerability
Disaster
Flood
Tangerang City

A B S T R A C T

This study aims to determine the level of Social Vulnerability of Flood Disasters in tangerang city area by using SoVI (Social Vulnerability Index) method. This study uses 6 indicators as an assessor of the level of Social Vulnerability of flood disasters in village units. Each village unit is calculated quantitatively using PCA (Principal Componen Analysis) technique and weighted on each indicator. Each weight depicts the association of each indicator/ variable with its vulnerability level. The results of this study showed there are 5 Categories of vulnerability levels. The level of social vulnerability with a very low category is found in 4 villages, namely: Pasar Baru, Nambo Jaya, Panunggangan Timur, and Sukarasa. Low category is found in 16 villages including: Kunciran Jaya, Pakojan, and Kelapa Indah. The current category is found in 27 villages including Nerogtog, Cipete, and Babakan. High category is found in 15 villages including Gebang Raya, Kunciran, and Piang. Very high category is found in 7 villages including: Kunciran Indah, Petir, and Cipondoh Indah.

Introduction

Natural phenomena on earth is a mechanism of balance for living things. Phenomena can be disastrous if they have a negative impact on living things. Law No. 24 of 2007 on Disaster Relief mentions disasters are events or series of events that interfere, threaten people's lives and lives caused by natural, non-natural, or human factors resulting in human fatalities, environmental damage, property losses, and psychological impacts. Ayu, 2019 in Kompas.com quoting from BNPB said that in 2019 there have been 3,721 disasters and many disasters are hydrometeorological disasters. Hydrometeorological disasters are disasters caused by the disruption of hydrological cycle systems that affect water reserves on the surface of the earth and climate stability (Hermon, D. 2012). Hydrometeorological disasters are one of them is flooding.

Flooding is the result of river water runoff that later became inundation (Kodoatie JR, 2013) and most of the flooding that occurred is related to the quantity of water in the river and the distribution of rainfall that is not accommodated in the drainage of river basins (Bennett et al., 2018).

In addition to the high intensity of rainfall that falls, flooding can also occur due to changes in land use and community activities that inhabit the Watershed (Kodoatie &Sjarief, 2010). BPS Tangerang city records the population density in tangerang city which is 13,280 people per Km2 which means that every 1 Km is inhabited by 13,280 people, causing land use for settlements continues to increase.

Based on the Indonesian Disaster Risk Index (IRBI, 2018) mentioned that tangerang city has a high potential to be affected by flood disasters with a score of 33.6. Flooding that occurs in tangerang city is caused by high intensity of rainfall, poor drainage and the presence of runoff/ shipment of water volume from katulampa river in Bogor area in Hulu. If you look at the daily report of flood disaster events issued by BPBD Tangerang city from 2015-2019 the most severe floods occurred in 2016 with the number of events as many as 112 incidents, and the number of victims affected is 46,742 people. In January-February 2020 there were 345 incidents, with 103,591 victims and 6 fatalities. The period January-February 2020 was recorded as the most severe flood and resulted in the most losses when compared to the previous 5 years.

The small loss caused by the flood disaster is not only caused by the high intensity of rainfall and reduced land cover, but also due to the level of vulnerability and capacity of the people who inhabit the area. Identification and assessment of vulnerability in terms of time and place is necessary to control and reduce disaster damage by creating an effective design strategy (Anderson, 2004 in Wismarini &Sukur, 2015). Disaster risk reduction is an important step for every Country to protect its people from future threats and grow disaster-aware communities (Rosyidah et al., 2019). Disaster Risk Reduction can be done by increasing the capacity of the community (Rosyidah et al., 2019) and reducing the level of vulnerability of the community (Fatimahsyam, 2018).

Seeing the number of victims affected and the number of fatalities need to be minimized the impact of the disaster that occurred, especially in terms of population and social. Determining the extent of the impact of flood disasters both economically and socially can pay attention to the large population, activity, and distribution of the population (Katherina, 2016), as the vulnerability of a disaster is triggered by population growth and its activities (UNFPA, 2011 in Katherina, 2016). Social conditions can describe fragility in the face of disasters often referred to as Social Vulnerability (Paimin et al., 2009). Social vulnerability is related to demographic conditions and population structure in an area that has the potential to impact a disaster (Tiyansyah &Setiawan, 2017).

Vulnerability assessment is considered an effective and useful determinant to promote a disaster-resistant culture that has important benefits to reduce the risks and losses from the impact of natural hazards (Birkmann, 2006 in Siagian et al., 2014). Social vulnerability assessment can provide additional insights to support disaster planning especially at the local level and to inform decision makers in following up on potential strategies to reduce disaster vulnerability (Kirby et al., 2019). The purpose of this study is to determine the level of social vulnerability of flood disasters in the Tangerang City area of Banten Province with 6 indicators of social vulnerability and map areas that have social vulnerabilities and know the spread of social vulnerability in areas identified as prone to flooding.

Method

The research was conducted descriptively quantitatively using secondary data based on the SoVI (Social Vulnerability Index) indicator. This study used 6 indicators as an assessor of Social Vulnerability level in the village analysis unit. Tangerang city has 13 subdistricts in which there are 104 subdistricts. Each village unit is calculated quantitatively using PCA (Principal Componen Analysis) technique which is an indicator reduction technique (Sarwono, 2017) and weighted on each indicator using equations (Liu and Li, 2015). Each weight depicts the association of each indicator/ variable with its vulnerability level. After the calculation of the value of social vulnerability is done overlay using arcGis 10.4.1 tool.

Research analysis measures are 1) Collection of research data from several sources such as from the Central Statistics Agency of Tangerang City, Subdistrict in Figures 2019, Bappeda Tangerang City, and village potential data 2019, 2) Normalization of data aimed at obtaining data with data distribution in the same dimension (Liu and Li, 2015). This normalization uses two equations for each indicator that has a positive and negative relationship to vulnerability. Each indicator has only one relationship i.e. positive or negative, no indicator has a relationship between the two (Solangaarachchi et al., 2012). For those who have a positive relationship that is $V = {(x - A)}/{(B - A)}$ and for indicators that have a negative relationship that is $V = {(B - X)}/{(B - A)}$ provided that V is the Normalization value, X is the original value, A is the lowest actual, and B is the highest actual, 3) The feasibility test of the use of PCA analysis (Principal Componen Analysis) which includes: KMO and Bartlett's Test, Anti Image Matrixs, Communalites, Total Variance Explained (Ilmaniati and Putro , 2019 in Saepurohman and Putro, 2019), 4) Varimax Rotation. Armas and Gavris (2013) mention varimax rotation in SPSS used to run PCA which is useful for simplifying the underlying dimensional structure and producing more independence among the components, 5) Weighting of each indicator using Liu and Li equations in 2015

$$W_1 = \frac{\sum_{j=1}^{k}\left(\frac{a_{ij}}{\sqrt{\gamma_j}} x V_j\right)}{\sum_{i=j}^{n}\left[\sum_{j=1}^{k}\left(\frac{a_{ij}}{\sqrt{\gamma_j}} x V_j\right)\right]} \quad i = 1,2,3 \ldots 8, j = 1,2,3,4$$

where a_ij is the value of the i-indicator at j which is drilis on the rotated component. γ_j is the total value of eigenvalue, while V_j is variance (%) in PCA rotation, 5) Calculating the vulnerability value with the formula SoVI = ∑_(i=1)^n⁡〖x_i×w_i 〗 where X is the standard data (origin), and W is the weight of the index value generated from the PCA prose, while to determine the level of social vulnerability in a village area is done by summing the value of each vulnerability indicator (Liu and Li, 2015). The addition model was chosen on the grounds of not making a priori assumptions about the importance of each component in the overall quantity, then this method is the best choice in the absence of a defense method for assigning weights (Cutter et al., 2003 in Mavhura et al. 2017), 6) Classification or scoring of social vulnerability levels using standard deviation techniques to visually see or figure differences between each other (Letsie , 2015) grouped into 5 vulnerability level classes. The use of standard devias for classifying indicators shows each class defined by the distance from the average value and standard deviation of all features (Crisana, 2014), 7) Map overlay using arcGis 10.4.1 tool to determine the spread of social vulnerability level in Tangerang City area of Banten Province.

Result and Discussion

Based on the results of the management of the 6 indicators of social vulnerability using PCA techniques with ibm SPSS Statistics 25 tools obtained the value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.679 and bartlett's Test of Sphericity value with Approx, and sig. 0.000. The minimum limit of kmo value is 0.50 and Bartlett's Test sig value. p < 0.05 (Fekete, 2011), so the 8 indicators used in this study were tested feasible and further analysis can be done using PCA techniques. Once declared eligible the next step is to know the feasibility through the MSA (Measure of Sampling Adequacy) test. MSA test results can be seen in table 1 showing the 6 indicators have an MSA value of > 0.50 as the minimum eligibility requirement in the use of PCA analysis techniques, as well as communalities test results showing a value of > 0.50 (Siagian et al., 2014 and Solangaarachchi et al., 2012) which means indicators can be further analyzed and can represent other indicators well, while values close to 1 are interpreted indicators in peenelitian can be predicted and analyzed without error.

Table 1. MSA Results, Communalities, and Weights Research Indicators

Research Indicators	Result			Matric Rotation Results	
	MSA	Communalities	Weight	Component	
				1	2
Average Number of Family Members	0,702	0,669	0,140	0,913	0,058
Population Less than 5 years old	0,634	0,899	0,199	0,847	0,430
Population over 65 years old	0,717	0,740	0,176	0,844	0,431
Female Residents	0,638	0,902	0,200	0,824	0,248
Growth Population	0,746	0,837	0,171	0,777	-0,254
Poor People	0,680	0,819	0,113	0,080	0,902

Source: Researcher Management Results, 2020

Table 2. Total Variance Explained analysis results

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,846	64,093	64,093	3,846	64,093	64,093	3,553	59,213	59,213
2	1,021	17,018	81,111	1,021	17,018	81,111	1,314	21,898	81,111

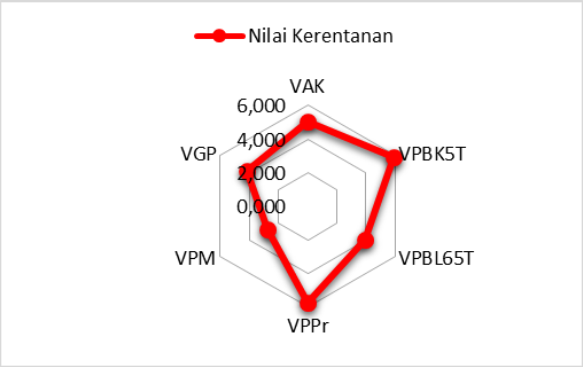
Source: Researcher Management Results, 2020

Based on the PCA analysis process, new components will be formed. In this study, from 6 indicators/ components that exist, formed 2 components can be seen in table 2. Table 2 shows a cumulative percentage of 81.111% which is higher than 80,000% so that it shows the main component extraction information can include most of the initial indicator information (Liu and li, 2015). In table 1 Varimax Rotation Results column describes the magnitude of the relationship or correlation between the initial indicator and the formed component. Each indicator has 1 relationship with the formed component, so it does not cause double calculations that complicate the interpretation as in the column of matrix components. With the indicators that still have a relationship with the 2 components, it is necessary to rotate varimax to simplify the existing dimension structure to be independent (Liu and Li, 2015) the results of varimax rotation and the group of indicators can be done in table 1 on bold numbers. The weights for each indicator can be seen in table 1 of the weight column obtained using the PCA methode (Qu, 2012 in Liu and Li, 2015).

The highest weight is found in the indicator of the female population of 0.200 and the number of people aged less than 5 years 0.199. Once it is known the weight and data that has been normalized, it is necessary to accumulate by multiplying, as well as mapping with arcgis 10.4.1 tools to know the spread of vulnerability level of each indicator in each village in Tangerang City. To know the level of social vulnerability of flood disasters in tangerang city needs to be done overlay between social vulnerability data obtained through the management of six indicators with flood disaster prone maps obtained from BPBD Tangerang City. The spread of social vulnerability of flood disasters in areas that have been identified as flood disasters can be seen in figure 2.

In general, social vulnerability of flood disasters in tangerang city has a value of social vulnerability of flood disasters of 27,266 with a contribution in adding the value of social vulnerability of flood disasters, namely variable vulnerability of residents aged less than 5 years of age of 5,910 or 21.68%, vulnerability of the female population of 5,745 or 21.07%, the average vulnerability of family members of 5,040 or 18.49%, vulnerability to population growth of 4,145 or 15.20% , the vulnerability of the over-65s was 3,910 or 14.34%, and the vulnerability of the poor was 2,571 or 9.43%.

Figure 1. Graph of The Value of Social Vulnerability of Flood Disasters in Tangerang City, Banten Province



Source: Researcher Management Results, 2020

Tangerang City area that has been identified as a flood-prone area has the most dominant vulnerability or contributor to the highest value of social vulnerability of flood disasters in the vulnerability of residents aged less than 5 years (toddlers). The number of toddlers in Tangerang city in the area identified flooding according to BPS in 2019 recorded 135,481 people with an average of 2,084 people. Seeing the large number of toddlers inhabiting flood-prone areas, causing additional social vulnerability in the face of flood disasters (Utomo et al., 2012). This is because physically the toddler does not have the ability to cope and recover from the impact of natural hazards (Dintwa el al., 2019) so it can result in a high vulnerability in facing flood disasters and have a high risk to be affected by flood disasters.

The second contributor to the value of social vulnerability in tangerang city area identified by flooding is the vulnerability of female residents. This is because the area of Tangerang City that has been identified as flooding has a female population of 705,749 people with an average of 1,858 inhabitants. The more the number of women living in flood-prone areas will be the higher the risk in the face of flood disasters that occur and will further increase the value of social vulnerability. This is because the female population has a more difficult time recovering from the impact of the disaster compared to men (Cutter et al., 2003 in Mavhura et al., 2017) and an area that has a large female population, is often neglected in disaster management and has a vulnerability to high flood disasters (Ghafur et al., 2012) in Danianti and Sariffudin, 2015).

The third contributor to the value of social vulnerability in tangerang city area identified by flooding is the vulnerability of the average family member. Tangerang city has an average number of members of the congress is 4 people. The large number of family members can increase social vulnerability because more and more family members will be exposed to flood hazards (Liu and Li, 2015) and the large number of family members often face economic difficulties, and the acquisition of health services making it difficult for them to recover from the impact of natural hazards Cutter et al., 2009 in Siagian et al., 2014).

The fourth contributor to the value of social vulnerability in tangerang city area identified by flooding is the vulnerability of population growth. Population growth in Tangerang city in areas identified as flood-prone amounted to 31,706 people per year with an average of 488 people. The higher the population growth, the more the population will inhabit the flood-prone area and the more people will be exposed and have a high risk in the face of flood disasters. This is because a large number of residents will make it difficult to evacuate when disaster strikes.

The fifth contributor to the value of social vulnerability in tangerang city area identified by flooding is residents over 65 years old (elderly). The number of elderly people in the area identified by the flood is 35,890 people with an average of 552 people. Elderly people are more likely to be evacuated during disasters (Rygel, 2006 in Siagian et al., 2014) and older people are more likely to be vulnerable to flooding than younger ones because older people tend to be disproportionately causing functional and physical limitations , prone to disease, and sensory imbalance (Lowe et al., 2013 in Roder et al., 2017).

The lowest contributor to the value of social vulnerability in tangerang city area identified by flooding is the poor. The more poor people who inhabit flood-prone areas, the higher the vulnerability in the face of flood disasters. This is because the poor have a tendency and are more likely to live in low-quality housing and suffer from malnutrition. Poor people with low economic status cannot afford emergency supplies and take a long time to recover from the impact of the dangers that occur compared to those with high economic status (Rygel, 2006 in Siagian et al., 2014).

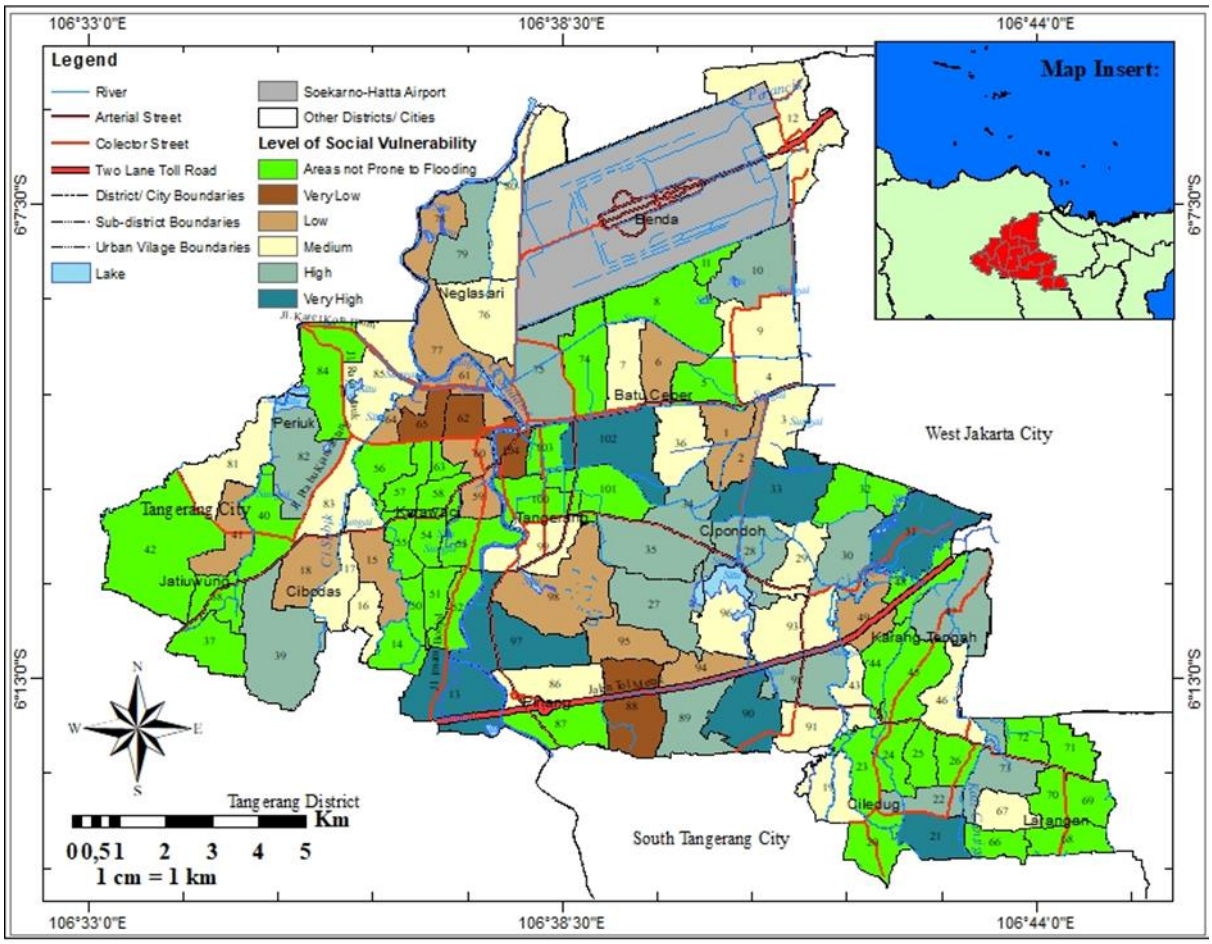


Figure 2. Social Vulnerability Map of Flood Disasters in Tangeran City Area

Source: Researcher Management Results, 2020.

Based on the map picture above, there are 65 villages identified as flood-prone areas and have a social vulnerability value of flood disasters divided into 5 classes of vulnerability levels. The social vulnerability level of flood disaster category is very low in 4 villages out of 65 villages identified as flood prone, while the social vulnerability level of flood disasters is low category in 16 villages. The social vulnerability level of moderate flood disasters is present in 23 villages out of 65 villages identified as flood-prone. The high level of social vulnerability of flood disasters is found in 15 villages out of 65 villages identified as flood-prone, while the social vulnerability level of flood disaster categories is very high in 7 villages. The value of social vulnerability for each village and the contribution of each vulnerability indicator in the addition of the value of social vulnerability can be seen in appendix 1. Among others, villages that belong to the category of social vulnerability level of flood disasters can be grouped as follows:

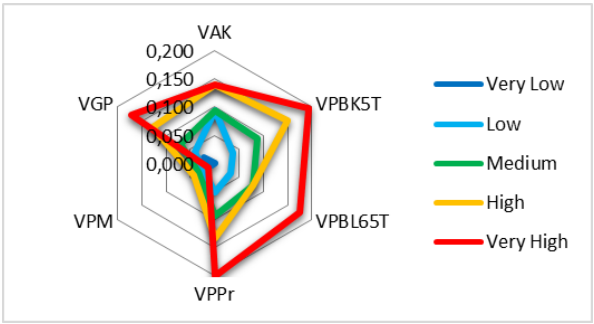


Figure 3. Social Vulnerability Level of Flood Disaster

Source: Researcher Management Results, 2020

Social Vulnerability category is very low among them is found in The Village of East Panunggangan in Pinang Subdistrict which has a social vulnerability value of 0.028 which consists of the value of vulnerability rat-average number of family members of 0.000, the vulnerability of the population of less than 5 years is 0.000, the vulnerability of the population over 65 years old is 0.000, the vulnerability of the female population is 0.000, the vulnerability of the poor is 0.007, and

the vulnerability of population growth is 0.021. Low-category Social Vulnerability is found in Pondok Bahar Subdistrict in Karang Tengah Subdistrict which has a social vulnerability value of 0.280 which consists of a rat-average vulnerability value of 0.093 family members, the vulnerability of the population aged less than 5 years is 0.038, the vulnerability of the population over 65 years old is 0.034, the vulnerability of the female population is 0.051, the vulnerability of the poor is 0.024, and the vulnerability of the population growth is 0.040.

Social Vulnerability of medium category is found in Babakan Subdistrict in Tangerang Subdistrict which has a social vulnerability value of 0.455 which consists of a rat vulnerability value of an average number of family members of 0.093, vulnerability of the population aged less than 5 years of age of 0.089, vulnerability of the population over 65 years of age of 0.078, vulnerability of female population of 0.092, vulnerability of the poor population of 0.033, and vulnerability of population growth of 0.070. High category social vulnerability is found in North Paninggilan Subdistrict in Ciledug Subdistrict which has a social vulnerability value of 0.672 which consists of a rat-rated vulnerability value of 0.140 family members, 0.150, 0.079, 0.132 female population vulnerability, 0.043 poor population vulnerability, and 0.128 population growth vulnerability. Social Vulnerability category is very high among them are cipondoh indah subdistrict in Cipondoh subdistrict which has a social vulnerability value of 0.895 which consists of the value of vulnerability rat-average number of family members of 0.140, the vulnerability of the population aged less than 5 years is 0.194, the vulnerability of the population over 65 years of age is 0.176, the vulnerability of the female population is 0.200, the vulnerability of the poor is 0.014, and the vulnerability of population growth is 0.171.

Conclusion

The Level of Social Vulnerability of Flood Disasters in Tangerang City is divided into 5 categories of Social Vulnerability levels. This vulnerability level assessment uses 6 Social vulnerability indicators analyzed using PCA (Principal Component Analysis) techniques and weighting with Liu and Li's (2015) timeline. In general, social vulnerability of flood disasters in tangerang city has a value of social vulnerability of flood disasters of 27,266 with a contribution in adding the value of social vulnerability of flood disasters, namely variable vulnerability of residents aged less than 5 years of age of 5,910 or 21.68%, vulnerability of the female population of 5,745 or 21.07%, the average vulnerability of family members of 5,040 or 18.49%, vulnerability to population growth of 4,145 or 15.20% , the vulnerability of the over-65s was 3,910 or 14.34%, and the vulnerability of the poor was 2,571 or 9.43%.

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