

Role of social media towards flood disaster adaptation in Bojonegoro region of East Java, Indonesia

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Abstract. The community along Solo Riverbank has strong ability to deal with their frequent flood disaster. It seems that their strong social tie through formal network of their community groups able to bring them live safely in the prone flood areas. This research scrutinized social tie of the community towards social media in order to strengthen capability of the community on dealing with flood disaster as the form of social structure through informal network. Questionnaire survey was distributed and analysed with social network approach covering three indices - rate of participation, density and centrality. The result illustrates that the whole indices have low level, meaning that social media played weak role towards flood disaster adaptation. Therefore, this research continued to measure social tie of the community towards multiple memberships on the local community groups as a form of formal network. Hence, this research suggests that integration between strong of social tie through formal network with weak of social tie through informal network might enhance community resilient on dealing with flood disaster.

1. Introduction

The development of technology, especially social media has an important role in disaster's mitigation system. The social media could be used for any purpose; one of them is for emergencies or disasters aspect. Since 2006, social media has increased the role in disaster management [1]. Bojonegoro regency is one of the districts in Indonesia that is often affected by floods due to Bengawan Solo River. The impacts of climate change, unpredictable weather and high rainfall increased preparedness of communities and local governments to deal with disasters. Disaster preparedness is always vital in disaster management, which can reduce the impacts of disasters. The disaster preparedness applied through an early warning system website, social media and community participation.

According to Disaster Mitigation Agency's (BPBD) data, Bojonegoro Regency is the most affected area of flood disaster from Bengawan Solo River with 4 days of flood in 2016. The level of water was 15.02 meters high classified to a dangerous level. The flood disaster in Bojonegoro District extended to 51 villages with 3,410 houses submerged by floods. This disaster also caused one fatality and as many as 156 people had to evacuate. The impact of flood in Bengawan Solo River not only to community housing but also rice fields, school buildings, and government buildings (BPBD, 2016).

This research aims to determine the role of social media in Bojonegoro Regency as the main source of information about flood disasters. As described earlier, to deal with the disaster in Bojonegoro District, the government uses social media (informal network) to disseminate flood disaster information. This research observes the use of social media such as Twitter, Facebook and WhatsApp in Bojonegoro Regency through a descriptive research approach. In addition, it also requires the participation of the community by their connection in formal network, so that the efforts to reduce the impact of disasters



can be more effective. This study also examined social structure of the community by measuring three indexes consist of level of participation, density and degree centrality.

2. Research Method

Referring to the formula that derived by [2], this research measured social tie of the community in order to draw their social structure using Social Network Analysis (SNA) approach. Furthermore, referring to [3, 4] this research scrutineer social structure of the community in the research area using the proposed three indices consist of Rate of Participation (RoP), density and degree centrality.

Firstly, affiliation data is compiled from two sources:

- i) Formal network: affiliation of head of households towards local community group. Local community groups as the sample of this research are active local groups in Bojonegoro Regency covering total 13 community groups as illustrated in Table 3.
- ii) Informal network: affiliation of head of households towards the presence social media - the local government website "Flood Early Warning Early Action System (FEWEAS), Facebook, Twitter and WhatsApp". The data used in this informal network is whole interaction between twitter account in the form of a tweet, reply or retweet. Tweets are taken using "flood" keywords to facilitate the search for data. The tweet should also accompanied by geotags or flood locations in Bojonegoro regency. Data retrieval obtained by advanced search feature, provided by twitter.com.

Secondly, number of sample for this research consists of 119 head of households as community representatives of the 5 urban villages in Bojonegoro District as the most flood prone areas. The respondents are distributed proportionally based on the number of people in study areas. Data is collected through depth interview to the key person of each community group in Bojonegoro Regency.

Thirdly, in order to measure the community participation, this research use three indexes covering Rate of Participation, Density and Degree Centrality. The units in a network are actors and events (formal and informal group) that affiliated in disaster mitigation. Relationships between actors for affiliation network shown from the participation of respondents to the group in Bojonegoro Regency. This is binary choice data input, which we put "1" for respondents who join in community group and "0" for respondent who did not join to the group. The whole data in the form of incidence matrix ($n \times m$) changed to adjacency matrix ($m \times m$) in order to measure the three indices within three level – low, medium and high.

Rate of participation (RoP) illustrates how high level of participation of the community in dealing with flood disaster through the local community groups as well as the social media as their means. Rate of participation calculated through the following formula (1):

$$\bar{a}_{i+} = \frac{\sum_{i=1}^g \sum_{j=1}^h a_{ij}}{g} = \frac{a_{++}}{g} = \frac{\sum_{i=1}^g x_{ii}^N}{g} \quad (1)$$

Where g is node (respondent), h is number of institutions x_{ij}^N is matrix of respondent participation. In the other formula, it can also obtained from total of diagonal matrix divided by the number of respondents. Category level of participation divided into three categories (low, medium and high) depend on the number of existing groups.

Density describes on how dense connection amongst community within a ascertain area on dealing with flood disaster. Density of network calculated by formula (2).

$$\Delta(N) = \frac{\sum_{i=1}^g \sum_{j=1}^g x_{ij}^N}{g(g-1)} ; i \neq j \quad (2)$$

Where, $\Delta(N)$ is density size, g is node, $(g-1)$ is isolated respondent, x_{ij}^N is primary matrix from respondent i to j , and L is number of lines connected between nodes (actors). Density shows the large-scale the connection of each node with range of value from 0 – 1

Degree centrality represents the most central actors (head of households) as well as the most prominent local community groups and social media (event), with range of value from 0 - 1. Degree centrality calculated through formula (3)

$$C'_D(n_i) = \frac{d(n_i)}{g-1} \quad (3)$$

Where, (g-1) is the number of isolated respondent and d(n-1) is degree centrality value. This analysis argues that some people or event might play important role on disaster mitigation in Bojonegoro regency. UCINET 6 version 6.365 is the analytical software that has been used in this research.

3. Result and Discussion

Bengawan Solo River is the largest watershed in Java Island. Bengawan Solo Watershed is located in East Java province and Central Java province. Bengawan Solo basin has a total area of 1,594,716.22 Ha. The Bengawan Solo River Basin passes through 11 regencies/cities in East Java Province [5]

Bengawan Solo basin is divided into three sub-basins covering Bengawan Solo Hulu Sub-Basin, Kali Madiun Sub-Basin and Bengawan Solo Hilir Sub-Basin. The flooded area due from Bengawan Solo River in Bojonegoro Regency reached 126 villages spread in 16 sub-districts. Floods also occur outside Bojonegoro regencies such as Ngawi, Madiun, Gresik and Lamongan. Bojonegoro District has flood-prone conditions from the flood of bengawan Solo River that annually occur. The floods of Bengawan Solo River are seasonal or annual and occurs for days.

The cause of the overflowing floods of the Bengawan Solo River is deforested, landslide and climate change. The impact of the flood disaster was the destruction of buildings and food crops damage. In 2015 sub-districts affected by floods amounted to 7 districts with 28 affected villages. The sub-districts that have the most affected villages are Baureno Sub-district with 8 affected villages. In 2016 the number of affected sub-districts and affected villages is increasing. There are 11 districts affected by 52 villages. The sub-districts that have the most flood-affected villages are Trucuk Sub-district with 12 affected villages.

3.1 Early Warning System

Bojonegoro District has an early warning system. The system is connected with other districts that are also passed by the Bengawan Solo River. The Early Warning System includes information on a short term, medium term, and observation predictions. It is reported by the observer post then input it into the application. Short-term prediction information is information on predicted flood alert status, puddle, water level and weather for up to three hours. Medium-term information is a prediction of floods in 10-day intervals. Observation info is information about real-time weather observation from weather station and water level from spreader station. The system will provide a signal if the water conditions in the upstream area of the Solo River are rising. Based on the survey results, it is known that the tools used for early warning system has been damaged and not re-enabled. It caused Disaster Mitigation Agency (BPBD) in Bojonegoro only rely on postal information observers through communication via mobile phone or social media (whatsapp). The damage makes information delivered longer than it should be.

The district through which bengawan solo river also has an early warning system related to application system involving community participation. The application is called Flood Early Warning Action System (FEWAS). This application is based on android and ios so people can use via mobile phone. This system is based on a flood early warning system based on weather and climate information with high resolution and accuracy. Existing information is weather observation and prediction, climate prediction and flood prediction.



Figure 1. Website of Early Warning System and Early Action of Bengawan Solo

Based on Figure 1 it can be seen that on the website of the early warning system and early action of Bengawan Solo flood, there is a report column telling the condition in the area which contains information of status symbol, location and water level and time of the incident. In the flood alert column, there is information about the water level. The symbols divided into three namely standby 3, standby 2, and standby 1.

3.2 Role of social media – informal network

Social media has a role in disseminating information before it arrives. The use of social media gives the organization an access to communicate with the community. The communication is appropriate to provide plans and information on what to do in the case of an emergency. Bojonegoro District has several accounts in social media used for the dissemination of information on the region and disaster. The use of social media for the dissemination of information about the flood disaster is still very low in Bojonegoro District.

BPBD Bojonegoro has some social media that is Facebook, twitter and WhatsApp. In Facebook, BPBD Bojonegoro is not active in providing information or receiving information. The last activity carried out by Bojonegoro District BPBD account is in 2013. This shows that Facebook no longer used to disseminate information about flood disasters.

Twitter used by community and disaster account in delivering or receiving information about the flood. Based on Figure 1 there can be seen several accounts to delivering information about flood disaster. But, there is no account owned by the government of Bojonegoro and BPBD who actively provide information and receive information on twitter. The other social media is WhatsApp. Whatsapp is a closed social media because not all people can join to receive information directly. The government together with BPBD formed an information group involving related agencies.

The use of social media in Bojonegoro Regency only used during the disaster and post-disaster to know the water level and the location of the disaster. The use of social media needs to be maximized so that information can be spread faster. Prior to the disaster, social media can also be used to educate the public about what they need to prepared in disaster case and provide the public with information about contacts that can be contacted during an emergency



Figure 2. Facebook account of BPBD Bojonegoro

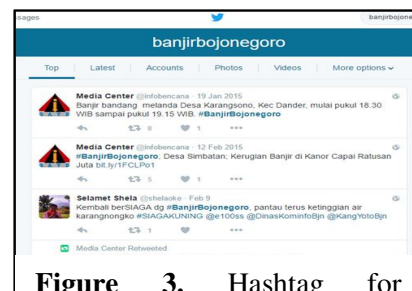


Figure 3. Hashtag for Bojonegoro flood on twitter (#banjirbojonegoro)

3.3 Role of community groups – formal network

Based on the previous research, community in the research area is divided into three level of vulnerability community – low, medium and high by physical, economical, infrastructural and social indices [6].

Table 1 illustrates result of density of the three level vulnerability communities. In general, we may see that the highest density is belong to the medium vulnerability community with value of 0,6190. Meaning that flow of information as well as other resources might spread well among the people in the medium vulnerability community. In other words, the two communities might face more difficulties on dealing with flood disaster compare to the community in the group of medium vulnerability.

Table 1. Density Level of the Community

Vulnerability	Density
High	0,4381
Medium	0,6190
Low	0,3143

Table 1 describes result of the two indices consist of rate of participation and density based on each neighbourhood as the lowest level of the community. At the high vulnerability community, there are 4 of 12 neighbourhoods with complete network illustrated by density with value of 1. At the medium and low vulnerability communities, there are 4 of 12 and 6 of 9 neighbourhoods have also complete network shown by density, respectively. Meaning that on those 14 neighbourhoods, the whole community members might have similar possibility on receiving information as well as other resources. Into more specific information related with flood disaster adaptation and mitigation, in case the information comes to those communities it seems that the community might act as good recipient that it will bring them to better solution on dealing with flood disaster. However, the community in the category of high vulnerability seems still higher risk compare to the other two-vulnerability community, since the least number of neighbourhoods with density value of 1 is at the high vulnerability community. This result finding makes sense since the community in the area with high vulnerability has the highest risk towards their residential location along the flood prone areas.

Table 2. Rate of Participation and Density Based on Location

Vulnerability	Urban Village	Hamlet	Neighbourhood	Density	Rate of Participation
High	Jetak	1	1	1	2.30
			2	1	2.56
			3	0.8667	3.83
	Klangon	2	8	0.523	1.14
			2	0.654	2.94
			4	0.733	3.33
	Ledok Wetan	1	6	0.55	1.88
			7	1	2.83
			5	0.2444	1.20
	Ledok Kulon	3	2	0.3736	1.57
			3	1	4.67
			3	0.818	1.92
Medium	Banjarjo	1	4	1	1.29
			5	1	2.14
	Ledok Wetan	1	1	0.6	3.00
			3	0.85	3.36
	Ledok Kulon	1	1	0.1905	0.86

Vulnerability	Urban Village	Hamlet	Neighbourhood	Density	Rate of Participation		
	Kauman Banjarjo	2	5	0.285	1.00		
		3	1	0.238	1.14		
			2	1	1.18		
		4	4	1	2.25		
		2	11	0.7876	0.83		
		1	6	0.775	3.00		
			7	0.1905	1.57		
		Low	Klangon Ledok Wetan Banjarjo	1	1	1	3.67
				2	10	1	3.71
1	1			0.285	1.29		
	2			1	1.00		
	5			0.381	1.09		
2	9			1	1.13		
3	22			1	3.00		
	23			0.8	3.40		
Kauman	2			10	1	2.46	

In general, average membership in the research area is about 1 – 5 among the 14 community groups. There are 4 of 9 neighbourhoods in the community of low level vulnerability have average memberships towards 3 – 4 community groups. Meanwhile, at the other two level vulnerability community, there are 3 of 12 at both with average number of membership between 3 – 4. Meaning that in the community with low vulnerability level might present higher participation compare to the other two communities. In the sense of dealing with flood disaster, the low vulnerability community might has better adaptation among others.

The following Table 3 describes degree centrality of the 13 community groups in the research areas within the three vulnerability level of the community. For the high vulnerability community, the highest degree belongs to the Religious 1, following by Hamlet Gathering and Hamlet Administrators groups with value of 85,714 – 78,571 – 71,429, respectively. In the medium vulnerability community, the highest degree is at the Religious 1 with full connection – meaning that the whole community members affiliate with the group. The second highest degree of centrality belong to Hamlet Gathering and Hamlet Administrators with value of 85,714. Then, the third highest value is at the PNPM group wherein about 78 percent of the community members belong the this group. Different with the other two communities, in the low vulnerability community, the highest degree of centrality is at the Hamlet Gathering group. In specific, there are 6 community groups with no one of the community becomes their member.

Table 3. Degree Centrality Analysis

Community Group	Normalization Degree		
	High Vulnerability	Medium Vulnerability	Low Vulnerability
Jamaah Tahlil (Religious 1)	85,714	100,00	57,143
Arisan RT (Hamlet Gathering)	78,571	85,714	64,286
Pengurus RT (Hamlet administrators)	71,429	85,714	42,857
PNPM (National Program for Community Empowerment)	57,143	78,571	35,714
Pos Ronda	57,143	64,286	35,714
Karang Taruna (youth organization)	57,143	64,286	50,000
Kelompok Tani (farmers)	57,143	35,714	0
Arisan Desa (villagers gathering)	50,000	64,286	0

Community Group	Normalization Degree		
	High Vulnerability	Medium Vulnerability	Low Vulnerability
PKK Bhayangkari (Women group)	42,587	50,000	0
Remaja Masjid (Youth mosque activist)	28,571	35,714	0
Organisasi Keagamaan (Religious 2)	28,571	21,429	0
Jamaah Kausaran	21,429	35,714	0
BKM	21,429	35,714	35,714

In conclusion, we might compare degree centrality value among the three vulnerability communities, whereby the low-vulnerability community has the lowest level of degree centrality. Meaning that even the Hamlet Gathering has the highest degree centrality in the community, still only covering around 64% of the community member. In other words, once information or resources come to this community group, it will be about 36% of community members will be the one who could not reach it. Then, if we compare degree centrality among the community groups, it seems that the most popular community group is the Religious 1 amongst the whole three community category. It might infer that the most effective information and other resources might flow softly through the activity of the Religious 1.

4. Conclusions

Social media as a tool for society to deal with flood disaster might function well, however, in case for residents along Bengawan Solo River in Bojonegoro district, through social network analysis using density, rate of participation as well as centrality, it has shown that the residents has low social network. In other words, social media has not play an important role for the residents since there are few people who has connection with the social media on that case. Then, when the measurement of social tie continued with affiliation data through residents' membership towards community groups that has presence in their living neighborhood, in general, residents in Bojonegoro District have able to form strong social tie that might prevent them from the disaster. Finally, we may conclude that in order to strengthen community resilient on dealing with flood disaster, it seems good to combine the strong social tie through formal network and the weak of social tie through informal network for the betterment coordination for the whole actors on dealing with the disaster. Meaning that the local government could utilize the 'popular' community group – a group that has a lot of number of membership as an initiation approach to strengthen community network on dealing with flood disaster to the introducing towards social media as the more innovative tool in this millennium era.

5. References

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