Community adaptive capacity using social media at the aftermath of tropical cyclone cempaka, Indonesia

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Abstract. Tropical Cyclone Cempaka is one of the tropical cyclones that hit the southern Coast of Java Island, Indonesia. The occurrence triggered flood and landslide which impacted to disrupted community livelihood. There were damages upon paddy fields, settlements, and many other public facilities such as roads and bridges at the aftermath of Tropical Cyclone Cempaka. This research aims to evaluate how community adaptive capacity towards Tropical Cyclone using social media. The main idea to use social media is to expand response coverage towards Tropical Cyclone. The community is understood not only as person or accumulative people who live in specified administrative unit, it could also those who had interest towards particular administrative unit. The research method employed spatial temporal approach to identify distribution of Twitter data responded towards the event. The research intends to collect data with series of relevant hashtags, and to observe data into several categories. The preliminary research reveals that there are significant changes in most frequent keywords during the disaster event. The most frequent tweet during emergency situation is the general information about the events. Afterwards, tweets characteristics shifts during rehab-recons phase into words relevant to raise supports and spirits. The spatial distribution of tweets originated from cities, and megacities, such as Jakarta, Surabaya and many others. Relevant to the idea, community adaptive capacity towards Tropical Cyclone Cempaka was not merely conducted by local community, it also involved variedly to the national to regional community using social media.

1. Introduction
Tropical cyclone Cempaka (TCC) was one of tropical cyclones taking place in south coastal area of Java Island in 2017. The origin of the TCC has emerged for the first time on November 26th, 2017, about 240 km Southwest of Cilacap district and moved closer to Java Island. As recorded on Tuesday, November 28th, 2017, the velocity of the tropical cyclone was 65 km per hour [1]. As recorded by Badan Meteorologi Klimatologi dan Geofisika (BMKG) on November 29th, the tropical cyclone moved away and weakened and vanished. The track of TCC is shown in Figure 1.

The occurrence of the tropical cyclone Cempaka resulted in storm and heavy rain that caused in turn floods and landslides in several points. The areas affected by the storm and the heavy rain included Banten Province, the Special District of Capital City of Jakarta, West Java Province, the Special District of Yogyakarta, and East Java Province [2]. The worst impact took place in the areas that were in the closest distance to the track of the tropical cyclone Cempaka, including the Special District of Yogyakarta, Pacitan Regency, Wonogiri Regency, and Ponorogo Regency [3], [4]. There were in Pacitan representing the worst affected district 20 dead individuals, 14 of them were dead because they were buried under landslide and 6 of them were washed away by flood [5]. The tropical
cyclone Cempaka had serious impact on human life. The landslide cut the Pacitan-Ponorogo main road [6] that obstruct the distribution of goods. The landslide taking place in Ponorogo buried 300 houses and caused several roads collapsed [7]. There were in Gunungkidul district 48 hectares of seriously damaged agricultural land because of flood [8].

The objective of the study was to find out community’s adaptive capacity condition in facing tropical cyclone Cempaka in 2017 using social media. Adaptive capacity was all of the existing resources of a community that were robust, redundant, or rapidly accessible. The resources might be in the forms of objects, characteristics, condition, and energy that were recognized by community. A good adaptive capacity condition would cause strong community in facing disasters [9].

Social media could be used to predict the adaptive capacity condition because the social media recorded the majority of community’s thoughts and occurrences taking place in a period of disaster. People loved to share information in social media, especially during the occurrence of a disaster. The social media became one of the instruments for the people to communicate their thoughts and feelings to each other and also to communicate with authorities to ask for help and to get access to official information. Among so many popular social medias, Twitter was selected to be main data source because of its data availability and easy access. Additionally, the tweet structure of limited words (140 words only) enabled easy classification.

2. Theoretical Background
An occurrence of disaster might be defied as external disturbance that had significant impact on the condition of a community. The “disaster” was the phrase used when an occurrence of “danger” hit a community and inflicted losses [11]. A disaster might be defined as an occurrence with the potential to cause collective trauma. There were several types of disaster, including natural disaster, technological disaster, and social disaster [9].

The community affected by a disaster would try to recover themselves into normal condition. The constantly adapting condition of the community to external influences was referred to as “adaptation” [11]. The measurement of the community in the adaptation process to various kinds of
disturbance was called “adaptive capacity” [11], [12]. If a community had a good adaptive capacity, it would not have any significant difficulty in facing disturbances that it would become strong one in facing disaster [9].

The adaptive capacity might be in several forms [9]. Each kind of disaster required different adaptive capacity. It was also the case of a group of communities. The communities in the group would have different characteristics of adaptive capacity [12]. The adaptive capacity of a community might be found out by observing the behavior of the community during a period of disaster.

Social media was one of the instruments for people to be connected to each other. They could freely share posts containing thoughts, feelings, and opinions [13] in the form of writings, voices, images or videos. Interaction process also took place to each of the posts in the form of replies, retweets, and likes [14]. The activities in the social media after the occurrence of a disaster might be a means for a community to recover its condition. They could get emotional support, develop collective awareness of the disaster, and distribute information [13].

In the era where disaster should be public awareness, many worldwide institutions developed public warnings towards disaster. Unlike many other types of natural disaster, TCs normally predicted in advanced, via radar information, satellite monitoring and advance meteorological surveillance [15]. Therefore, right before the occurrence of TCs, most possible warning has been distributed by the local authorities, which then responded variedly via social media. The following Figure 2 indicated components of integrated warning system works in praxis.

![Figure 2. Integrated warning system components. Source: Mileti & Sorensen, 1990 [15].](image)

The research argues, within the integrated warning system components, what are the possible role may arise from public awareness indicated by social media. Is the whole components works properly in monitoring, informing, interpreting, and in responding the environmental cues? How their adaptive capacity reflects how the components of warning system itself.

The previous research on adaptive capacity to TCs mentioned that ability to response positively is relevant to what so called adaptive capacity [16]. Furthermore, to response the warning there are steps to proceed, such as belief the warnings, confirm the warnings and respond to warnings. This research tries to explore the segmented process of responding the warnings to TCs.
Notwithstanding to the fact that adaptive capacity was not measure thoroughly, some previous research revealed that preparedness which include ability to response positively or adaptive capacity is pivotal role within subjective measure to community preparedness. There are two important measurement to preparedness, such as objective measure and subjective measure. Objective measure includes those “hard” preparatory actions, such as do they prepare shelters, food, blanket, and many other emergency tools. While subjective measure, embraces individual and collective readiness, perceptions, willingness to respond properly etc. [17].

3. Methods
The study was in general conducted using a descriptive qualitative analysis of a collection of tweets. The analysis was made to find out the content of the tweets uploaded by a community. Additionally, spatial and temporal approaches were used to see how the spread and the dynamics of the tweets during the occurrence of a disaster. The research method is shown in Figure 3.

![Figure 3. Research method.](image)

3.1. Data Collection
The tweets related to the occurrence of tropical cyclone Cempaka were obtained using several keywords and hashtags appertaining to the disaster in certain period of time. Followings were some examples of the keywords and the hashtags: “flood,” “landslide,” and “Cempaka”. The period of time was two weeks starting from November 26th, 2017 on which the origin of the cyclone was identified for the first time, and ending in December 11th, 2017. The data resulting from the tweets included usernames, user locations, tweet times, tweet locations, and tweet contents. The data were collected using the programming language Python 3.7 operated in the software Pycharm Community Edition. They were then saved in the .csv (comma separated values) file format.

3.2. Data Processing
The collected data were filtered to remove the tweets that did not relate to the study. The tweets that did not relate to the study might come from outside Indonesia or those that were not in context of the tropical cyclone Cempaka. Homogenizing process was also carried out for easy tweet processing. The homogenizing process included the removal of unnecessary characters such as “[ ] / \ . , @ #”, and changing all the characters of the tweets into lowercase.

Each of the tweets contained the information of the location of the tweets that were useful in identifying the area of origin of the tweets. The processing was carried out to see the number of the tweets coming from each city. Therefore, it would be spatially observed which city had the highest tweet frequency and which one had the lowest tweet frequency.

The tweets were temporally classified into three disaster phases, including early phase, emergency phase, and rehabilitation and reconstruction phase. The early phase started from the official announcement by Badan Meteorologi, Klimatologi dan Geofisika (BMKG) about the emergence of the origin of the tropical cyclone on November 26th, 2017 to the period before the heavy rain and the
storm took place on November 27th, 2017. The emergency phase was characterized by many occurrences of landslide and flood in several locations. The phase started from November 28th to November 29th. Disaster management process taking place in this phase was carried out by searching victims and evacuation of affected people. The rehabilitation and reconstruction phase began once the condition of the affected people has been recovered. The phase started from November 30th to December 11th. The rehabilitation was the recovery the social and psychological condition of the affected people, while the reconstruction was the recovery of the affected infrastructures.

The identification of the frequently emerging words was conducted in each of the tweet groups both on spatial and temporal bases. The tweet data were transformed into string data and then the emerging frequency of every single word was counted. The frequently emerging words were indicative of the presence of resonance of the people to the word. Also, it was indicative of the similarity in the thought and the feeling of the people that they expressed in the words.

### 3.3. The Expected Results
Community’s adaptive capacity condition might be described using the words that frequently emerged in the tweets of the community. It would temporally indicate how the change in the frequency of each word showed the dynamics of the community. The general words emerging in the early phase would be different from those emerging in the emergency phase and in the rehabilitation and reconstruction phase. It would also indicate the difference between the emerging words in the areas affected by disaster and those emerging in the areas that were not affected by the disaster.

### 4. Results and Discussion
Community adaptive capacity due to TCC is characterised by on-site capacity and off-site capacity. The research findings indicated upon off-site capacity which reflected by social media responds. According to the integrated warning system components, the community adaptive capacities were abundant and last longer than those preparedness at the pre disaster and per disaster phase. Urban community performs significantly towards community adaptive capacity via social media.

Generally, the number of the tweets with geotag location was very small as compared to that of the tweets without geotag location. There were more people who posted their tweets without activated the geotag feature because the feature was inactive by default setting or it has not been activated. The tweets used in the study were only those with the geotag location information. Therefore, there was only a small number of the tweets related to the tropical cyclone Cempaka (TCC) in 2017. The graphics of the number of the tweets posted by the community in the period of disaster might be seen in Figure 4. Meanwhile the reflected finding towards integrated warning system is presented in Figure 5.
Figure 4. Tweet intensity during disaster period.

Derived from Figure 4, the majority of the tweets coming from Java Island, especially from cities such as Jakarta and its surrounding, Surabaya, and Yogyakarta. The big number of the tweets coming from the cities was indicative of the high twitter activity of urban community. It was supported by the easy access for the urban community to internet and communication gadgets. The adaptive capacity of the community to the information and communication environment was therefore classified as high. Jakarta and Surabaya cities represented two big cities that were not directly affected by the TCC. However, there were many of their citizens posted their tweets related to the TCC. It indicated that they paid a good attention to the problems at both regional and national levels, especially huge disaster like the TCC.

Figure 5. Reflection of spatial aspects into integrated warning system in TCC, Indonesia.
Despite the facts that tweets data are poor in geotagging of location indicator, thus the research identified that off sites’ community originated from urbanized area are predominant in responding to the event. Therefore, reflecting to the finding, this research argued that in Figure 5, whereas the components of monitoring, informing, interpreting and providing cues are bounded to specified spatial unit. It will continue to focus on the area of “danger”. Meanwhile, the process of responding, there will no specified spatial unit attached. It is distributed as much as it gets. Everyone outside the “danger” may also be informed, and be alarmed as indicated from the tweet distributed from social media.

Aside from the finding on spatial aspects, the following Figure 6 reflects the findings towards temporal aspects. The reflection of temporal aspects into integrated warning system indicated that components of monitoring, informing and interpreting is actually conducted during pre-disaster. As for the warning itself lasts until the period of per disaster or during emergency situation also. The response components as indicated from the Figure 5 and Figure 6, actually dominant during post disaster. It is stated within the result that pre disaster tweet only captured 2 days, and per disaster also lasted for 2 days, while post disaster captured for nearly 2 months.

The number of the tweets in the early phase was zero because there was not any tweet related to the TCC. It was indicative of the low attention of the community to early warning of bad weather by the BMKG on November 26th, 2017. The community in the early phase has not felt any change in the weather so that it was not necessary for them to make any preparation to face the coming bad weather.

The next phase was the emergency phase in which there was an increase in the number of the tweets related to the TCC as seen in Figure 5. The results of the identification of the words that frequently emerged were summarized in Table 1. The biggest number of the tweets was found in the emergency phase, which contained the information of the occurrence and the impact of the tropical cyclone Cempaka. It was indicated by the words “cyclone,” “tropical,” and “Cempaka” that were on the top of the words that most frequently emerged. The frequency of the words emerging in the phase was low so that the condition of the community could not be described clearly. Generally, the adaptive capacity condition of the community in the phase put more emphasis on information and communication aspects.

Figure 6. Reflection of temporal aspects into integrated warning system in TCC, Indonesia.
Table 1. The list of top 20 words frequently emerging in each of disaster phases.

| Emergency | 20 words frequently emerging in each of disaster phases. | Rehab-Recon 1 | Rehab-Recon 2 |
|-----------|---------------------------------------------------------|---------------|---------------|
| cyclone (17) | Yogyakarta (3) | disaster (142) | nature (24) | disaster (112) | status (14) |
| tropic (17) | Jakarta (3) | Cempaka 107 | storm (22) | twitter (72) | alert (14) |
| Cempaka (15) | dahlia (3) | twitter (97) | Indonesia (22) | flood (62) | Jakarta (14) |
| twitter (5) | kbr (3) | instagram | status (20) | instagram | fund (12) |
| team (5) | weather (2) | (66) | land (18) | (41) | help (11) |
| landslide (3) | aftermath (2) | cyclone (65) | care (17) | Cempaka (41) | together (11) |
| flood (3) | enough (2) | dahlia (51) | Jakarta (16) | landslide (30) | Indonesia (10) |
| instagram (3) | Java (2) | tropic (48) | Pacitan (16) | victim (26) | big (10) |
| alert (3) | day (2) | flood (33) | help (16) | Pacitan (24) | trauma (10) |
| disaster (3) | tree (2) | landslide (32) | hope (14) | village (20) | mountain (9) |
| | | | | | nature (19) |

The number of the tweets in the rehabilitation and reconstruction phase was significantly bigger than that in the previous phase (as seen on Figure 4). It indicated that there was a growing awareness of the community of the TCC phenomena. The massive information dissemination through social media became main factor. Through the social media, it was easy for the people to get access to the information related to the disaster such as the time and the place of the occurrence of the disaster, the number of victims, the damage, and so on. There were many information related to the disaster circulating in Twitter in the phase as evidenced by the emergence of the words such as “Cempaka,” “cyclone,” “flood,” and “landslide.” It became the proof of the high adaptive capacity of the people in the aspects of information and communication, especially in the rehabilitation and reconstruction phase.

The rehabilitation and the reconstruction phases were quite long, which was 12 days. It was necessary to divide the phase into two to find out the detailed dynamics of the community, which were the rehabilitation-reconstruction 1 starting from November 30th to December 5th, and the rehabilitation-reconstruction 2 starting from December 6th to December 11th. The first and second phases were generally the same. In the second phase the words “disaster,” “Cempaka,” “flood,” and “landslide,” were on the top position. As a part of the adaptive capacity, community’s high social capital was clearly observed in the big number of the words “care,” “help,” “hope,” “fund,” and “aid.” It seemed that the community had the feeling of sympathy related to the ongoing disaster. The feeling of the sympathy of the community for the victims of the disaster was expressed in the utterances of care and prayer and in donating certain amount of fund. Based on the collected tweets, the community had a good awareness and high social support.

5. Conclusion

Derived from the finding, the social media enable scholar to evaluate community adaptive capacity towards TCC in Indonesia. The social media data is an input towards subjective measurements taken by the community at on-site and off-site of the hazard prone areas. They are able to indicate their beliefs towards existing warnings, they confirm about the warnings and response variedly upon the event. Predominantly the spatial boundary taking into the monitoring, informing, and interpreting components, while responding mechanism have no spatial boundary. This research has learned that urban community has play pivotal role in shaping subjective measure towards community adaptive capacity during the whole process of pre-disaster, per-disaster and post-disaster.

Community’s adaptive capacity could be described on the basis of the tweets uploaded by a community in a period of disaster. The period of disaster was classified into three, which were early phase (pre disaster), emergency phase (per disaster), and rehabilitation and reconstruction phases (post disaster). Each of the phases had different adaptive capacity condition. The community still had low attention to the tropic cyclone Cempaka in the early phase. And then, the adaptive capacity of the community in the emergency phase put the emphasis on the aspects of information and
communication as evidenced by the big number of the tweets containing the information of the disaster. The adaptive capacity of the community in the rehabilitation and reconstruction phase put the emphasis on the social capital as evidenced by the big number of the tweets containing support, sympathy and prayer, and by the fund raising for the victims of the disaster.

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