Coastal Community Resilience Planning Toward Disaster: A Case Study on Coastal Area in Malang Regency, East Java, Indonesia

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Abstract. Indonesia is a tropical islands-country which frequently impacted to natural disasters. The coastal area of Southern Java Island is one of an area prone to meteorological disasters, including Desa Gajahrejo. Desa Gajahrejo is susceptible to tidal wave disaster owing to its physical condition. Tidal waves disaster impacted both the socio-economic and environment of the area. The aim of this paper to identify the awareness and preparedness of the community and tourism actors in Desa Gajahrejo as the basis of further tourism planning. This research used field observation, in-depth interview and focus group discussion (FGD) as part of a community service agenda for the data-collection methods. The community service agenda was held in Ungapan Beach, which was attended by the representatives of each board in Desa Gajahrejo. The results showed that the tidal waves disaster has one-month, one-year and 5—7 years return periods. It impacted tourism activity both directly and indirectly. The community has good awareness, knowledge, and response to the multi-disaster hazards. It is shown from the well-understanding of the role and function of each board. Despite that, structured and documented planning is still unavailable. Therefore, further contingency planning is needed for tourism activity and disaster management implementation.

1. Introduction
Indonesia is a tropical islands-country which frequently impacted to natural disasters. Data from Indonesia National Disaster Management Agency (BNPB) showed that there were 1,858 disasters occurred in Indonesia on January—August 2020 only (Table 1). Most of it was meteorological disasters. Meteorological disasters are affected by extreme weather phenomena such as high-intensity rainfall and windspeed due to climate change [1].

| Code | Disaster | Total Event | Dead & Lost | Injuries | Impacted & Evacuated | Major | Partial | Less | Flooded |
|------|----------|-------------|------------|----------|----------------------|-------|---------|------|---------|
| 102  | Landslide| 725         | 18         | 10       | 627                  | 74    | 155     | 206  | 30      |
| 101  | Flood    | 546         | 48         | 15       | 617,492              | 647   | 2,628   | 5,499| 78,365  |
| 105  | Whirlwind| 450         | 6          | 31       | 245                  | 417   | 549     | 2,997| 0       |

Table 1. Natural Disasters in Indonesia in 2020 (January—August)
| Code | Disaster                          | Total Event | Fatalities | House Damaged |
|------|----------------------------------|-------------|------------|---------------|
|      |                                  |             | Dead & Lost| Major| Partial| Less| Flooded|
|      |                                  |             | Injuries  | Evacuated|      |      |    |
| 107  | Forest and land fire             | 101         | 0          | 0      | 0     | 0   | 0     |
| 104  | Tidal waves/abrasion             | 18          | 0          | 0      | 13    | 19  | 8     | 117  |
| 108  | Earthquake                       | 11          | 0          | 0      | 0     | 0   | 1     | 0    |
| 111  | Volcanic eruption                | 7           | 0          | 0      | 0     | 0   | 0     | 0    |
|      | **Total**                        | **1,858**   | **72**     | **618,377**| **1,157**| **3,333**| **8,711**| **78,512**|

Source: [2]

The coastal area of Southern Java Island are prone to meteorological disasters—such as tidal waves. In particular, the disaster is triggered by the marine meteorological condition of the area. Based on Meteorological, Climatological, and Geophysical Agency (BMKG) [3] data, the area has a moderate to strong wind speed in the Beaufort scale. It created tidal waves disaster on June 3rd—5th, 2020 with the height category of "High" (2.5—4 m) on 3rd June and "Very High" (4—6 m) on 4th and 5th June. One of the impacted areas is Desa Gajahrejo.

Desa Gajahrejo, Kecamatan Gedangan, Kabupaten Malang, East Java is located in 7°21'-7°31' S dan 110°10'-111°40' E. It has a gently sloping topography, rising 156 m above sea level. The coastal area is facing directly to the Indian Ocean, creating a headland-bay beach morphology (crescentic beach). Although located in the same area, the west and east bay has different shapes. The west bay is a v-shaped beach and the east bay is a pocket beach [4]. The location of Desa Gajahrejo is shown on Figure 1.
Desa Gajahrejo is susceptible to tidal wave disaster owing to its physical condition. Along with a strong to stormy wind from the Indian Ocean, it could worsen the disaster as happened in 1992, 2002 and 2013. The impact also reached the back-swamp area of Desa Gajahrejo which is shown by the occurrence of a post-disaster tidal flood. Usually, tidal waves disaster occurred on a transitional season between rainy and dry season.

As well as the environmental impact, the tidal wave disaster was impacted the socio-economic condition of Desa Gajahrejo. It is because the tidal wave shut down the coastal tourism activities, which is the main economic sector in the area. The impact is even worse in the well-developed tourism area, such as Ungapan Beach, Watubolong/Bajulmati Beach and Jolangkung Beach.

In response to the tidal wave disaster, this paper aimed to identify the awareness and preparedness of the community and tourism actors in Desa Gajahrejo. It is essential for further tourism planning which considers the multi-hazard disaster and environmental sustainability. Furthermore, it could be translated into an applicative contingency planning [5].

2. Methods
This research was carried out in Desa Gajahrejo, Kecamatan Gedangan, Kabupaten Malang, East Java, Indonesia by field observation, in-depth interview and focus group discussion (FGD) as part of community service agenda. This was carried out to identify the community planning in response to reduce the coastal disaster risks in Desa Gajahrejo. This research was carried out using a qualitative approach, which aimed to understand, construct and generate hypotheses from certain phenomenon [6,7,8,9].

Field observation is a process of observing and recording a series of phenomena, behavior and atmosphere with respect to nature and organisms in the natural situations [10]. In social research, field observations are often combined with interviews [11]. In-depth interview is a technique designed to obtain a clear picture from the perspective of the informants regarding the research topic [12]. In-depth interviews consider the informants as the expert, while the interviewer as the student. Therefore, interviewer is going to dig deeper information from the informants. In this research, field observations and in-depth interviews were conducted to obtain some data, which are 1) physical and social conditions of Desa Gajahrejo, 2) tidal waves phenomena in the area, 3) historical information about the disaster, and 4) the community’s views and planning regarding to the disaster.

In-depth interview is an effective qualitative method to obtain information about the informant’s feelings, opinions, views and personal experiences [13]. With the in-depth interview method, researchers will have the opportunity to gain insight into how local community interpret and respond certain phenomena that occur. The informants of an in-depth interview are key informants. By interviewing key informants, the information provided will be in accordance with conditions in the field. In addition, the use of key informants also aims to expand and deepen the information. Each interview topic has at least one key informant. This research used in-depth interview method to validate and obtain a deeper understanding about the tourism activity in Desa Gajahrejo, historical events of tidal waves disaster, local wisdom regarding to the disaster, as well as the task, function and role of each community groups.

The in-depth interview is done only based on the outlines of the problem (unstructured interview), which the interviewers gave no specific predetermined questions. Therefore, the key informants have a freedom to express all of their knowledge and interests owing to the research topic. The purpose is to provide a complete and comprehensive information as possible. In addition, direct interviews allow researchers to interpret the body language and facial expressions of the informants [15]. In this research, interviews were conducted with several key informants, such as 1) community leader, 2) tourism actors and 3) the SAR Team. Interviews were conducted informally, but focused
on the disaster management topic. The informal interviews were aimed to make the informants more comfortable and natural, so that more information can describe the existing condition.

FGD is a focused discussion to bring up a certain topic in a certain community. FGD can help to understand the perception, conception and comprehension of the discussion participants about the discussed topic [3,8,17,18]. Accordingly, FGD is ideal to gain rich information resources. There were 17 participants in this research's FGD, which includes 1) village government representative, 2) community leader, 3) Forest Village Community (LMDH), 4) Superintendent Society Association (POKMASWAS), 5) Search and Rescue (SAR) Team, 6) Bajulmati Sea Turtle Community (BSTC), and 7) tourism actors. Correspondingly, it was going to generate more comprehensive and complex information from different points of view. The researcher should assure the efficiency of the discussion; thus, every representative could express their knowledge without any domination tendency [15].

This research was carried out in three stages; namely pre-community service, community service agenda and post-community service. In the pre-community service agenda, researchers tried to preliminary identify the problems and find the appropriate solution for the community service agenda. The next agenda was primary data collection through observation, interview and FGD as part of community service agenda. Lastly, the post-community service agenda was carried out through secondary data collection, primary and secondary data integration, and data analysis, visualization, and presentation. Systematically, the steps of this research can be seen on Figure 2.
3. Results and Discussion

3.1. Gathering Information About Location from Community

Community service agenda was carried out in Ungapan Beach, Dusun Bajulmati, Desa Gajahrejo, Kecamatan Gedangan, Kabupaten Malang, East Java, Indonesia for one day. The agenda was divided into two sessions, which are 1) explaining the physiographic condition of the area in relation to the multi-disaster hazards and the socio-economic condition in the area, also 2) FGD for gaining the information about the role of each community groups as the foundation of further regional planning and disaster risk reduction strategy. The agenda was aimed to identify the existing community's knowledge, awareness, and preparedness on the local disaster hazards.

The agenda was attended by several boards in Desa Gajahrejo, namely: 1) village leader representation, 2) community leader board, 3) local tourism board, 4) coastal environmental conservation board, and 5) SAR board. The purpose was to acquire a comprehensive point of view from each board. In general, the task and function of each board are 1) village leader: communication coordination between the local community, tourism actors, tourists, private sectors and local government, 2) coastal environmental conservation board: assure the ecological and tourism activity sustainability, and 3) SAR Team: assure the safety of tourists and the tourism activity itself. Thenceforth, the integrated corporation between boards is necessary for disaster risk reduction actions.

To validate the FGD results, in-depth interviews with key informants were done. In addition, the goal of the interview is to bring up the local community's perception and comprehension of the existed disaster hazard. The respondents also informed historical events regarding the coastal disaster in Desa Gajahrejo.

3.2. Current Disaster Hazard in Gajahrejo

Desa Gajahrejo can be divided into three parts based on its morphological features, which are upper part (hilly area), middle part (flat to undulating area) and lower part (coastal area). It is located on Wonosari karst formation which is dominated by carbonate rocks. The southern part of Desa Gajahrejo resulted from the karst uplift action [20]. The genesis was formed as a result of tectonic activity in the southern offshore of Java. Later on, it will develop karst features such as underground rivers, caves, conical hills and dolines. The features are distributed across a slightly steep (16—25 %) karst genesis.

Other than karst genesis, Desa Gajahrejo also has a fluvial and marine genesis. Desa Gajahrejo is located in Penguluran Watershed. It has six 1-ordo rivers, two 2-ordo rivers and one 3-ordo river. The river ends up on Telok Beach.

The physical condition of Desa Gajahrejo is implicated in the multi-hazard disasters in the area. Some of them are tsunami, earthquakes, tidal waves and floods. In particular, tidal waves are the most hazardous disaster. It is supported by BMKG data which showed a "High" category (2.5—4 m) tidal wave on June 3rd, 2020. The next day, a "Very High" category (4—6 m) tidal wave hit Desa Gajahrejo until June 5th, 2020.

The coastal area of Desa Gajahrejo resembles a V-shaped beach, which going to increase the damage from the tidal wave disaster. The V-shaped beach can accelerate the tidal wave speed as it enters the land. Furthermore, a landslide can occur as the impact of a tsunami or tidal waves' rip current [21]. The condition is worsened by the pocket beach's morphology. The rip current is strong enough to drag human offshore [22].

The variability of beach slope in Desa Gajahrejo is implicated in the different types of breaking waves in the area. There are three types of breaking waves, such as plunging, spilling and surging. Spilling waves is a slow wave that formed on a beach with a gradual-slope ocean floor. Plunging waves move towards a steep beach. The crest formed as the top of the wave travels faster than the base, thrusting the crest forward. On a very steep beach, surging waves are formed. The wave moves in a great speed and
energy, which right at the shoreline. As a consequence, it will bring some of the materials from the wave-breaking zone to the beach.

Tidal waves are an annual event in Desa Gajahrejo, which occurs around May—June. One of the contributing factors is the marine meteorology condition in the area. The wind speed can reach moderate to strong wind according to the Beaufort wind scale [21]. As stated by the local community, there is a 5—7 years return period for the tidal wave disaster with a higher impact. Historically, the biggest disaster occurred in 1992, 2002 and 2013. It impacted the coastal area structurally.

The local community also stated that the wave height is higher in the afternoon rather than at night. The maximum height occurred at 10.00 am with the range of 3—5 m. It is because the differentiation of air temperature and pressure between the land and sea are much extreme at noon rather than at night.

### 3.3. Disaster Impact to Tourism Sector

Natural and human-induced disasters are capable to impact tourism activity [22, 23]. In SWOT analysis, disasters are categorized as one of the external factors that can hinder a tourism activity [24, 25, 26]. Regarding that, nature tourism is exposed to greater hazards and vulnerability in comparison with other types of tourism. The threats are increasing for beach tourism in archipelagic-country and geologically lays on active plate tectonics—just like Indonesia [27]. In addition, global climate change also shifted the marine meteorological conditions of a coastal region which also leads to more catastrophic events in the area [28, 29]. As a result, coastal areas in Indonesia area are prone to tsunami, earthquake, sea level rise and intrusion, coastal inundation and erosion, storm surge, etc.—not to mention volcanic eruption in some coastal areas [30, 31].

Desa Gajahrejo, Kecamatan Gedangan, Kabupaten Malang relies its economic activity on beach tourism. However, the development still disregards the multi-disaster hazards in the area. This gives, both direct and indirect, impact to the tourism activity [32, 33]. Directly, the tourists’ safety is threatened as well as the tourism supporting facilities (e.g., homestay, food stalls, toilet, prayer room, etc.). Without proper disaster management in the longer term, the multi-disaster hazards are capable to indirectly interfere the regional economic stability as tourism holds a vital position in it.

Even worse, the tidal wave disaster also impacted the number of visitors in Desa Gajahrejo. The local community said that there was some fake news spillover. It stated that all beach tourism in Desa Gajahrejo was closed due to tidal wave event. In fact, nothing was happening. One of the events occurred in 2019. The fake news significantly decreased the number of visitors as the potential visitors were overreacting. The scammer spread old videos and/or tidal events in a different tourism area. The motive was a competition between beach and mountain tourism. Despite that, the tourism actors of Desa Gajahrejo succeeded to tackle the hoax and processed it with the judge. Nevertheless, a preparation action plan should be in a preponderant position rather than a responsive action.

Based on observation and FGD agenda, Desa Gajahrejo still lacks of adequate facilities and infrastructures regarding disaster emergency preparation. The assembly points are still relatively far, which takes 5 minutes to access under a panic condition. The risk is even higher for children and elderly people as their mobility takes a much longer time [34]. As a matter of fact, timely evacuation is crucial to attenuate possible casualties [35, 36, 37]. In addition, tourists can be distracted by the evacuation signs that direct to two different assembly points (the east and west part of Ungapan Beach), yet it is unwritten on the signs. Moreover, there is only one speaker that can be operated for early warning alerts. Those conditions can create confusion for the tourists, who are unfamiliar with the area.

Another threat for the tourists owing to the multi-disaster hazards is the insufficiency of guard personnel in the area. There are only 3 SAR Team personals for a 3.13 km²
tourism area. On the other hand, the number of visitors can reach 400 people per day on the weekdays—tripled or even quadrupled on the weekends. Consequently, a mass emergency evacuation can be a real challenge and, eventually, threatened the tourist’s life.

Based on the above situations, Desa Gajahrejo needs contingency planning owing to the coastal multi-disaster hazards [38, 39]. Fundamentally, the improvement of quantity and quality of facilities and infrastructure relating to disaster emergencies is required. Second, the number of guard personnel is additionally necessary to increase the time effectivity and efficiency during a disaster evacuation process. Lastly, a proper publication regarding the local coastal disaster management is needed. More than that, the development of an integrated beach tourism information system is feasible to be included as a tourist facility in the southern coast of Malang.

3.4. Characteristic of Community Knowledge and Comprehension Toward Hazard and Disaster

Based on the FGD results, the environmental condition of Desa Gajahrejo is well-understood by the local community. They also have a great awareness and knowledge about the coastal multi-disaster hazards in the area, particularly tidal wave. It is seen from the well understanding of the tidal wave return periods in the area.

According to the local community, tidal waves event has one-month return period, a one-year return period and a 5—7 years return period. Monthly, the tidal wave event occurred every beginning and end of the month as an effect of moon-earth-sun gravitational activity (astronomical tides) [23]. Annually, the tidal wave event occurred around May to June with a height of 3—5 meters. Based on the community statement, tidal wave disaster with higher impact occurred in 1992, 2002 and 2013.

Since the development of beach tourism in Desa Gajahrejo, some efforts were done in order to increase community capacity in response to the multi-disaster hazards. One of them was evacuation training and simulation held by LMDH in 2017. In 2019, Red Cross Indonesia (PMI) and Regional Disaster Management Agency (BPBD) held the same agenda. The 2019 agenda was attended by several community groups and tourist actors’ preparedness facing sudden disaster. Furthermore, knowledge can be transferred to the local community. Notwithstanding, the frequency and target participants are still unmanaged. The ineffective efforts can be improved by involving tourists as the participants of the simulation.

In general, there is good coordination between boards. Some of the boards are 1) local government, 2) community leader board, 3) local tourism board, 4) coastal environmental conservation board, and 5) SAR board. Correspondingly, it is possible to integrate the tourism activity with ecological sustainability in Desa Gajahrejo.

3.5. Community Resilience Planning to Reducing Disaster Impact in Gajahrejo

The community of Desa Gajahrejo has good coordination for regional and disaster risk reduction planning. It is shown from the FGD result. Each community group of Desa Gajahrejo understands their role and function in response to the multi-disaster well. The detailed role and function of each board can be seen in Figure 3.
Community leader (tokoh masyarakat) is a respected person in the community. Together with the community, the leader will solve the existed problem in Desa Gajahrejo—including disaster management. Also, he assures the existence of local values and wisdom in every activity. The locals believe that misfortune will come if the value and wisdom are broken. In addition, the community leader leads every traditional event, such as suro, larung ketupat, petik laut and adus gaman event.

Most importantly, community leader holds the key to increase the awareness of the community related to the coastal disaster hazards in Desa Gajahrejo. Such conditions are possible because the community leader wins community trust and collaboration. For that reason, the community leader can 1) surpasses the disaster prediction information from SAR Team to the community and LMDH, 2) reconstruct the community as a post-disaster recovery effort, 3) decide the post-disaster tourism activity reopening, and 4) recompense the local value and wisdom depreciated actions associated with the socio-economic and environmental sustainability.

LMDH manages the daily activity of tourism in Desa Gajahrejo, in particular at Ungapan Beach, Bajulmati Beach and Batu Bengkung Beach. There are a total of 11 personals spread in the Ungapan Bay. If a sudden disaster strikes, LMDH also has the responsibility to guide the tourists to the assembly points with SAR Team. They communicate using handy talkie, so it will create an immediate response. Moreover, LMDH also markets and publish information about the tourism activity, including the visiting days.

The function of POKMASWAS is to protect the environment from irresponsible actions. POKMASWAS also has the right to sentence the actor with the community leader and other community groups. The agreements are coming into a form of punishment and environmental restoration.

Bajulmati Sea Turtle Conservation (BSTC) is a local conservation group that focused on sea turtle preservation in Ungapan Beach. Uniquely, BSTC is more concerned with the physical aspects rather than the anthropogenic aspect. Based on an in-depth
interview with the head of BSTC, the locals believe that trapping sea turtle can bring unfortunate situations. Therefore, local fisherman willingly releases sea turtles back to the ocean if it is accidentally trapped. Instead of the anthropogenic factors, sea turtle mortality is more affected by the tidal wave and abrasion phenomenon in the area. In the short term, the phenomena threat to wash the sea turtle's eggs to the ocean. In the longer term, a high abrasion rate will change the beach morphology and make it unsuitable for sea turtles to spawn. For that reason, BSTC—together with POKMASWAS—uses environmental protection, restoration and preservation approach to conserve the sea turtles in Desa Gajahrejo.

As one of the coastal environment conservation efforts, BSTC and POKMASWAS planted bio shields vegetation to protect the area form tidal wave disaster and abrasion. Some of the vegetation is *Casuarina equisetifolia* and *Pandanus odorifer*. Therefore, it is an effective and applicative mitigation strategy for 1) tidal wave disaster risk reduction, 2) sea turtle conservation and 3) sustainability of tourism activity.

The SAR Team of Desa Gajahrejo's beach tourism area is well-understood about the local coastal disaster hazard and thus well-trained to respond to that. They have knowledge about the return period of tidal wave events in the area. It is known from their ability to read the natural signs before a tidal wave event strikes. Systematically, the SAR Team guard and watch the tourism area on a daily basis. If they saw the pre-disaster signs, they are going to inform an early warning to the tourists and community. As the tourists and community pull back from the beach, SAR Team must guide them along the evacuation route to go straight to the east and/or west assembly points which are 30—50 tall mountains.

Even though each community group of Desa Gajahrejo already well-understand their role and function, the corporation between the groups are still uncoordinated. In other words, the tourism activity in Desa Gajahrejo is still unplanned. Each community group works by themselves without one vision, particularly related to disaster risk reduction and/or sustainable tourism activity (ecotourism). Such conditions occurred due to the unavailability of structured and documented planning. Moreover, the participation of the village government is also lacking. Therefore, further contingency planning is needed.

Contingency planning arises the urgency to minimalize the impact of multi-disaster hazards [40], not to mention in Desa Gajahrejo. The fundamental lies in the hazard calculation and the scale of its impact. It is also necessary to assess the available resources to cope with the hazard on a preparation stage. It includes structural (facilities and infrastructure) and non-structural (i.e., social capital and policy) initiation. Then, the plan needs to bring up effective and efficient response action during and after the disaster.

Desa Gajahrejo can adapt Participatory rural appraisal (PRA) in its tourism development. PRA is a powerful tool for planning and implementing in developing a specific area with a particular purpose [41]. In general, PRA is a community-based development that mainly focused on the local community’s value and participation based on their tasks and roles [42]. It involves ideas and knowledge exchange, as well as its integration with common local belief. Such an approach can prompt continuous and stable coordination between local communities regarding coastal disaster management [43].

4. **Conclusions**

Desa Gajahrejo needs to develop a well-documented and structured disaster risk reduction planning through participatory. Furthermore, the planning can be translated in the form of rural appraisal (PRA) contingency planning. The purpose is to create useful and applicative planning for tourism activity and disaster management implementation.
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