Analysis of Disaster Mitigation in Carita with Environmental Learning in Elementary School

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Abstract. This study analyzes the profile of Carita people in the efforts of tsunami disaster mitigation and the role of environmental learning in coping with the disaster, then analyzes the use of environmental learning. The method used is a mixed method of qualitative and quantitative methods. The quantitative method measures various community readiness levels in performing disaster mitigation, whereas the qualitative method is utilized to obtain various further information from the communities using interview technique. There were 88 randomly selected respondents participating in this research. The study results indicate a low land utilization density (below 33%). Indicators suggest a good category, namely: people evacuate when a disaster occurs (86%), rescue during a disaster (96.59%), and try to find new livelihoods (82.95%). In addition, public knowledge of disaster evacuation route is at a good level (87.50%) and there is an increase of 39.77% respondents with improved knowledge after the tsunami disaster occurred. Environmental learning, in this case, plays an important role to provide information to the public relating the efforts in disaster mitigation. The conclusion is that community’s disaster mitigation readiness still requires some improvement through various efforts, one of them is environmental learning with learning media in elementary school.

1. Introduction
The combination of the number and the impact of geological disasters in Indonesia is closely related to the Indonesia’s own geographical position. Geographically, Indonesia is located at the confluence of...
three of the world’s most active tectonic plates that forms a ring of fire, namely: Eurasian, Pacific, and Indo-Australian plates. Most of the collision lines between the plates are located under the ocean. The plate movement triggers various geological disasters, such as earthquake, volcanic eruption, tsunami, or liquefaction. The geographical condition increases the risk of disasters for the population at the coastal areas. This is further supported by Indonesia’s condition as an archipelago with long coastlines. These factors increase the risks and vulnerability to disasters [1][2][3].

Sunda Strait is one of the areas with potentials of earthquake and tsunami disasters in Indonesia. The strait separates the Java Island to Sumatera Island. History records that tsunami events, either triggered by earthquake or volcano eruption, has periodically occurred due to the three subduction zones located in the strait. The subduction patterns are in the form of plate subduction zone that creates earthquake vulnerability; active fault that creates earthquake vulnerability; and the existence of Anak Krakatau Volcano that contributes to volcanic eruption vulnerability. People who live around disaster-prone areas should anticipate possible disasters by taking various prevention measures and mitigation efforts [4][5].

Carita Sub-district is one of sub-districts with a high potential of tsunami disaster risk. Based on the sub-district, the area has the largest number of accommodation companies, rooms, and cottages in Pandeglang Regency. This reflects the dependency of the area to the tourism sector. As a village that depends on the beach tourism objects as its main tourism, the Sukarame Village bears more impact from tsunami. The majority of the villagers who work and earn their income from the tourism sector would experience the greatest losses when a tsunami happens along the coast. The village would continue to bear the tsunami risk due to the trigger of geological activity that repeats periodically. Therefore, disaster mitigation efforts are necessary to create resilience when similar events happen by decreasing the current vulnerability level.

Flanagan et al. [6] stated that vulnerability is influenced by various factors, among others: age, income, the power of social network, and environmental characteristics. Understanding how and where the socially vulnerable community is impacted could help to effectively allocate resources [6]. Resilience consists of social, economic, and cultural capital resilience; disaster risk management resilience; and disaster-based spatial planning resilience [7]. The accomplishment of disaster mitigation efforts is extremely determined by social resilience. Social resilience becomes an important aspect that should be strengthened in a disaster-prone society by strengthening its social capital roles [8]. Social resilience can be formed in schools. Therefore, school resilience is strategic for disaster mitigation [9]. Vulnerability and resilience level analysis is expected to become a material in formulating strategies to increase community resilience to tsunami disasters so that it could reduce the number of fatalities as well as damage caused by the tsunami. Environmental learning, in this regard, has an interest in providing education in the effort of environmental disaster mitigation. The environmental learning is not only limited to the classroom learning but is also applicable in the communities [10][11][12][13]. This study analyzes the condition of vulnerability, resilience, and formulate strategies in facing tsunami threats in Sukarame Village with environmental learning in elementary school as a solution.

2. Method
This research was conducted in Sukarame in 2019. The research employed a mixed method, which included quantitative method and qualitative method. The quantitative method was used to analyze the vulnerability of a region and community resilience level to tsunami. Respondents participating in this research were 88 people chosen by random sampling. Qualitative case study is an approach to research that enables the exploration of a phenomenon within its context using a variety of data sources. This mixed method was used to confirm the research data obtained from quantitative with qualitative data. This ensures that the issue is not merely explored through a singular perspective, but rather a range of perspectives which allows for the multiple facets of the phenomenon to be revealed and understood [14]. The qualitative method, on the other hand, was utilized to dig information from respondents through interviews. The interviews aimed to provide additional data in formulating strategies to improve community resilience to tsunami disasters.
Data collected in the research was comprised of secondary and primary data. The secondary data were research data sources obtained indirectly by the researchers via intermediary media or other parties. The data could be in the form of records, evidences, or reports prepared in an archive either officially published or not. The primary data was generated through field observation and in-depth interview.

Questionnaires were used as research data collection tool. The researchers carried out questionnaire tests to respondents prior to its use to evaluate its validity and reliability. The validity test was conducted using Statistical Program for Social Science (SPSS) by comparing r-value listed in the corrected item column – total correction with r-statistic. Criteria in determining the validity of a questionnaire is if the r-value>r-statistic, then the statement is valid, whereas if r-value<r-statistic, then the statement is not valid. The reliability was measured using Cronbach’s Alpha (α) statistical test. The data collection results would be analyzed using descriptive statistic method by analyzing the sample data based on the assessment results of the questionnaires.

3. Results and discussion

Respondents as the information source had general characteristics that must be identified. The Respondent characteristics were characteristics of the respondents from the environment related to the tsunami. General characteristic consists of data of the 88 respondents from nine RT (neighborhood unit) in RW (community unit) 1 and RW 4 of Desa Sukarame. The following section elaborates these characteristics.

The research sample targets included heads of families or other family members who could represent or were considered by the researchers as capable of providing the information needed for the research (Table 1). About 86.4% of the respondents were male and the remaining 13.6% were female. The research was carried out during weekend (Friday, Saturday, and Sunday) as they are the main working days for the people of Sukarame Village. As tourists mostly travel during the weekend, the villagers would be busier. The tsunami, however, had caused a decrease of tourism on the weekends, let alone weekdays; thus, the heads of families mostly stay at home instead of working.

Age was deemed as a determinant in the respondents’ decision-making process in understanding the disaster risks they could face and taking disaster adaptation measures. Around 40.9% respondents were at the age interval of 18-40 years, 56.8% at the age interval of 40-60, and 2.3% were >60 years. This suggests that most respondents were in the adult and productive age group; therefore, they were assumed to understand the measures need to be taken in the preparedness and response to tsunami disaster. As much as 2.3% respondents were more than 60 years old; however, they were able to provide better information despite their age which is no longer considered as productive.

Educational background characteristic is assumed as a factor that could determine one’s mindset regarding disaster risks and responses. According to the characteristic data gained, there were respondents who had no educational background (4.5%) and did not graduate from elementary school (SD) (2.3%); hence, they had limited capacity at reading and writing. Consequently, the researchers read and wrote their answer. Most respondents (40.9%) in the research, however, were elementary school (SD) educated, senior high school (SMA) graduates (27.3%), junior high school (SMP) graduates (20.5%), and diploma graduates or bachelor (4.5%).

The respondent targets were heads of families as they could provide comprehensive information related to the research data, such as income, expenses, response when disaster strikes, and adaptation taken by families if further disaster occurred. The characteristic data indicated that 80.7% of the respondents were heads of families, 13.6% were wives, and 5.7% were children. The large number of heads of family as respondents could represent the families’ conditions in the village in facing the tsunami disaster.

Physical vulnerability is the potential of physical impacts on the environment or infrastructure and population. It illustrates the condition and number of buildings along with the density result in areas with the potential to be inundated by tsunami. The physical vulnerability in Sukarame Village in facing the tsunami disaster threat was in moderate condition. Several aspects influenced the vulnerability, namely: distance to the closest buildings, building density, types of houses, distance to coastal line, and
land utilization density. The table indicates that the distance of the houses to the coastal line was not in a close proximity. The villagers did not build their house close to the beach. The average distance of the houses to the beach was between 100 and 300 meters. Distance between the houses was mostly 3 to 10 meter or not adjacent to each other. Building density in the Sukarame Village indicated a low density level. The land utilization density is also low, which is below 33%.

Table 1. Characteristics of Respondents in Sukarame Village in 2019.

| No | Characteristics          | Total (people) | Percentage (%) |
|---|--------------------------|----------------|----------------|
| 1 | Gender                   |                |                |
|   | Male                     | 76             | 86.4           |
|   | Female                   | 12             | 13.6           |
|   | Total                    | 88             | 100            |
| 2 | Age                      |                |                |
|   | 18-40 years              | 36             | 40.9           |
|   | 41-60 years              | 50             | 56.8           |
|   | >60 years                | 2              | 2.3            |
|   | Total                    | 88             | 100            |
| 3 | Education Level          |                |                |
|   | Not educated             | 4              | 4.5            |
|   | Did not graduate elementary school | 2 | 2.3 |
|   | Elementary school        | 36             | 40.9           |
|   | Junior high school       | 18             | 20.5           |
|   | Senior high school       | 24             | 27.3           |
|   | Diploma/ Bachelor        | 4              | 4.5            |
|   | Total                    | 88             | 100            |
| 4 | Status in the family     |                |                |
|   | Head of family           | 71             | 80.7           |
|   | Wife                     | 12             | 13.6           |
|   | Child                    | 5              | 5.7            |
|   | Total                    | 88             | 100            |

Social vulnerability analysis aims to disclose the human resilience aspect when hit by negative impacts of a disaster or crisis. It is affected by several demographical aspects, among others, the density of potentially-exposed-to-tsunami population, the number of people with disabilities, the number of pregnant women, the number of elderly people, and the number of children.

Improvement in the resilience level from low to medium was related to the 14 indicators used to analyze the social, economic, and cultural capital resilience. The analysis results of the seven indicators before and after the disaster are presented in Table 2. It was found that there was an increase in the resilience of Sukarame Village community to the tsunami disaster after the disaster occurred, which was between 23.86% and 52.57%. The increase was expressed in seven indicators; therefore, the result of assessment accumulation before and after the disaster put the majority of the indicators at a good and medium level. There were three indicators at a good level, three indicators at a medium level, and one indicator at a bad level.

The second indicator group reflects the factual condition of the community during the disaster. It consisted of disaster emergency response, which included the performance of evacuation during a disaster, prioritization on saving family members, impacts on house building structure, measures to save properties, sustainability of livelihood, efforts to look for new livelihoods, and the roles of local leaders in the recovery phase (Table 3).
Table 2. Social, Economic, and Cultural Capital before and after the Tsunami Disaster in Sukarame Village in 2019.

| No | Indicator                                                                 | Before the disaster (%) | After the disaster (%) | Cumulative after the disaster (%) | Description after the disaster | No Knowledge Knowledge (%) |
|----|---------------------------------------------------------------------------|-------------------------|------------------------|-----------------------------------|---------------------------------|---------------------------|
| 1  | Disaster knowledge                                                       | 20.45                   | 50.00                  | 70.45                             | Good                            | 29.55                     |
| 2  | Understanding of tsunami early warning                                    | 14.77                   | 35.23                  | 80.06                             | Good                            | 50.00                     |
|    | Involved in gotong royong in PRB (disaster risk reduction)                |                         |                        |                                   |                                 |                           |
| 3  | The roles of local leaders in the PRB                                    | 5.68                    | 52.27                  | 57.95                             | Medium                          | 42.05                     |
|    | The roles of local leaders in disaster socialization                     |                         |                        |                                   |                                 |                           |
| 4  | Preparation of essential supplies for easy-carrying during disaster       | 2.27                    | 23.86                  | 26.14                             | Bad                             | 73.86                     |
|    | Involvement in the disaster risk reduction efforts                        |                         |                        |                                   |                                 |                           |
| 5  | Still has the livelihood                                                  | 6.82                    | 27.27                  | 34.09                             | Medium                          | 65.91                     |
| 6  | Efforts to look for new livelihoods                                       |                         |                        |                                   |                                 |                           |
|    | The strong role of local leaders in the recovery phase                   |                         |                        |                                   |                                 |                           |

Three indicators showed a good score level where most people evacuate during a disaster (86%), rescue family members (96.59%), and try to look for new livelihoods (82.95%). The impact on house construction (53.41%) and the roles of local leaders in the recovery phase (34.09%) were the two indicators at a medium level. The low efforts to save properties during disaster (23.86%) and the high number of villagers who lost their livelihood (93.18%) brought these two indicators at the poor level. The analysis results are described in Table 3.

Table 3. Social, Economic and Cultural Capital in Facing the Tsunami Disaster in Sukarame Village in 2019.

| No | Indicator                                                                 | Yes (%) | No (%) | Description |
|----|---------------------------------------------------------------------------|---------|--------|-------------|
| 1  | Disaster emergency response (evacuation)                                  | 86.36   | 13.64  | Good        |
| 2  | Family rescue during a disaster                                          | 96.59   | 3.41   | Good        |
| 3  | Impact on house                                                           | 53.41   | 46.59  | Medium      |
| 4  | Rescue properties                                                         | 23.86   | 76.14  | Poor        |
| 5  | Still has the livelihood                                                  | 6.82    | 93.18  | Poor        |
| 6  | Efforts to look for new livelihoods                                       | 82.95   | 17.05  | Good        |
|    | The strong role of local leaders in the recovery phase                    | 34.09   | 65.91  | Medium      |

The people of Sukarame Village had the knowledge of the existence of a disaster evacuation route that were cumulatively at a good level (87.50%). The community knowledge was also passable before the disaster and there was an increase of 39.77% of respondents with improved knowledge regarding the existence of evacuation route after the tsunami occurred. It was similar to the indicator of knowledge of the existence of disaster information boards and signs. The community knowledge had improved by
39.77%. The enhancement had shifted the indicator from a sufficient level to a good level. Evacuation sites were also accessible after the disaster (84.09%). The two other indicators analyzed included the knowledge of disaster risk map and the knowledge of the existence of spatial regulations. The research observed a quite a significant improvement among the community regarding the two indicators, which shifted from 4.55% to 36.36% and 6.82% to 30.68%, respectively. The community became more aware of the two indicators; the accumulation results, however, were still at the poor position. The analysis results are presented in Table 4.

Table 4. Disaster-based Spatial Planning before and after Facing the Tsunami Disaster of Sukarame Village in 2019.

| No | Indicator | Before the disaster (%) | After the disaster (%) | Cumulative after the disaster (%) | Description after the disaster | No Knowledge (%) |
|----|-----------|------------------------|-----------------------|----------------------------------|-------------------------------|------------------|
| 1  | Knowledge of the existence of disaster evacuation route | 47.73 | 39.77 | 87.50 | Good | 12.50 |
|    | Knowledge of the existence of disaster information boards and signs | 35.23 | 32.95 | 68.18 | Good | 31.82 |
| 3  | The accessibility of the evacuation sites | 34.09 | 50.00 | 84.09 | Good | 15.91 |
| 4  | Knowledge of Disaster Risk Map | 4.55 | 31.82 | 36.36 | Poor | 63.64 |
| 5  | Knowledge of the existence of spatial regulation | 6.82 | 23.86 | 30.68 | Poor | 69.32 |

Improvements of community resilience in facing the tsunami disaster threat is necessary to reduce disaster risks; thus, minimizing its impacts. Factors influencing the disaster risk consisted of resilience, danger, and capacity. Danger is an irreducible factor as it is the factual condition of a disaster threat in an area. Resilience improvement efforts will be varied between regions. Three dimensions of resilience towards disaster are comprised of resistance, recovery, and creativity [15]. Resistance is defined as a distance between pre-disaster levels and the time required by a community to recover from disruption [16]. The key to success in recovery planning from an earthquake is by applying resilience as a framework that could give noteworthy contributions to the quality of life recovery [17]. The improvements must be done in stages and measures chosen to reduce the potential of impacts should be based on the community’s conditions and their behaviors as well as the characteristics of the inhabited area so that the improvements would be optimal. Before formulating strategies in improving community resilience, this section will first discuss the resilience results acquired. Regardless of the deficiencies of the indicators, they proved useful in identifying the disaster risks, comparing and prioritizing measures, and improving risk management skills. Practically, most strategies are independently developed and the related actors work in silos.

The research result of the vulnerability condition of the Sukarame Village community in Carita Sub-district is ‘very vulnerable’. If the result was negative, then its impact must be minimized, and on the contrary, if the result was positive, then it must be improved so that it would become adaptive in the future. The condition demands strategies to achieve better community resilience to tsunami disaster threat [18][19][20]. Resilience always involves risk factors and protective factors. Risk factors are factors that can directly increase a high potential risk for individuals, in addition to increasing their chance to show negative behaviors [21]. SWOT analysis is rooted in a logic that could maximize strengths and opportunities, yet at the same time could minimize weaknesses and threats. This analysis is expected to balance the internal and external conditions implemented in the SWOT matrix to secure
several best strategies. The four stages in forming a SWOT matrix include: (a) matching internal strengths with external opportunities and recording the resultant of SO (strengths-opportunities) strategies; (b) matching internal weaknesses with external opportunities and recording the resultant of WO (weaknesses-opportunities) strategies; (c) matching internal strengths with external threats and recording the resultant of ST (strengths-threats) strategies; and (d) matching internal weaknesses to threats and recording the resultant of WT (weaknesses-threats) strategies. This analysis could produce four possibilities of strategy alternatives, namely: SO, WO, ST, and WT.

The SWOT analysis results indicated that the manner in which the community members of the Sukarame Village in Carita sub-district are facing the tsunami disaster threat was still on the quadrant III because they still have an opportunity that could be optimally utilized despite their very vulnerable condition. Placement decision on quadrant III was based on the research location condition that had a serious internal weaknesses and relatively small opportunities or attraction. This condition had encouraged the government, local government, and the communities to synergize in adjusting the strategies to improve the community resilience in facing the tsunami disaster threat. One of the efforts is by improving environmental learning [22][23][24]. Schools must operate as preparatory grounds for learners to become environmental ambassadors [25][26][27][28][29]. who will assist in providing guidance to the community regarding relevant concepts and science-based actions on disaster mitigation efforts and disaster resilience, specifically on tsunami threat. Furthermore, promoting environmental responsibility in Elementary school systems could also create active and environmentally aware students who would later become leaders in the community [12]. Environmental education, as a strategy to overcome environmental problems and disasters, it needs to be undergone early, particularly since the elementary school. This is important to be improved, especially in relation to disasters.

The implementation of environmental learning must be improved in terms of environmental disaster mitigation efforts in elementary school, especially tsunami mitigation. The form of environmental learning that can be carried out is by providing various concepts related to the mitigation efforts. In addition, it can also be done by developing various educational models to enhance the community’s various skills in disaster mitigation. The community should be provided with good education, both formal and informal for elementary/primary school students. This will have excellent impact on their understanding in performing tsunami disaster mitigation. The implementation of other programs can be conducted by means of training and intensive learning while involving various parties. Students as one of the components of the community can participate in providing learning to the communities on environmental disaster mitigation efforts [30][31][32].

4. Conclusion
Based on the discussions in previous chapters, the conclusion that can be drawn from the research is that the (physical, social, and economic) vulnerability in facing the tsunami disaster threat in Sukarame Village, Carita Sub-district was generally at a high vulnerability condition due to the proximity of buildings to the coastal line, high population density, and low household income. The (social, economic, cultural capital; disaster risk management; and disaster-based spatial planning) of Sukarame Village, Carita Sub-district in facing the tsunami disaster threat was at a medium vulnerability condition, thanks to the improvements of community knowledge related to the disaster and supports from related parties since the emergency response period up to recovery phase. Strategies to improve the community resilience of Sukarame Village in facing the tsunami disaster threat can be carried out through the development of disaster-safe ecotourism, enhancement of community and local apparatus disaster capacities, development of community economy, and disaster facility and infrastructure management. In addition, it could also be done through the strengthening of various environmental learning at school and in the community. Environmental learning could provide education to the community in terms of the disaster mitigation efforts. The limitation of this study is that this research was only conducted in the Sukarame area, if it was carried out in other areas it would produce different results.
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