Measuring Community Resilience to the Tsunami Disaster (Study of Sukarame Village, Carita District, Pandeglang Regency)

D A P Sari and T E B Soesilo

1 School of Environmental Science, Graduate Program University of Indonesia
Central Jakarta, Indonesia

diyan_andry@yahoo.com

Abstract. Pandeglang Regency has the potential of a tsunami disaster due to its location, which is close to the megathrust segment of the Sunda Strait. The tsunami disaster caused negative impacts such as death, loss of property, and damage, which could be lessened by increasing community resilience aimed at reducing the disaster risk. Community resilience is related to the community's ability to recover from shocks or pressure to its original state. A resilient community can return to its previous state relatively quickly. It is crucial to know the tsunami disaster resilience index in Pandeglang Regency to obtain recommendations or concepts for tsunami disaster mitigation that are appropriate in creating community resilience to tsunami disasters in Pandeglang Regency. The purpose of this study was to measure community resilience to the tsunami disaster in Sukarame Village, Carita District, Pandeglang Regency using The Integrated Concept of Community Resilience (ICCR), which was adjusted to the conditions of the study area. Measurement indicators are developed based on internal and external factors that affect community resilience, such as social, cultural and economic capital, disaster risk governance, and disaster-based spatial planning. The analysis is based on data from the household questionnaire, which is then transcribed into statistically analyzed indicators. The results show that the combination of the social, cultural and economic capital, as well as the disaster risk governance index is medium, while the disaster-based spatial planning index is low. The ICCR index in Sukarame Village is in the medium category. It is necessary to improve disaster risk governance and disaster-based spatial planning in this area to reduce the tsunami risk that may occur in the future.

Keywords: Community Resilience, Pandeglang Regency, Tsunami Disaster, Sunda Strait, Tsunami

1. Introduction

Disaster or catastrophic event is one of the challenges for the sustainable development of every country throughout the world. In addition to causing casualties and damage, disasters can also reverse the long-term development achievements after its occurrence [1]. Throughout 2018 in Indonesia, there
were 2,572 catastrophic events with 4,814 death tolls and missing victims and 10,239 million affected and displaced. Most victims were caused by earthquakes followed by tsunamis and liquefaction in Central Sulawesi by 2,101 death tolls, followed by earthquakes in West Nusa Tenggara as many as 564 death tolls and tsunami disasters triggered by the eruption of Anak Krakatau volcano in the Sunda Strait as many as 437 death tolls [19]. The Sunda Strait is one area that has the potential for earthquakes and tsunamis in Indonesia. This area is a strait that separates Java and Sumatra. History records both tsunami events triggered by earthquakes and volcanic eruptions that have occurred periodically due to three subduction patterns found in the southern Sunda Strait. The subduction pattern is in the form of plate subduction zones, which give rise to earthquake vulnerability, active faults or faults which give rise to earthquake hazard, and the existence of the Anak Krakatau Volcano, which gave rise to volcanic eruption vulnerability. All three subduction patterns have the potential to trigger a tsunami [20]. The latest tsunami disaster in this area occurred on 22 December 2018. This tsunami was triggered by the eruption of Mount Anak Krakatau, followed by underwater landslides in the Sunda Strait, which affected the coastal areas of both Banten Province and Lampung Province. There are five districts in those two provinces that were affected by the tsunami, namely Tanggamus Regency, Pesawaran Regency, South Lampung Regency, Serang Regency, and Pandeglang Regency. The tsunami resulted in 437 fatalities and 1,459 injuries [2]. Pandeglang Regency has an area of 2,747 km² with 35 districts [21]. Several sub-districts in this district were affected by the 2018 tsunami, one of which was Carita District. The tsunami in Carita District on 22 December 2018 reached an altitude of 2.58 meters and struck the surrounding coastal area after the 40th minute [20]. Although a tsunami recently hit it due to an avalanche of Mount Krakatau, it did not reduce the risk of a tsunami disaster in this area. It is because this area is at risk of a tsunami disaster from the Sunda Strait earthquake. Tsunamis can occur due to earthquakes, volcanic eruptions, and underwater landslides [2].

2. Location

Sukarame Village is one of the Villages in Carita District, Pandeglang Regency. In general, Sukarame Village is located at the height of 50 meters above the sea level, thus from its geographical condition, Sukarame Village is included in lowland zone (below 100 meters above the sea level) [23]. The author chose Pandeglang District as the research location since it was the district that is most affected by the
tsunami due to the Mount Anak Krakatau avalanche on 22 December 2018 and also was a potential area submerged by the tsunami due to the Sunda Strait fault [20].

The author also chose Sukarame Village, Carita District, it is the most populated village in Carita Sub-District that populated by 2,734 residents with an area of 1.76 km², the second widest village area in Carita Sub-District. The area with a density of more than 1,000 people / km² categorized in the high population density so that the risk of disasters caused will also be even more significant.

3. Method

Community resilience to the tsunami disaster was assessed used The Integrated Concept of Community Resilience (ICRR). This method provides a new conceptual framework for measuring disaster resilience in Indonesia to improve and build comparative assessments and can be applied at the local, community, or national levels for multi-hazard [7]. This method was chosen because it is considered appropriate to measure the resilience of people who have been affected by disasters and potentially will be affected by disasters in the future. This method considers social, cultural, and economic aspects, governance, and disaster-based spatial planning in assessing the resilience index of its people. The Framework for Integrated Community Resilience Concepts is explained in Figure 1.

![Figure 1. The Integrated Concept of Community Resilience/ICCR framework](source: Herryal et al., 2017)

Each factor has indicators, all the factors and its indicators carry equal weight. The calculation of the contribution and role of each factor is based on the equation below: The Integrated Concept of Community Resilience index of social, cultural and economic capital (SCE) to the total maximum SCE data = Eq. 1.:

\[
\text{total } \% \text{ questionnaire data of SCE} \over \text{total } \% \text{ maximum questionnaire data of SCE} = \text{(1)}
\]

The Integrated Concept of Community Resilience index of disaster risk governance (DRG) to the total maximum DRG data = Eq. 2.:

\[
\text{total } \% \text{ questionnaire data of DRG} \over \text{total } \% \text{ maximum questionnaire data of DRG} = \text{(2)}
\]
The Integrated Concept of Community Resilience index of disaster-based spatial planning (DBSP) to the total maximum DBSP data = Eq. 3.:

\[
\frac{\text{total \% \ questionnaire \ data \ of \ DBSP}}{\text{total \% \ maximum \ questionnaire \ data \ of \ DBSP}} \quad \text{................. (3)}
\]

The range of the Integrated Concept of Community Resilience index is shown in Table 1.

**Table 1. The range of The Integrated Concept of Community Resilience Index**

| No | Index | Resilience Level |
|----|-------|------------------|
| 1. | 0 – 30 | Low |
| 2. | > 30 – 60 | Medium |
| 3. | > 60 – 100 | High |

*Source: Herryal et al., 2017*

### 4. Results

#### 4.1 Socio-Cultural and Economic Capital

A critical aspect of social security is the capacity for individuals to learn from their experiences and then incorporate it into their community interactions, so they can shape change and play an essential role in the level and type of impact caused by the changes that occur [8]. It is due to the role of individuals and communities in resilience refers to the ability of individuals, groups, or communities to overcome difficulties [9]. The results of the questionnaire showed that many people had knowledge and experience about the danger of a tsunami because a tsunami catastrophe had ever occurred in Sukarame Village. Previous experience shows that efforts to prevent the hazard itself are not reliable. It can make the impact worse because the steps needed to reduce the impact need to look at the condition of the community and its behavior, to increase resilience to disaster events [10].

Questionnaire data also shows that most people in Sukarame Village know that their home buildings are prone to tsunamis because, in the last three years, their area was affected by the tsunami. When the disaster struck, they saved their family as a top priority, but the residents did not have a chance to save their belongings because the tsunami came abruptly. Fortunately, most people know about evacuation planning, so there is an effort to save themselves when a potential tsunami occurs again in the future. The occurred tsunami had disrupted the livelihoods of the people of Sukarame Village, the majority of which relied on the marine tourism sector as the main livelihood. So in the future, the strategy that can be carried out is to encourage community adaptation to disasters by diversifying livelihoods, while migration can also be done or preparing food and fuel stocks for preparedness before a disaster occurs [11].

Sukarame village did not have a community organization related to disaster risk reduction when the disaster occurred, but currently, it exists due to concern to be prepared adequately to face future disasters. Most of the community had never been involved and participated in disaster risk reduction activities before the disaster occurred, but after the previous tsunami disaster, they did both socialization and mangrove planting. The tsunami in Sukarame Village in 2018 can be used by the community as a lesson to increase their preparedness and awareness of danger. From this point of view, it can be assumed that people in Sukarame Village are better prepared to face the next disaster. The experience of dealing with the tsunami disaster is an essential lesson learned for the people in Sukarame Village that can be used to increase the community’s readiness and awareness. The overall results of the application of the ICCR to socio-cultural and economic capital to the people of Sukarame Village show that community resilience in the area is categorized as medium with a value of 58.98 with detailed results as shown in Figure 2.

#### 4.2 Disaster Risk Governance

Disaster management has now begun to focus on direct solutions to problems faced by people affected by disasters [12]. Strengthening community resilience can be realized by emphasizing adaptive
governance in disaster risk reduction with four characteristics, namely: polycentric and multilayer institutions, participation, and collaboration, self-help and network, and learning and innovation [13]. Policy and institutional changes, in addition to being intended to respond to disasters, also affect the community’s susceptibility to disasters [14]. The faster people recover from risk, the more resilient they are considered. The availability of disaster regulations and disaster risk reduction laws is a vital part of disaster management to protect the community from the effects of disasters. There are 11 specific indicators used to determine the effect of disaster risk management on community resilience in Sukarame Village. The study result shows that Sukarame Village has no policy related to disaster risk reduction. There is also no contingency plan to deal with the threat of a tsunami disaster. Tsunami early warning systems during disasters also do not yet exist. It was only after the disaster occurred that the Tsunami Early Warning System was planned to be installed by the parties concerned. When the disaster happened, the facilities at the refugee camp were still inadequate despite the availability of logistical assistance and equipment for flood victims so that the community assumed that the role of the regional apparatus and regional authorities was active in reducing the risk of disaster. The overall results from the application of the ICCR to disaster risk management show that community resilience in Sukarame Village is categorized as medium with a value of 57.73. These results indicate that the disaster risk management system in Sukarane Village has not been running well in assisting people affected by the tsunami.

![Social, cultural, and economic capital](image)

**Figure 2.** Survey Results for Social, Cultural and Economic Capital (in %)
4.3 Disaster-Based Spatial Planning

Effective disaster-based spatial planning can help reduce susceptibility to disasters because spatial planning is a vital element to reduce disaster risk, especially in countries experiencing rapid urbanization with high social susceptibility like in Indonesia [15]. Some indicators are used to determine the effect of spatial planning on community resilience in Sukarame Village. Household questionnaire data on spatial planning shows that in Sukarame Village, there are significant land-use changes that have brought a negative impact. One of the negative impacts is a large number of physical constructions of lodging and other tourism facilities. Land-use change may have positive or negative effects depending on the effect it has on the community. In this case, it becomes negative because the business owner tends to set up his business along the coast and builds a safety fence along with the building so that it prevents the community from the access out of the beach area faster. The community at the beach will need to turn around the fence when they are evacuating away from the beach because they cannot pass through the accommodation area. Fortunately, at this time, the local government began to realize the importance of land use regulations, thus limiting permits for the construction of lodging along the red tsunami zone. To become favorable, the impact of land-use change must be based on sustainable development that gives priority to social and environmental factors, not just economic considerations. Land-use changes that have a positive impact on the environment can reduce the susceptibility of communities to disasters and strengthen community resilience. Resilience, as something that must be improved after a disaster such as re-build better in a structured manner, and at the same time, also re-build more sustainably [16].

![Figure 3. Survey Results of Disaster Risk Governance (in %)](chart.png)
Even though a tsunami once hit it, unfortunately, the early warning information board and the evacuation site are not yet well available. The government has indeed created a disaster risk map so that people know about disaster risk, but it has not been followed up with disaster mitigation infrastructure. The overall results of the application of the ICCR to disaster-based spatial planning showed that community resilience in Sukarame Village was categorized as low with a value of 25.14. Spatial planning is still low because even though disaster risk maps have been prepared, the rarely conducted socialization results in the community not understanding disaster risk in their area. Increasing public awareness of the potential and impact of disasters in disaster-prone areas should be a priority program of the local government. Because without the support of the local government, even though community awareness of disasters is relatively high, community preparedness to face disasters is still low.

4.4 The Integrated Concept of Community Resilience Results

Based on the average of all indicators, the overall results of the resilience criteria at ICCR in Sukarame Village are medium, with a value of 56.4. In particular, community disaster resilience is strengthened by increasing community engagement in Disaster Risk Reduction (DRR) activities and utilizing traditional cultural factors in dealing with natural disaster risk. Strengthening community resilience in areas that potentially affected, is most important to anticipate similar events in the future. Resistance to natural disasters can directly be compared to infection or viruses. The healthier, fitter, and better prepared an individual is, the faster and more complete their recovery [17]. Community resilience and its increase in dealing with disasters also need to be improved, since increasing disaster resilience can have a positive impact to reduce the number of deaths [18].

| Indicators                        | ICCR index | Level ICCR |
|----------------------------------|------------|------------|
| Social, cultural, and economic capital | 58.98      | Medium     |
| Disaster risk governance         | 57.73      | Medium     |
| Spatial planning disaster based  | 25.14      | Low        |
| The ICCR Index Results           | 47.28      | Medium     |
Although the resilience of the Sukarame Village community is categorized as medium, the role of disaster risk management systems and disaster-based spatial planning needs to be improved. The implementation of disaster-based spatial planning is strongly influenced by indicators of land-use change, which has a negative impact on community resilience. In addition, the main problem in strengthening community resilience in Indonesia is to address the increment of public participation and private institutions in disaster risk reduction efforts. Besides, coordination between stakeholders involved in disaster risk reduction and the implementation of sustainable development programs must also be increased, to ensure effective management of disaster risk reduction. To be resilient, it is necessary to intensively empower the social, economic, and cultural capital of the community. Also, disaster risk management must be improved by building the capacity and quantity of human resources in risk management. Other tasks include the need to implement national and local sustainable development planning so that spatial planning is in line and align with disaster risk considerations.

5. Conclusion

Community resilience to natural hazards in Indonesia is not only influenced by internal factors but also by external factors. Internal factors consist of social, cultural, and economic dimensions, which can trigger people's susceptibility or capacity. Cultural heritage, which is found in many communities in Indonesia, plays an essential role in strengthening resilience to natural disasters. While external factors are influenced by disaster risk management systems and disaster-based spatial planning, they can have positive or negative impacts on community resilience. Positive impacts can contribute as a supporting factor for the community to anticipate the effects of disasters. However, if they have a negative impact, it can create inhibiting factors that increase susceptibility or reduce capacity. The last tsunami disaster event in Carita did not suddenly improve community resilience toward disaster. The disaster resilience of the people of Sukarame Village is currently medium on average because of the increased awareness of both the government and the community towards the potential for a tsunami disaster that might come-strike back. Various efforts were made to improve the resilience of the community to the tsunami after the disaster, which was done synergistically by the local government, and supported by the community. Community participation and engagement in a related disaster preparedness initiative currently increase, as well as assistance by NGOs and government for tsunami disaster preparedness. However, livelihood diversification should be developed, not merely focus on marine tourism as existing conditions with external intervention since the community has no pathway idea how to find it out. In the future, it is still necessary to improve disaster risk management and disaster-based spatial planning. It is crucial because risk management in Indonesia is a relatively new recognized, with limitations in terms of quality and quantity of human resources. Meanwhile, disaster-based spatial planning is crucial because many areas in Indonesia are prone to natural hazards, and many development programs are still focused on economic and physical aspects and less attention to social and environmental factors.

Acknowledgments

The author would like to acknowledge the National Disaster Management Agency (BNPB) for providing disaster data. The author would also thank the Government of Sukarame Village, family, and friends to support this research. The author is also thankful to fellow students and lecturers at the School of Environmental Science University of Indonesia (SIL UI) for all of the input for the improvement of this study.

References

[1] Coppola D P 2016 Introduction to International Disaster Management
[2] Alhamidi V H, Pakpahan, and J E S Simanjuntak 2018 Analysis of tsunami disaster resilience in Bandar Lampung Bay Coastal Zone IOP Conference Series: Earth and Environmental
Science 158(1)

[3] Mavhura E 2017 Building resilience to food insecurity in rural communities: Evidence from traditional institutions in Zimbabwe Jambh J. Disaster Risk Stud. 9(1)

[4] Cox R S and Hamlen M 2015 Community Disaster Resilience and the Rural Resilience Index Am. Behav. Sci. 59(2) pp 220–237

[5] Yu J, Zhang C, Wen J, Li W, Liu R, and Xu H 2018 Integrating multi-agent evacuation simulation and multi-criteria evaluation for spatial allocation of urban emergency shelters Int. J. Geogr. Inf. Sci. 32(9) pp 1884–1910

[6] Ludin S M, Rohaizat M, and Arbon P 2018 The association between social cohesion and community disaster resilience: A cross-sectional study Health and Social Care in the Community Blackwell Publishing Ltd

[7] Djalante et al 2017 Disaster Risk Reduction in Indonesia

[8] Potangaroa R, Santosa H, and Wilkinson S 2014 Disaster Management: Enabling Resilience

[9] Zakour M J and Gillespie D F 2012 Community Disaster Vulnerability

[10] Davies T R H and Davies A J 2018 Increasing communities resilience to disasters: An impact-based approach Int. J. Disaster Risk Reduct. 31 pp 742–749

[11] Bhattacharjee K and Behera B 2018 Determinants of household vulnerability and adaptation to floods: Empirical evidence from the Indian State of West Bengal Int. J. Disaster Risk Reduct 31 pp 758–769

[12] Padawangi R and Douglass M 2015 Water water everywhere: Toward participatory solutions to chronic urban flooding in Jakarta 88(3)

[13] Djalante R 2018 Review article: A systematic literature review of research trends and authorships on natural hazards, disasters, risk reduction and climate change in Indonesia Nat. Hazards Earth Syst. Sci 18(6) pp 1785–1810

[14] Djalante R and Garschagen M 2017 Disaster Risk Reduction in Indonesia

[15] Wijaya N, Bustanul M, Bisri F, and Artenang A F 2017 Disaster Risk Reduction in Indonesia

[16] Mabon L 2019 Enhancing post-disaster resilience by ‘building back greener’: Evaluating the contribution of nature-based solutions to recovery planning in Futaba County Fukushima Prefecture Japan Landsc. Urban Plan 187 pp 105–118

[17] M cgowan J 2012 A Missed Opportunity to Promote Community Resilience? - The Queensland Floods Commission of Inquiry Australian Journal of Public Administration 71(3) pp 355–363

[18] Shabrina F Z, Meilano I, Windupranata W, and Hanifa N R 2018 Measure coastal disaster resilience using community disaster resiliency index (CDRI) in Mentawai Island Indonesia AIP Conference Proceedings 1987

[19] Badan Nasional Penanggulangan Bencana (BNPB) 2019 Data Informasi Bencana Indonesia http://dbi.bnpb.go.id/ last visit on 9 Mei 2019

[20] Badan Meteorologi Klimatologi dan Geofisika (BMKG) 2018 Potensi Gempabumi dan Tsunami di Indonesia

[21] Badan Pusat Statistik (BPS) 2018 Kabupaten Pandeglang Dalam Angka https://pandeglangkab.bps.go.id/publication.html last visit on 7 Februari 2019

[22] Badan Nasional Penanggulangan Bencana (BNPB) 2014 Kajian Risiko Becana Kabupaten Pandeglang http://imarisk.bnpb.go.id/pdf/BANTEN/Dokumen%20KRB%20PANDEGLANG_final%20draft.pdf last visit on 10 Mei 2019

[23] Badan Pusat Statistik (BPS) 2019 Kecamatan Carita Dalam Angka https://pandeglangkab.bps.go.id/publication.html?Publikasi%5BtahunJudul%5D=2019&P ublikasi%5BkataKunci%5D=carita%y0 last visit on 7 Februari 2019