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STRENGTHENING THE SOCIAL CAPITAL OF THE BANDA NEIRA COMMUNITY TO IMPROVE THE ADAPTIVE CAPACITY OF TSUNAMI MITIGATION

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ABSTRACT

Adaptive capacity is one of the essential components of tsunami disaster mitigation. One of the determinants of the high level of adaptive capacity is the strength of the community's social capital. Social capital plays an essential role as the basis for community response, especially during the emergency period. Communities with good social capital positively affect the implementation of tsunami mitigation strategies. This study seeks to assess the actual condition of the adaptive capacity of the Banda Neira community in dealing with the tsunami disaster and efforts to increase it through strengthening social capital. The adaptive capacity assessment uses an index-based approach by identifying a set of determinants based on respondent interviews related to perceptions and knowledge of disaster mitigation. The three variables of social capital (bonding, bridging, and linking) are used to measure each determinant numerically or qualitatively with the value of the Likert model scale (1-5). Furthermore, the determinant scores are combined into a measurement of the overall adaptive capacity of the system. The results of the research indicate that it is necessary to strengthen the bounding and bridging variables, namely in the form of increasing the role and function of institutions in assisting, preparedness training, and strengthening relations between communities through social activities and optimizing the role of social groups.

Keywords: Community response, emergency period, disaster, & risk awareness.

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INTRODUCTION

Indonesia is known as one of the countries with high seismic frequency due to its location in the ring of fire and subduction zone. As a result, Indonesia has various characteristics of earthquakes and tsunamis recorded by experts for years (Hamzah *et al*., 2000). Based on the tsunami and destructive earthquakes, Indonesia is divided into six zones, namely: Zone A (West Sunda Arc), Zone B (East Sunda Arc), Zone C (Banda Arc), Zone D (Makassar Strait), Zone E (Molucca Sea), and Zone F (North Irian Jaya) (Hamzah *et al*., 2000).

The Banda Islands, included in zone C (Banda Arc), are a group of islands in the middle of the Banda Sea with at least 11 islands and are administratively Banda District under Central Maluku Regency. From an economic perspective, Banda has an extraordinary wealth of spices (especially nutmeg), making this a bone of contention for European nations. However, apart from the richness of spices, the geographical position and geological situation of the islands in the Banda Islands group also hold potential disasters, one of which is a tsunami.

One of the significant tsunami events recorded in the catalog was the tsunami on August 1, 1629. The tsunami caused heavy damage due to a 15-meter-high tsunami wave that occurred half an hour after the earthquake shaking stopped (Liu & Harris, 2014) described by Authur Wichmann (1918). The tidal wave was rolling towards the west, directly hitting Nassau Fort in Banda Neira and coastal villages. The recorded wave height was 9 fathoms (15.3) above normal tide.

In 1952, almost all parts of Indonesia felt a 5-minute earthquake in the Banda arc. The earthquake caused the lifting of new islands and a tsunami in the Banda Sea with a wave height of 8 meters in Banda Neira (Fisher & Harris, 2016). According to the Tsunami Catalog, Banda Arc experienced 20 destructive earthquakes that caused the death of 285 people. These destructive earthquakes have a return period of about 9 - 10 years.

According to Wichmann (1918), between 1600 and 1877 at least 600 major and minor earthquakes and 21 tsunamis were documented in the southern Banda Sea region, namely on the islands of Banda, Ambon, Haruku, Saparua, Seram and Timor. Most of the most dangerous tsunamis in Indonesia are caused by submarine landslides. Banda Islands is located in the middle of Banda Sea, the deepest sea in Indonesia which also has it own tectonic plate called Banda Sea Plate. Surround by several tectonic plates of the world makes Banda Islands strongly being danger by complex disaster such as volcanic eruptions, tsunamis and earthquakes (Fadhillah *et al*., 2015).

Vulnerability, its elements of exposure, sensitivity, and adaptive capacity, and their determinants are dynamic (they vary over time), they go by type, they differ from one stimulus to stimulus, and they are place- and system-specific (Smit & Wandel, 2006) Adaptive capacity research covers numerous topical sectors.

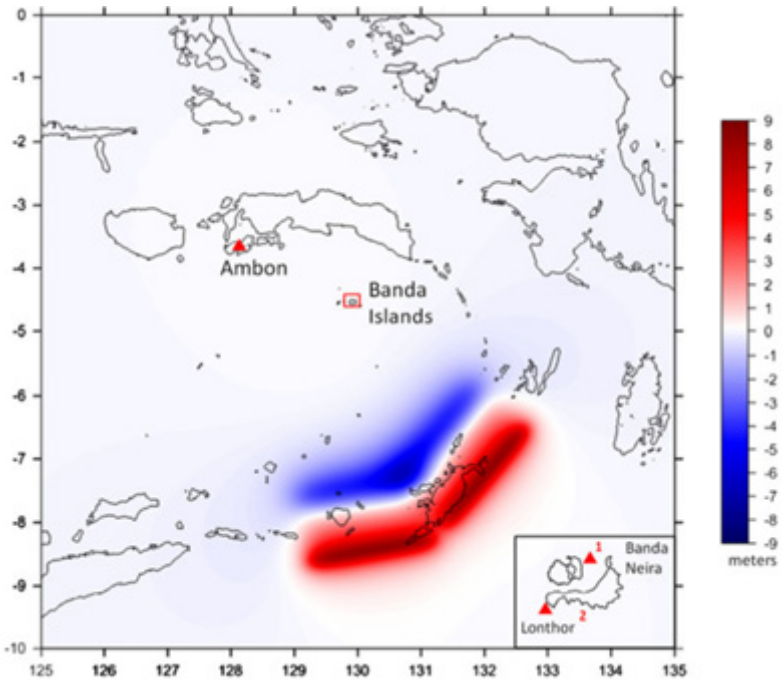

Figure 1. Models of the two fault segments of the Tanimbar arc that are thought to have caused the tsunami in Banda Neira. (Liu & Harris, 2014)

Figure 2. Inundation Levels of the three tsunamis that hit the island of Bandaneira, including the 1852 incident. The 1629 incident was reconstructed by Liu and Haris (2013).

For example, some studies researched the effects of a single hazard (e.g., wildfire) on a range of sectors and natural resources (e.g., health, industry, and biodiversity), while others focused on one sector (e.g., agriculture) or resource (e.g., water) and considered a range of hazards to which the social or social-ecological system must adapt (Siders, 2019).

The high frequency of earthquakes and tsunamis requires the community to be prepared to face the possibility of a disaster. The community must know the indications of a disaster and how to save themselves from the threat of the disaster. The level of adaptive capacity is seen from level of perception and knowledge of tsunami disaster mitigation and socialization of tsunami disaster mitigation. Level of "perception and knowledge" in coastal villages of Pariaman City is only filled by the "High" level. Average respondents know what a tsunami is, realize that they live in areas with potential tsunami hazards, know what to do when tsunami warnings arise, prepare before tsunami, know the location of tsunami evacuation, and know the exact evacuation route (Hadi & Damayanti, 2019). Responsive disaster management focused on post-disaster management has proven ineffective in reducing disaster risk. A paradigm shift in disaster management is crucial and urgent, namely by increasing community preparedness (Hidayat, 2008). Research on community preparedness in the face of disasters (Hidayat, 2008) in Padang Periaman, Serang, Cilacap, Sikka and Bengkulu City showed that the community was still poorly prepared in anticipating earthquake and tsunami disasters.

In disaster studies, social capital plays an essential role as the basis for community response, especially during the emergency period (Meyer, 2018). Communities with good social capital will suffer fewer losses and impacts from disasters. Social capital has a good effect on the implementation of individual and organizational mitigation and adaptation strategies (Chen *et al*., 2014) . The focus and locus of this research are 1) to find out the real condition of the social capital of the Banda Neira community, 2) to study its strengthening efforts to increase the adaptive capacity of the Banda Neira community to the tsunami disaster, and 3) compile a vulnerability map of tsunami.

This study seeks to reveal the current state of the community's adaptive capacity and efforts to improve it through strengthening social capital to deal with the threat of the tsunami disaster in Bandaneira.

METHODOLOGY

The study used primary and secondary data. Primary data includes field observations and interviews/ questionnaires, while secondary data is obtained from a literature review, statistical data center, and spatial data related to the research location. The spatial data includes DEMNAS, land cover, and village maps from the national data portal (https://tanahair.indonesia.go.id/demnas/#/demnas accessed March 13rd, 2022, https://portal.ina-sdi.or.id/downloadaoi/ accessed Marc 20th 2022). In addition, the high tsunami run-up is taken from the Tsunami Catalog (Hamzah *et al*., 2000) and the results of the Bandaaneira tsunami reconstruction study (Fisher & Harris, 2016).

Field observations were carried out to record physical phenomena in the field and take photos horizontally and vertically with drone media. In addition, interviews were conducted to reveal past tsunami events and community perceptions of tsunamis and explore the community's social capital.

Interviews were conducted using purposive or purposeful sampling and snowball sampling techniques. Purposeful sampling is a method where the researcher determines the selection of subjects who have knowledge or experience of the research question or phenomenon; while snowball sampling determines the individuals selected by the researcher in reference to a person or respondent who is potentially capable of building the final sample (Stratton, 2019). Snowball sampling technique is a multi-stage technique with the analogy of a snowball that gets bigger gradually because of the addition of snow when it is rolled in a snowfield. It starts with a few people or cases, then expands based on relationships to respondents (Nurdiani, 2014). Respondents were determined at locations that had been hit by high waves as mentioned in scientific writings. The main respondents of the snowball sampling were the regional heads, first the Bandaneira sub-district head and then the village heads. The main respondents were then extended to key figures recommended by the sub-district and village heads, and so on until the respondents obtained the necessary information as in the research plan. With the snowball sampling technique, the researcher is free to explore even the most detailed information.

Aspect has been the improved applicability of photogrammetric software, facilitating the processing workflow in the construction of DEMs which has resulted in numerous applications (Sonnemann *et al*., 2016) in relief analysis. The surveys were performed using a DJI Phantom III quadcopper. The results of drone mapping is combine with rectified topographic map. Rectification organized using Geographic Information Systems (GIS) to enable quantitative analysis of their accuracy, and to reveal new insights into settlement and sedentarization processes (Tapilatu *et al*., 2016)

Adaptive Capacity Assessment Method

Sanyal & Routray (2016) examines social capital according to three components of social capital: bonding, bridging, and linking. Social bonding plays a role in preparation for natural disasters in reducing threat opportunities through close interaction and togetherness in community groups that allow each community member to know each other well. All community members work together to solve potential problems in small-scale disasters. Bonding between community members increases the level of trust.

Bridging in disasters is realized by the existence of committees or special groups for disasters that are ready to hold meetings and organize disaster early warnings given by the authorities or the government at any time. Linking is trying to take advantage of the connection between citizens with power, for example, regulations and policies (policy) that have a political affiliation.

Social capital analysis in tsunami mitigation was carried out using a scoring technique based on a Likert scale to assess bonding, bridging, and linking variables. The score of each Likert scale variable is given a value of 1 to 5, which indicates the quality of social capital. In this social capital assessment, the comparisons were made at the village level, where a minimum locus of two ward will be selected, considering the factors of settlement density, community diversity, and ease of access to information.

The results of the scoring analysis of each variable from the two loci were then carried out with normalization analysis. The normalization calculation uses the Min-Max method as follows:

$$Normalisasi = \frac{(Data - Min) * (New\ Max - New\ Min)}{(Max - Min) + New\ Min}$$

where,
Data : Variable Value (average score)
Min : The lowest value of the indicator
Max : Highest value indicator
New Min : Minimum limit given
new max: Maximum limit given

$$score\ range = \frac{highest\ score - lowest\ score}{\sum score\ levels}$$

In this study, level 5 was assigned as the highest score, while 1 was the lowest score with the number of level 3 categories, namely high (5), medium (3-4), and low (1-2). The interval scale is categorized by formula modification (Norzistya & Handayani, 2020). The higher the score, the better the social capital. Given the importance of gathering information about social capital, the sampling method in the form of interviews was carried out by in-depth interviews. In this study, the first subject who became the target of snowball sampling was the head of the region, namely the Camat Bandaneira, which was then extended to community leaders and village heads.

RESULTS AND DISCUSSION

The impact of tsunami to Banda Neira coastal land and community

Sensitivity determined by the quality of buildings, while level of vulnerability to the impact of the tsunami

determined by the population density. The lower the quality of the building, the higher the sensitivity level. Also, a high population density also reflects a high sensitivity. Population density is spatially expressed by the density of buildings in a location.

Sensitivity The area against the tsunami is depicted on the map in Figure 3. Exposure as a morphological function reflected by the slope and run-up wave height indicates that the Dwiwarna and Kampung Baru coastal areas are included in the vulnerable zone. These two villages or countries have flat to gentle slopes. However, it is known that the arrangement of settlements and buildings in Dwiwarna has existed since the colonial era and has been sustainable until now. The beach area is vasttly used as a tourist area, even the Societe Harmony theater and restaurant are located right facing the sea beside the VOC Office Palace. On the other hand, Kampung Baru, as the name implies, is a village or country that emerged later on an open coast that has now been secured by a wave barrier along the coast.

From the results of the delineation and overlay of building density and building quality, it appears that Merdeka village has medium to high sensitivity. High sensitivity is found in the Lautaka settlement which is in a form similar to a button. The classification of population density per settlement area in the Banda District is shown in Table 1.

In addition to the close distance of the buildings, the settlement is located on a gentle slope with both sides facing the sea. Sensitivity at a moderate level is dominated by settlements in Kampung Baru with a fairly high density of buildings on a flat to sloping morphology. The density of this building is associated with the profession of most of the residents who are fisherman. The fishing villages always stand on the shoreline and even above the waters so that they can always keep an eye on the ships. In contrast to the structure of the buildings in Dwiwarna village which adopted the colonial period with settlements far from the shoreline, it even benefited from the existence of fairly wide road access to Belgica Fort as a Temporary Evacuation Place.

Adaptive capacity of the community to tsunami impact in Banda Neira

Adaptive capacity is largely determined by the level of community response to disaster threats. Social capital plays an essential role as the basis for community response, especially during the emergency period. This capital has a positive effect on the implementation of mitigation and adaptation strategies (Meyer, 2018). The roles of bonding, bridging, and linking social capital are different in each stage of the disaster risk management cycle (Sanyal & Routray, 2016),

This study is not related to post-disaster management but focuses more on preparation for disaster hence the variables tested are only related to preparedness. The bonding variable analyzes the indicators of trust, social ties, information acquisition, and socialization as well as participation in disaster

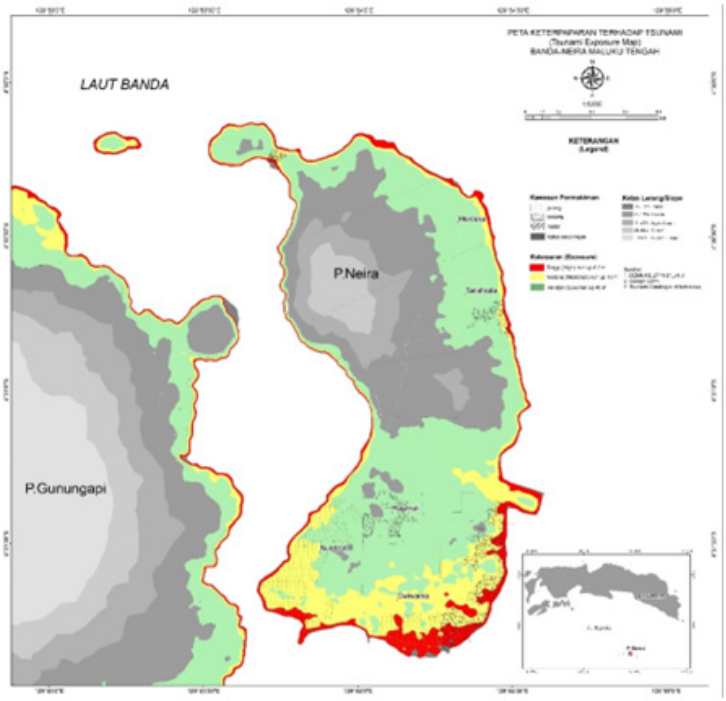

Figure 3. Bandaneira Tsunami Exposure Map (source: primary data analysis result).

Table 1. Population Density per settlement area in Banda District (processed data)

No.	Village	Population	Large Settlement (Ha)	Density (Ha/person)	Category
1.	Lonthoir	4185	60.12	69.61	Low
2.	Selamon	2188	11.30	193.63	Low
3.	Kampung Baru	3076	11.63	264.53	Moderate
4.	Dwiwarna	929	7.56	122.90	Low
5.	Rajawali	900	2.93	307.02	Moderate
6.	Merdeka	858	0.55	1567.70	High
7.	Nusantara	2053	16.70	122.91	Low
8.	TanahRata	843	2.18	386.35	Moderate
9.	Uring-Tutra	86	8.43	10.20	Low
10.	Walling-Spanciby	224	1.39	161.51	Low
11.	Boiyauw	181	3.81	47.45	Low
12.	Dender	72	23.90	3.01	Low
13	Combir-Kaisastoren	185	2.78	66.66	Low

(Sources:https://malukutengahkab.bps.go.id/publication/ accessed 14 june 2022)

preparation.

The bridging variable analyzes the spread of awareness about disasters and risk awareness; while the social capital linking variable analyzes organizational indicators that train rescue against natural hazards, policy implementation, and early warning systems. The weighting of the adaptive capacity assessment scores is shown in Table 2, while the results of the Banda Neira community's adaptive capacity assessment based on 3 social capital variables are shown in Table 3.

The criteria and weighting variables used were arranged based on several sub-criteria (list of questions) which were packaged in a questionnaire with a semi-structured interview method (attached). The results of the matrix analysis in Table 4 can be explained as follows:

Social Bonding:

- When viewed from the indicators of trust, social ties, and the ease of obtaining information in Dwiwarna village and Kampung Baru village, the criterion value shows a fairly good score, this is indicated by the green and yellow value indicators. However, the socialization of the program still has to be carried out periodically to remind and improve the community's preparedness in dealing with the tsunami disaster.
- As for the things that need special attention are indicators of Community participation in dealing with disasters (especially in Dwiwarna village). It gets a red score which means it is still weak and needs strengthening. Awareness of existing social cohesion needs to be increased by promoting awareness among fellow citizens about maintaining public facilities and evacuation signs that have been made by the government.
- Activities that directly involve individuals in the community must be encouraged and strengthened, including instilling awareness and participation in government programs through continuous awareness efforts.

Social Bridging:

- If you look at the indicators that spread awareness about disasters in Dwiwarna village and Kampung Baru village, the criteria scores showed a fairly good score (green and yellow indicators). However, it is still necessary to improve and increase the role of community leaders to be able to provide understanding and socialization related to disaster awareness and disaster risk to understand information related to the tsunami and its potential;
- As for the thing that needs special attention is the risk awareness indicator, especially in Kampung Baru village. This is indicated by the fact that the community has not fully implemented anticipation by complying with the coastal border rules, namely maintaining a distance of residence/settlement from the nearest shoreline. As for the results of interviews and field reviews, it is seen that the location of the

Table 2. Weighting of Adaptive Capacity Assessment based on Social Capital variables of the Bandaneira Community in Facing the Tsunami Threat

Scoring		
Low (1-2)	Medium (3-4)	High (5)

Table 3. Calculation of Adaptive Capacity Based on Social Capital

Adaptive Capacity Variable	Criteria		Social capital status per Criterion Village Dwiwarna	Village Kampung baru
Bonding	Trust	1	5	5
		2	4	5
	Social cohesion	1	3	3
		2	3	4
	Gathering information and disseminations	1	5	4
		2	5	5
	participation in preparedness activities	1	2	5
Bridging	spreading consciousness	1	4	3
	about disaster risk awareness	1	5	3
		2	4	2
Linking	Organization of trianings specific for hazard in the area	1	3	3
	Policy implementation	1	5	5
		2	5	3
	Early warning system	1	5	5

settlement is indeed very close to the shoreline due to limited land and proximity to the location of livelihood as a fisherman.

- Bridgingin a disaster is realized by the establishment of special committees or groups for disaster that is ready to bridge at any time to organize meetings and organize disaster early warnings given by the authorities or the government. Awareness of disaster risk, in this case, must continue to be increased through socialization and counseling by the government.
- The lack of socialization related to risk awareness to the public and only limited to community leaders is one of the problems that need to be addressed immediately. Government innovations in conveying understanding and awareness are not limited to government officials and community leaders, but program socialization must continue to be carried out periodically to remind and improve community preparedness in dealing with the tsunami disaster.

Social Linking:

- When viewed from the indicators of policy implementation, and the early warning system in Dwiwarna village and Kampung Baru village, the criterion value shows a fairly good score (yellow and green indicators). The existence of policies on budg*et* at location for disaster management, determination of tsunami shelters, and Early Warning Systems (EWS) has made the majority of policy implementations implemented.
- However, in the new villages, it is very unfortunate that in the past there was the formation of the Disaster Preparedness Youth Organization (TAGANA) but now it has been disbanded. In fact, the disbandment is a disaster in itself because one of the components to strengthen policy implementation is missing, especially the organization that trains former officers against natural hazards.
- The formation of non-governmental organizations needs to be done in an effort to increase the active

Table 4. Calculation of Adaptive Capacity Based on Social Capital

Variable	Village Dwiwarna	Category Social capital	Kampung Baru	Category social capital
Bonding	3.43	Medium	4.43	Medium
Bridging	4.33	Medium	2.67	Low
Linking	4.5	Tall	4	Medium
Social Capital	4.09	Medium	3.7	Medium

Figure 4. Diagram Mapping of adaptive capacity through social capital. (pelling & High, 2005)

participation of the community. A good early warning system and emergency budg*et* locations from the government are another essential instruments in disaster management

- trying to take advantage of the relationship between citizens with power, such as regulations and policies (policy) that have a political affiliation.
- Determination of a temporary evacuation place for the new village area is really needed considering that it is quite far to reach the Belgica fort.

The description of the situation of social capital in this study can be seen in the scheme below Figure 4 shows that the priority for adaptive capacity building is on institutional modifications that can stimulate awareness and preparedness for tsunami disasters. Adaptive capacity is described in terms of 4 intersecting axes (Pelling & High, 2005), the vertical axis represents the difference between interventions aimed at dealing with disasters and emergencies. Interventions are carried out directly on the impact of the vulnerability, for example by influencing socio-economic status. The horizontal axis distinguishes between material interventions in which social capital is mobilized as a resource to mitigate disasters; and institutional modification, interventions that aim to change the balance of decision-making power that ultimately forces access to resources for adaptation and development.

Future actions for tsunami mitigation in Banda Neira

Based on the diagram in Figure 4, it is necessary to generate social capacity through various organizational or institutional activities. It is necessary to establish a new institution to replace the previously dissolved disaster preparedness institution, so that the community can participate more. The institution functions to:

- Foster social bonds to increase tsunami awareness among community members. Evacuation signs should be installed and public facilities maintained by the local government.
- Socialization on disaster preparedness needs to be more intensive, not only for community leaders but also for all citizens of all ages.
- Determination of other Temporary Evacuation Sites (TES), especially for communities far from Fort Belgica.

CONCLUSION

1. Bandaneira's performance as a small island in the middle of the sea which several times in the history of the tsunami experienced high waves, of course, has a considerably high level of exposure. Modification of the hard structure by making dikes around the island is not the only solution to dealing with the threat of high waves.
2. Decreasing sensitivity by adjusting settlement patterns is another alternative to reducing risk. In addition to settlement patterns, it is also necessary to apply types of tsunami-resistant buildings, including determining temporary evacuation sites other than Belgica Fort for people living in villages located far from TEA, where evacuation sites have not yet been determined in the event of a high-wave disaster or tsunami.
3. The social capital that has been formed is strong enough with the ability to absorb information very

quickly. The motto of not hurting each other among citizens must be developed as togetherness in social and cultural containers.

4. Based on the diagram mapping of adaptive capacity through social capital Institutional, modification is needed to replace the youth organization that was once formed as an active driving force for community participation. Youth organizations must be inclusive and able to accommodate all lines and visions of local youth.

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