Community preparedness against the threat of abrasion and tidal floods in Padang City

Putri Nilam Sari1*, Yulina Wahyuningrum Purba1, Azyyati Ridha Alfian1

1 Faculty of Public Health, Andalas University, Padang, 25163, Indonesia

Corresponding Author: nilam@ph.unand.ac.id

Abstract. The tidal wave in Padang City resulted in 674 potentially eroded houses by sea abrasion over the next five years. Therefore, it is essential to improve community preparedness. This study aims to analyze the preparedness of coastal communities for the threat of abrasion and tidal flooding. This study used a cross-sectional study design, conducted from January to July 2020. The respondents were 74 inhabitants in Pasie Nan Tigo Village. The results showed that more than a half of the respondents were less prepared to face abrasion and tidal flooding (64.9%), having low knowledge of disaster preparedness (41.9%), low awareness of policies and guidelines concerning abrasion and tidal flooding (77.0%), having low emergency response plans (33.8%), having low disaster warning system (43.2%), and having low resource mobilization (44.6%). The statistical test results showed a relationship between knowledge, emergency response plans, disaster warning systems-resource mobilization, and preparedness. Meanwhile, there was no relationship between policies, guidelines, and preparedness. This study showed that the level of preparedness of coastal communities in the face of abrasion and tidal flooding is still unprepared, the society and government need to improve their disaster readiness by increasing their knowledge of abrasion and tidal floods preparedness in seminars, training, and providing sufficient facilities.

1. Introduction

One of the impacts of global warming is the increase of seawater volume and the slowly sinking of low-lying islands or coastal areas. A report from the Intergovernmental Panel on Climate Change (IPCC) in 2016 predicts that in the next 100 years, starting from the year 2000, sea level will rise by 15-90 cm [1]. Sea level rise causes coastal erosion or abrasion and tidal flooding. Tidal flooding occurs when maximum tidal conditions inundate areas lower than the mean sea level. Gravity helps seawater to flow towards low place and inundate these areas [2].

Indonesia is one of the countries that significantly influenced by the sea-level rise, which is estimated to lose a significant land area, of about 90,260 km². Based on the National Disaster Management Agency (BNPB) in 2017 risk assessment results, the total number of people exposed to the risk of extreme waves and abrasion in Indonesia is 9,825,782 people in all provinces, with a potential loss of IDR 259 trillion. BNPB noted that in 2019, there were 18 abrasion disasters caused by tidal waves throughout Indonesia. Abrasions are predicted to increase, in line with the climate crisis / global warming [3]. Flooding have been occurred in some areas in Indonesia since 2010. In January and February 2010, there was several tidal flooding in some areas of Surabaya, with inundation levels between 20 cm to 160 cm in 30 minutes to 6 hours flooding duration [4]. In 2011, tidal flooding occurred in the coastal area of Jakarta reaching a height between 30 cm and 50 cm [5]. In 2014, tidal flood occurred in the North Semarang sub-district, due to sea-level rise, covering an area of 823,545 ha or about 70.991% of the total area of the North
Semarang sub-district [6]. In Pariaman City, shoreline changes since 2010 caused residents' home damage [7].

Five factors that influence the disaster preparedness of the community are knowledge (and attitude) towards disaster risk, policies and guidelines, plans for disaster emergencies, disaster warning systems, and the ability to mobilize resources [8]. Disaster preparedness for families on the coast also depends on the perception of disaster risk. Previous research stated a significant and positive relation between perception of disaster risk and disaster preparedness. As many as 83% of high-risk country have a high level of disaster preparedness. A better perception of disaster risk means that the community believes that the place where they live, has a risk of natural disasters and ultimately feels that they have a high responsibility, control, acceptance, and response to this risk [9]. In that case, it will encourage the community to take preparedness in flood disaster event[10].

Padang City has the potential to experience inundation due to sea-level rise. Topographically, almost half of Padang City lying on coastal areas and lowlands. Rising sea level will cause some places on the coast of Padang City, that were predicted before, to be inundated [reference]. From 2008 to 2013, sea-level rise of about 1.1786 cm/year in Padang City. The height of inundation, in 2020, in Padang City is 89.671 cm, and cover an area of 0.382 km² (visualized on the tidal inundation map) [11,12]. Tidal flood damaged houses, road infrastructure, public facilities, such as schools and health services, sanitation, yards, fields, rice fields, and ponds [13]. In addition, tidal flood potentially causes various diseases too, even causes epidemics [14]. Some diseases often appear in floods, such as leptospirosis, diarrhea, digestive tract diseases, upper respiratory tract infections, typhoid, skin diseases, dengue fever, or malaria [15].

Pasie Nan Tigo Village (PNT) is one of the coastal areas in Padang City, which is often hit by disasters, especially coastal abrasion, tidal waves, floods, storms, seawater intrusion, and indicated to be prone to tsunamis. There are 674 houses inhabited by 1,164 families in the red zone and potentially eroded by abrasion over the next five years. This happens because the distance between the beach and the house is very close, only around 3-7 meters. In recent years, coastal scour has been high enough that many houses have been affected by abrasion. In fact, 12 houses have been destroyed by the waves, and other 24 houses will possibly be damaged because the waves often reach them. Therefore, it is crucial to determine the preparedness of coastal communities against the threat of abrasion and tidal flooding.

2. Method

The study was conducted in a quantitative research observational analytic approach using a cross-sectional design. This study was carried out by using data from 74 respondents, who live around coastal areas in the Village Pasie Nan Tigo, Tangah Koto subdistrict, Padang.

Through interviews with the respondents, data was collected in a questionnaire about preparedness as a dependent variable, knowledge, policies and guidelines, emergency response plans, disaster warning systems, and resource mobilization as independent variables [16]. First, the data was analyzed to see the frequency for each community preparedness indicators. Each variable was then divided into two categories (low, high) with a median cut-off point. The association between the dependent and independent variables was analyzed using the chi-square test with a significance level of 95%.

3. Result and Discussion

Pasie Nan Tigo Village is one of 13 villages in Koto Tangah District, Padang City. PNT village is located at 0.8406° S, 100.3203° E. The beaches width in this area are between 2m and 21m, and the coastline is 7.2 km long. The coastal area of PNT is located between 0 and 3m above sea level, with a land slope of 0-2%.

Table 1. Relationship between preparedness and the other five independent variables

| No. | Independent Variables          | P-value |
|-----|-------------------------------|---------|
| 1   | Knowledge                     | <0.001  |
| 2   | Policy and guidelines         | 0.580   |
| 3   | Emergency response plan       | <0.001  |
Table 1 shows the relationship between preparedness and the five independent variables. The statistical test results showed a significant relationship between knowledge, emergency response plans, disaster warning systems-resource mobilization, and preparedness (<0.001). Meanwhile, there was no relation between policies and guidelines with preparedness (0.580).

3.1 Knowledge

Family knowledge about abrasion and tidal flooding is necessary to understand how far the families, who live in PNT Village, is ready for this disaster. Based on the study results, only 13.5% of respondents knew that the tidal flood was a disaster that brought sources of disease such as diarrhea, typhus, DHF, malaria, etc. Table 2 shows the community knowledge.

Table 2. Distribution of knowledge

| No. | Knowledge                                                                 | True Answer |
|-----|---------------------------------------------------------------------------|-------------|
|     |                                                                           | f  | %  |
| 1.  | Tidal flood is a natural event that disrupts human life.                   | 41 | 55.4|
| 2.  | Human behaviour causes damage to nature.                                  | 19 | 25.7|
| 3.  | Tidal flood is a disaster caused by high tides that inundate the coastal area. | 60 | 81.1|
| 4.  | Tidal floods bring sources of diseases such as diarrhea, typhoid, dengue fever, malaria, etc. | 10 | 13.5|
| 5.  | Tides that inundate coastal areas cause tidal flood.                      | 70 | 94.6|
| 6.  | During the tidal flood, we have to save ourself to a safer place.          | 44 | 59.5|
| 7.  | During the tidal flood, it is necessary to evacuate to an area other than the tidal flood area. | 25 | 33.8|
| 8.  | During the tidal flood, we need to save ourself and invite family members. | 40 | 54.1|
| 9.  | When the tidal flood occurs, we need to monitor the condition of the water level. | 45 | 60.8|
| 10. | During the tidal flood, we have to avoid the power line                   | 19 | 25.7|
| 11. | During the tidal flood, we (don’t) have to save valuables things          | 40 | 54.1|

Table 2 shows the high level of community knowledge only about "Tidal flood is a disaster caused by high tides that inundate the coastal area" (81.1%) and "Tides that inundate coastal areas cause the tidal flood" (94.6%). For other knowledge question answers, scores are still low. The results of the previous study show relationship between flooding and the incidence of diarrhea, water shortages, water quality (smelly dirty water, and the presence of insects and worms), as well as community resilience to help each other in water supply and treatment of water sources to avoid contamination [17].

However, people who live in coastal areas have a high level of knowledge because they have already lived for more than ten years in areas that are prone to abrasion and tidal flood. Therefore, they have more experiences with abrasion and tidal flood. In addition, some elders also passed their knowledge related to the tidal flood to the younger generation, for example that tidal flood takes place during the full moon every month.

It is better to re-educate the community, who can cooperate with related cross-sector such as schools, youth groups, and PKK groups, about tidal abrasion and flooding, to increase public knowledge. Furthermore, the education should cover all ages to accelerate the delivery of information to the community, especially people who live on the PNT coast.
3.2 Policies and guidelines
Policies and guidelines are also a benchmark for family readiness to face abrasion and tidal floods. Table 3 shows policies and guidelines regarding anticipation of tidal flood.

| No. | Policy and guidelines                                         | Availability |
|-----|---------------------------------------------------------------|--------------|
| 1.  | Dissemination of policies/programs related to tidal flood    | 8            |
| 2.  | Assistance from the government to overcome tidal flood        | 59           |
| 3.  | There is a tidal flood alert group                           | 12           |

The research shows that 10.8% of respondents stated that there was a socialization of village policies/programs related to abrasion and tidal flood. Furthermore, 79.7% of respondents said that there was assistance from the government for abrasion and tidal floods. Communities affected by abrasion and tidal flood said that disseminating policies/programs not evenly distributed. This study aligns with another research, which found that 55.7% of respondents had unpreparedness in policies and guidelines for people in high-risk flood disaster areas [18].

To overcome flooding, government should give serious attention [19]. It is better if the local government also give an information related to disaster response policies/programs to the community, so the people in PNT, especially who live on the coastal areas will prepare themselves better in dealing with the possibility of abrasion or tidal flood. One of the efforts is by forming an abrasion or tidal flood alert group. The government should also provide an equal assistance to all communities affected by abrasion and tidal flood.

3.3 Emergency response plans
The community emergency response plan is illustrated in the following table (Table 4).

| No. | Emergency response plan                     | Availability |
|-----|--------------------------------------------|--------------|
| 1.  | Have some prepared actions during tidal flood| 38           |
| 2.  | Have a place for refuge                     | 21           |
| 3.  | Prepare evacuation routes                   | 4            |
| 4.  | Prepare long-lasting ready-to-eat food       | 12           |
| 5.  | Prepare first aid kit                       | 11           |
| 6.  | Prepare important and valuable documents    | 60           |
| 7.  | Prepare clothes, cash, and special needs    | 33           |
| 8.  | Save family photos                          | 8            |
| 9.  | Set up alternative communication tools       | 43           |
| 10. | Save important addresses                    | 17           |
| 11. | Participate in tidal flood evacuation drills | 10           |
| 12. | Increase knowledge about tidal flood        | 44           |
| 13. | Make an evacuation plan                     | 37           |
| 14. | Conducting family evacuation simulation before tidal flood | 10  |
| 15. | Build a house that prevents waterlog        | 18           |
| 16. | Move from the riverside area                | 10           |

In the emergency response plan, the highest score that exceeds 80% is preparing important and valuable documents (81.1%). Based on the research results, it is found that there are still at least 5.4% who are preparing for evacuation on the available routes. Low scores of emergency response plans can occur because the public awareness of the possibility of abrasion and tidal flooding, such as increasing
knowledge about abrasion and tidal flooding, having an agreement on evacuation/evacuation places with family members, and conducting simulation for tidal flood evacuation, is still low. This study is in line with Damayanti’s research in 2015, which states that only 14% of respondents have a good emergency response plan [20]. Therefore, the community should increase awareness and save themselves against the risk of abrasion and tidal flood. Improving emergency response plans can be done by increasing knowledge about abrasion and tidal flood, agreeing on evacuation/evacuation places, preparing important and valuable documents as well as storing numbers of emergency services such as hospitals, state electricity companies, disaster management agencies, and local police.

3.4 Disaster warning systems

The disaster warning system is a determining variable in the readiness of the families in PNT Village to face abrasion and tidal floods. The following table (Table 5) shows the disaster warning system owned by the community.

| No. | Sources of disaster warning system | Availability |
|-----|-----------------------------------|--------------|
|     |                                    | f | %  |
| 1.  | City/village official.             | 6 | 8.1|
| 2.  | Police and security.              | 5 | 6.8|
| 3.  | Radio.                            | 5 | 6.8|
| 4.  | Television.                       | 22| 29.7|
| 5.  | Printed media.                    | 12| 16.2|
| 6.  | Mosque.                           | 12| 16.2|
| 7.  | Community leaders.                | 60| 81.1|

Based on the research results, the source of information arrived to the respondents were received from the community leaders (81.1%). However, the disaster warning system from the local government is still low, 8.1%. The description of the community disaster warning system in PNT shows that it is essential to immediately give a socialization and training about disaster warning system by the government, mainly before the flood occurs. Community only relies mainly on the personal experience of observing the moon to know the conditions of the tides. This is in line with other research, in which the household preparedness in the disaster warning system is 43.3%. When disaster occurs, various prevention efforts including building and developing a non-traditional disaster warning system have to be carried out, even if it is only using a simple method [21]. Local governments should cooperate with the media to disseminate flood information to accelerate its delivery to the public.

3.5 Resources mobilization

Resource mobilization is the last variable in determining community preparedness to face abrasion and tidal floods. The following table (Table 6) shows mobilization of resources for tidal floods preparedness.

| No. | Resources mobilization                      | Availability |
|-----|--------------------------------------------|--------------|
|     |                                            | f | %  |
| 1.  | Attend a tidal flood preparedness seminar. | 11| 14.9|
| 2.  | Have first aid skills.                     | 18| 24.3|
| 3.  | Have evacuation skills.                    | 5 | 6.8|
| 4.  | Have scouting skills.                      | 4 | 5.4|
| 5.  | Have clean water treatment skills.         | 5 | 6.8|
| 6.  | Have food processing skills.               | 9 | 12.2|
| 7.  | Have savings.                              | 63| 85.1|
| 8.  | Have life / property insurance.            | 14| 18.9|
9. Have another house / place safe from disaster. 14 18.9
10. Having relatives/friends ready to help during the tidal flood . 64 86.5

Based on this study, 14.9% of respondents attended training, seminars, or meetings related to preparedness to face tidal flood. This condition is due to their lack of first aid, preparedness, evacuation of victims, and clean water treatment skill. Only a small part of the community in PNT participated in the related training. The existence of savings and insurance as part of family resources not adequate because awareness, interest, access, or information related to these points are still limited to certain circles. However, most people claim to have relatives or friends who are ready to help in the event of abrasion and tidal flood. This will reduce the burden and risk of abrasion and tidal flood in this area.

The previous study shows that the resource mobilization index was only 66.5%, because not every families are prepared for disasters [22]. Almost the same as this study, where there are only a few scores that are more than 80%, the category of resources mobilization is still relatively low. It is advisable to hold training or seminars related to preparedness for abrasion and tidal floods. The community should also gain important skills such as first aid, victim evacuation, scouting, clean water treatment, and food processing that can be useful for helping all people after the floods.

4. Conclusions
The community preparedness to face tidal flooding is lower than expected, preferably more than 80%. The public should be well prepared to minimize the risks and losses caused by abrasion and tidal floods. The government also needs to provide seminars, training, and sufficient facilities to raise community preparedness against the threat of abrasion and tidal flood.

References
[1] D. Sutrisno 2012 The Model of Sea Level Rise in Indonesia J. Shipp. Ocean Eng. 22
[2] P. L. Barnard et al. 2019 Dynamic flood modeling essential to assess the coastal impacts of climate change Sci. Rep. 9 1 pp 1–13
[3] BNPB 2017 Data Informasi Bencana Indonesia
[4] T. B. Nur, A. N. Rusydi, dan S. A. Wicaksno 2018 Pengembangan Sistem Informasi Geografis Berbasis Website (WEBGIS) Untuk Simulasi Pemetaan Daerah Genangan Banjir Rob Menggunakan Metode Neighbourhood Analysis (Studi Kasus: Pantai Utara Kota Surabaya) J. Pengemb. Teknol. Inf. dan Ilmu Komput. e-ISSN 2548 964
[5] Walhi 2011 Menanggapi Banjir Rob di Jakarta Utara
[6] D. Larasati, Johnny, dan Y. Fitriangingsih 2014 Perencanaan Sistem Penyaluran Air Buangan pada Komplek Perumahan Grand Sukati Kecamatan Sungai Kakap Kabupaten Kubu Raya
[7] A. P. Donal 2020 Coastal disaster mitigation through shoreline changes analysis in Pariaman city,” in E3S Web of Conferences 156 01007
[8] LIPI-UNESCO/ISDR 2006 Kajian Kesiapsiagaan Masyarakat dalam Mengantisipasi Bencana Gempa Bumi dan Tsunami. Deputi Pengetahuan Kebumian LIPI.
[9] A. Junaidi, N. Nurhamidah, dan D. Daoed 2018 Future flood management strategies in Indonesia MATEC Web of Conferences 229 1014
[10] Y. T. Kurnianto 2019 Pengaruh persepsi risiko bencana terhadap kesiapsiagaan bencana pada keluarga di pesisir pantai kecamatan sumur, pandeglang, Universitas Negeri Jakarta
[11] D. Daoed, B. Rusman, B. Istijono, dan A. Hakam 2016 Predictions of Vulnerability Flood and Flood Prone Areas in Watershed West Sumatra Province using Arc-GIS and Category Value International Journal of Earth Sciences and Engineering 9 3 pp 274-
279
[12] M. Rasyda, S. Widada, dan R. B 2015 Analisa Spasial Daerah Banjir Genangan (Rob) Akibat Kenaikan Muka Air Laut di Kota Padang *Oceanografi* 4 pp 379-385
[13] M. A. Marfai dan A. Cahyadi 2017 Dampak bencana banjir pesisir dan adaptasi masyarakat terhadapnya di kabupaten Pekalongan
[14] Kemenkes RI 2013 Buku Panduan Hari Cuci Tangan Pakai Sabun Sedunia (HCTPS) ke -6
[15] D. D. Saulnier, K. B. Ribacke, dan J. von Schreeb 2017 No calm after the storm: a systematic review of human health following flood and storm disasters *Prehosp. Disaster Med.* 32 5 pp 568-579
[16] A. A. Shah et al. 2018 Schools’ flood emergency preparedness in khyber Pakhtunkhwa province, Pakistan *Int. J. Disaster Risk Sci.* 9 2 pp 181-194
[17] P. N. Sari dan Nofriya 2018 Flood Disaster, Diarrhea and Community Resilience in Water Provision: A Case Study in The City of Bukittinggi *J. Kesehat. Masy. Andalas* 12 2 pp 23-29
[18] D. Sari dan C. Husna 2017 Kesiapsiagaan Bencana Banjir Pada Masyarakat Daerah Risiko Tinggi Dan Risiko Rendah Banjir *J. Ilm. Mhs. Fak. Keperawatan* 2 3 pp 1-9
[19] B. Hidayat, B. Istijono, T. O. Irwan, dan A. Junaidi 2020 The Effects Of Batang Kandis River Flood Control In Padang City-Palapa Metropolitan Urban Are *Int. J. 19* 71 pp 9-14
[20] H. N. Damayanti 2015 Kajian Kesiapsiagaan Individu dan Rumah Tangga Dalam Menghadapi Bencana Tsunami Di Kecamatan Grabag Kabupaten Purworejo. Universitas Negeri Semarang
[21] I. Murbawan, A. Ma’ruf, dan A. Manan 2018 Kesiapsiagaan Rumah Tangga Dalam Mengantisipasi Bencana Banjir Di Daerah Aliran Sungai (Das) Wanggu *J. Ecogreen* 3 2 pp 59-69
[22] L. Hanifah, S. A. Susilowati, D. A. Sasmita, A. Demawan, F. Zain, dan H. F. Fitrianto, 2017 Tingkat Pengetahuan, Mobilisasi Sumberdaya dan Kesiapsiagaan Keluarga terhadap Bencana Gempa Bumi di Desa Tangkil, Kecamatan Sragen, Kabupaten Sragen