

## Spatial Planning and Disaster Mitigation in Post-Tsunami Housing Complexes: A Case Study of Baitussalam District, Aceh Besar Regency

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### ABSTRACT

Baitussalam District, Aceh Besar Regency is one of the areas affected by the 2004 Aceh earthquake and tsunami. After the rehabilitation and reconstruction process was completed, Baitussalam was inhabited again by residents. Many housing developers built new housing complexes in Baitussalam. This causes potential disasters that residents may face, especially if the development is not following the Spatial and Regional Plan. This research aims to determine the suitability of housing complexes plan in Baitussalam with the Aceh Besar Spatial and Regional Plan and the residents' knowledge regarding spatial planning, tsunami mitigation and preparedness. This research used qualitative and quantitative methods, through interviews with related parties and residents of housing complexes. The results show the spatial layout of housing complexes in Baitussalam is in accordance with Aceh Besar Spatial and Regional Plan but lacks disaster mitigation facilities and infrastructure. Most respondents chose to reside in Baitussalam because housing prices were cheap and close to working place. They have a good understanding of tsunami disaster mitigation but do not know the implementation of tsunami preparedness in their neighborhood. Some respondents said Aceh Besar's spatial planning had considered the interests of community and wanted to be involved in managing and controlling its utilization.

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## INTRODUCTION

On December 26, 2004, Aceh was rocked by an earthquake with a magnitude of 9.1 on the Richter Scale, which was followed by a tsunami wave. This disaster caused enormous damage and loss of life. More than 200,000 people died. Many people also had to lose their homes (Syamsidik, 2017).

One of the areas affected by the earthquake and tsunami was Baitussalam District, Aceh Besar Regency. The earthquake and tsunami disaster caused several settlements to be badly damaged, and many residents became victims. Over the years, there was a massive reconstruction process, which was conducted between 2005 and 2009, to rebuild the areas affected by the tsunami (Syamsidik, 2021). Areas that had been affected by the tsunami disaster were again inhabited by residents, including Baitussalam District. These residents are returning natives and people from other areas outside Baitussalam District. Social, Economic and Environment are among factors causing residents to keep living in areas affected by disaster (Wahid, 2019).

The population of Baitussalam District has increased significantly in the few years following the 2004 tsunami disaster. Based on data from the Center of Statistic Bureau (BPS) of Aceh Besar, population increased around 400 persons each year since 2010. In 2018, the population of Baitussalam District is 19.651 people (BPS Aceh Besar, 2020). The increasing population has resulted in an increasing need for housing. Many housing developers are building new housing complexes, including in areas that were affected by the tsunami disaster, such as Baitussalam District.

Coastal areas affected by the 2004 tsunami are expected to become increasingly vulnerable in the future. Therefore, the impact of changes in sea level must be considered in spatial planning, which will be important in long-term adaptation and mitigation strategies (Meilianda, et al., 2019). Moreover, with the increasing number of housing complexes built in this area, spatial planning and tsunami mitigation procedures should be important factors to be considered.

The construction of a housing complex in an area that has been affected by disasters can certainly cause problems in the form of vulnerability and potential disasters that may be faced by residents living in the housing complex. Development that is extensive and increasing must also pay attention to local regional spatial planning, so that it is in accordance with regional development plans and land use allocation. Spatial planning can serve as a primary tool to limit the impact of disasters and to increase community resilience (Perera, 2022). One implementation of spatial planning suggested by Meutia (2021) is using vegetation such as mangroves to reduce tsunami impact on tsunami prone areas.

In 2005, during rehabilitation and reconstruction phase, Indonesian government received fund allocation by People Representative Parliament, where Rehabilitation and Reconstruction Board of Aceh and Nias (BRR Aceh-Nias) managing rehabilitation and reconstruction in housing, infrastructure and land use field worth IDR 1,619 trillion (Syamsidik, et al., 2019). Housing and settlement infrastructure development is one of the priorities of post-disaster rehabilitation and reconstruction programs (Modifa, et al., 2020). Since then,

many new houses have been built in new areas, saved from tsunami. This makes tsunami survivors have to be relocated. Some of them stay in new places, but many also go back to their original place because of their livelihood and environmental factors.

Later many more houses were built in tsunami affected areas, including Baitussalam. Followed several years later by housing developers which built many new housing complexes for their business purpose. These new housing complexes in tsunami affected area are cheaper than one in other places, those many people buy them and become new residents in this area, causing an increasing number of populations again.

Spatial planning and disaster mitigation in housing complexes are very important things as they affect many aspects of the residents' lives. Reform of spatial planning should begin, particularly in coastal areas, by directing investments in grey infrastructure resilience and green infrastructure to reduce the level of vulnerability and protect development outcomes (Tiar, 2021).

All these points, including the increasing number of populations, increasing needs of housing could become problem for regional spatial planning, especially in areas affected by disaster like tsunami and still disaster prone. Spatial planning which became reference in this research is Spatial Planning of Aceh Besar Regency 2012-2032 of Rencana Tata Ruang dan Wilayah (RTRW) Kabupaten Aceh Besar Tahun 2012-2032. RTRW is the integration of regional spatial planning on a regional which is a geographical entity with all related elements whose limits and systems are determined based on administrative aspects.

Based on the things mentioned above, the problem formulation that will be put forward in this research is as follows:

1. What is the suitability of the location and spatial layout as well as the disaster mitigation program in the housing complex in Baitussalam District to the applicable Spatial Planning of Aceh Besar Regency.
2. What is the level of knowledge about spatial planning, mitigation and preparedness for tsunami disasters among residents living in areas that have been affected by the tsunami disaster?

The objectives of this research are as follows:

1. To find out what the current spatial planning and disaster mitigation conditions are in housing complexes in Baitussalam District, Aceh Besar Regency and their suitability with the existing spatial planning plans in the RTRW of Aceh Besar Regency.
2. To find out the level of knowledge about spatial planning, potential, mitigation and preparedness for tsunami disasters among residents living in housing complexes in Baitussalam District.

## METHODS

This research uses mixed methods, namely conducting qualitative interviews and quantitative questionnaires for respondents. If the research aims to carry out measurements and gain a deep understanding behind the phenomenon, it is necessary to combine qualitative and quantitative methods (Mulyadi et al, 2018). Mixed Methods is a method that combines qualitative and quantitative approaches in terms of methodology (such as in the data collection stage), and mixed model studies combine the two approaches in all stages of the research process (Justan et al, 2024).

The quantitative method is focusing its attention on symptoms that have certain characteristics in human life, which are called variables (Mulyadi et al., 2018). The quantitative survey method was carried out in the form of a questionnaire to residents of Baitussalam District who live in housing complexes. Respondents were given a questionnaire to answer online in the form of a Google Form on their phone or gadget. Population is used to refer to all elements/members of an area that is the target of research or constitutes the entire object of research (Noor, 2012). The population in this study was the people of Baitussalam District, Aceh Besar Regency.

The research sample was the people of Baitussalam District who lived in housing complexes. Sample are part of the population (Nazir, 2011). The number of samples for this quantitative survey is 100 people. This number is obtained by using Slovin method. The calculation is based on number of residents in Baitussalam District in 2018 (19.651 souls).

$$\text{Slovin method: } n = \frac{N}{1+(Nxe^2)}$$

Information:

n = Number of samples;

N = Number of populations;

e = Error Level

There are several criteria to be fulfilled by the respondents, those are:

- 1) People of Baitussalam District, proven by ID card
- 2) Live in housing complexes in Baitussalam District
- 3) Minimum Age of 17 years old
- 4) Can answer the questionnaires using smartphone

Researchers come to the housing complexes in Baitussalam District and meet the sample randomly, as long they are living in housing complexes. Samples from this research answered the question on google form using the link shared to their phone. Google form chosen because it is an easy way to collect the data. We can design questionnaires and the way to answer them based on our need. The answer collected immediately to spreadsheet on google drive after respondents submit the forms. So only completed forms which already follow each step and sections of the questionnaire's forms can be submitted. This ensures the quality of the questionnaire results. The collected answers are later analyzed using SPSS software.

Respondents are given questions in 3 categories related to research problems. They are housing and mitigation, spatial planning and disaster preparedness in their living area. These questions are asked to determine how

the perception of residents of housing complexes in Baitussalam District about housing and mitigation is, spatial planning and how is condition of tsunami preparedness in their neighborhoods.

The instruments used in quantitative questionnaires are related to housing and mitigation, such as reason to choose housing location, knowledge about tsunami mitigation. About spatial planning such as whether they get information about spatial planning, people's involvement in spatial planning. About tsunami preparedness such as how disaster preparedness in their neighborhood is running and whether their neighborhood has disaster mitigation board.

The qualitative survey method is a method that aims to gain a deep understanding of human and social problems, not to describe the surface of a reality as quantitative methods do with their positivism (Mulyadi et al, 2018). Qualitative survey method was carried out in the form of interview with officials or related parties, including Head of Baitussalam District, Head of Kajhu Village, representative of housing developers, representative of General Work and People Housing Office of Aceh Besar Regency and Lecturer of Syiah Kuala University. Quantitative sample determined using purposive sampling method, where chosen sample has specific criteria, such as related or has knowledge or information about research problems. These interlocutors were chosen because they can represent the picture of condition related to research problems in Baitussalam District.

The interview questions that were given related to housing and tsunami mitigation, spatial planning and tsunami preparedness at the research location. These questions in general ask and discuss the same problems asked in quantitative survey method. The questions include how spatial planning is general, how is procedure to get permit to make housing complexes in Baitussalam, how are mitigation strategies applied or implemented in Baitussalam District nowadays. These interviews were conducted to get perspective from selected parties about the problem of this research outside of sample quantitative survey.

The data collected using qualitative and quantitative methods are primary data in this research. Meanwhile, secondary data was obtained from literacy studies from various sources related to research, such as maps from BNPB (Badan Nasional Penanggulangan Bencana) or National Board of Disaster Mitigation, Spatial Planning (RTRW) 2012-2032 of Aceh Besar Regency and statistical data from BPS (Badan Pusat Statistik) or Center of Statistic Board of Aceh Besar Regency. This secondary data is useful as an addition and complementary to this research information. These data are used for example to show the increasing number of housing complexes in Baitussalam District from time to time and to plot situation of current spatial planning in housing complexes compared to maps of Aceh Besar Regional Spatial Planning and map of tsunami hazard from BNPB.

The location of this research is housing complexes in Baitussalam District which were built in an area that was affected by the 2004 Aceh tsunami disaster. Baitussalam located in northeastern side of Banda Aceh, capital city of Aceh Province. Geographically it is located at 5°34'38" N - 5°37'13" N and 9°521'20" E



Most respondents in this study had a high school/MA degree, 56%, followed by a bachelor's degree or equivalent at 29%. More than half of the interviewees in this study work as students with a percentage of 58%. Next followed by self-employed 18%, other jobs 12%. Education levels and occupations are divided into six categories. The majority of respondents lived in the research location for less than 5 years. Furthermore, 13% of respondents lived in the research location for 5-10 years and 11% for more than 10 years.

Table 1. Demographic Data of Quantitative Respondents

		Age	Sex	Education Level	Job	Duration Living on Research Location
N	Valid	100	100	100	100	100
	Missing	0	0	0	0	0
Mean		1,91	1,29	3,74	2,25	1,35
Median		1,00	1,00	3,00	3,00	3,00
Minimum		1,00	1,00	1,00	1,00	1,00
Maksimum		5,00	2,00	6,00	6,00	3,00

### ***Respondents' Perceptions of Housing Choice and Tsunami Disaster Mitigation***

Most of the respondents interviewed from the first 3 questions can be seen that they are people who come from another area in or outside Aceh or not native residents of Baitussalam District, and they did not experience the 2004 Aceh tsunami disaster. Most of them (75 percent) lived in other cities or districts in Aceh when the tsunami occurred, 12 percent live in other cities or districts outside Aceh and 2 percent of respondents live abroad. Of the small number of original residents of Baitussalam District who have lived since before the 2004 tsunami, 8 percent of them live in their own homes, 2 percent live in rental houses and 1 percent live in family homes. Most residents (84 percent) said they would evacuate if the tsunami disaster occurred, and they lived in Baitussalam. Most of the respondents interviewed currently live in rental houses (50 percent), while the rest live in their own homes (37 percent) and family homes (13 percent).

There is a small part of respondents (19 percent) who live in housing complexes that are very close to the beach (<500 m), the rest live in housing complexes that are 500-2000 m (58 percent) and more than 2000 m from the beach (23 percent). Most respondents (75 percent) did not know how high their residence was above sea level. Meanwhile, 17 percent of respondents answered that they lived in an area <5m above sea level and 8 people answered that they lived in an area between 5-10 m above sea level.

Furthermore, in the question regarding factors that influence the choice of place to live, 48 percent of respondents answered because of their own house or land, 77 percent because the rental price was low, 71 percent because it was close to work, 83 percent because of family inheritance, 58 percent because it was safe from the tsunami and 85 percent because the surrounding environment is safe.

Most residents (64 percent) felt that their current residence was in an area prone to tsunamis, but they (69 percent) also suggested that they had relatives or friends who wanted to live in the area.

Most respondents (71 percent) also answered that they knew about the causes, characteristics and impacts of the tsunami. As many as 61 percent of respondents answered that they had access to early tsunami warnings and 68 percent of respondents knew the evacuation directions if a tsunami occurred.

#### ***Respondents' Perceptions of the Aceh Besar Regional Spatial Planning***

As many as 23 percent of respondents had received socialization regarding the Aceh Besar Regional Spatial Planning. More than half (53 percent) of respondents did not know whether the current spatial planning for Aceh Besar Regency had considered the tsunami disaster.

As many as 43 percent of respondents believed the current spatial planning of Aceh Besar district was in favor of the interests of the community, 35 percent were providing protection for community livelihoods, 53 percent were considering establishing evacuation zones and routes, 51 percent were considering strengthening the preparedness of communities at risk.

Furthermore, 53 percent of respondents did not know whether the Regional Spatial Planning preparation process had involved local communities or not. Meanwhile, respondents were quite evenly divided on the question of whether they wanted to be involved in the management of planned spatial planning and participation in controlling the utilization of Regional Spatial Planning implementation, namely 33 percent yes, 31 percent no and 36 percent don't know.

#### ***Respondents' Perceptions of Tsunami Disaster Preparedness***

From the questionnaire questions in the tsunami disaster preparedness section, the respondents' answers showed a lack of tsunami preparedness in housing complexes in Baitussalam District. For example, in the question regarding village policies related to disaster preparedness, most respondents (55 to 70 percent) answered that they did not know the question regarding the existence of village policies for 5 points of village preparation for disaster preparedness. Most respondents (54 to 72 percent) also did not know whether the village where they lived had several disaster mitigation indicators such as evacuation maps, hazard maps, public education materials, tsunami emergency operations plan, public education activities, etc.

Most residents (66 percent) also do not know whether there is a disaster preparedness group in their village. Of the 20 percent who knew, 11 percent said that the group already had a decision letter from the village head. Most of these groups already have the function of disseminating disaster education, early warning, first aid, evacuation and rescue, and logistics. Most residents (66 percent) also do not know whether the village where they live has a special program related to disaster preparedness. Only 22 percent of residents knew about the program and 12 percent of residents answered they didn't know.

From quantitative questionnaire it can be concluded that people who live in housing complexes in Baitussalam district mostly know about tsunami mitigation. This results almost similar with finding by Hall (2022) where about half of respondents believed they were susceptible to a tsunami (49.8%) and that they would be able to save themselves if a tsunami occurred (48.5%). But the respondents have little knowledge about spatial planning and tsunami preparedness in their living area.

### ***Result of Qualitative Interview***

Qualitative interviews with five respondents answered the problems with this research. From the answers, it is concluded that people in Baitussalam district are not yet receiving socialization about Spatial Planning of Aceh Besar District but had received socialization about tsunami and disaster preparedness and awareness, even though it was long time ago. The result also shows that developers are already following the procedure in processing permission to build housing complexes in the research area. But according to one of respondents, not all housing complexes are built according to the plan or blueprints. There are some shortcomings in the development, such as lack of public facilities and tsunami mitigation infrastructures. The interviews show there is still lack of tsunami preparedness in neighborhood or local community in housing complexes in Baitussalam district.

## **DISCUSSION**

### ***Aceh Besar Regional Spatial Planning 2012-2032***

The Aceh Besar Regency Regional Spatial Planning or Rencana Detail Tata Ruang (RTRW) functions as a direction for spatial structure and patterns, resource utilization and regional development as well as aligning National, Provincial and Regency/City spatial planning policies. The Regency Spatial Planning also functions as a guideline in preparing the Regency Medium Term Development Plan and a guideline for preparing the Regency Long Term Development Plan.

In the Aceh Besar Regional Spatial Planning 2012-2032 Article 28 paragraph 6 (Aceh Besar District Government, 2013), Baitussalam District is included in an area prone to tsunami disasters. A total of 32.83 Ha of the Baitussalam District area is included in the protected area in the Aceh Besar Spatial Planning Article 26 as a coastal border area. The Baitussalam District area, which is included in the urban residential area according to the Aceh Besar Spatial Planning Article 39 paragraph 2, covers an area of 469.12 Ha, divided into 9 villages (Aceh Besar District Government, 2013). Therefore, when carrying out infrastructure development, including housing complexes, in this area, especially in areas designated as residential areas adjacent to disaster-prone areas, it is necessary to pay attention to spatial planning and disaster mitigation.

### ***Spatial Conditions of Housing Complexes in Baitussalam District***

Based on the research results, the spatial conditions of housing complexes in Baitussalam District, most of the construction location followed the Aceh Besar Regency Regional Spatial Planning. But there are still shortcomings in terms of specifications and completeness of public facilities and disaster mitigation. For example, there is a lack of sign to evacuation routes, local streets not wide enough for evacuation in emergency state. Minimum wide of local streets are 4,5-5,5 m (Ministry of Public Work and Public Housing of Republic Indonesia, 2023).

Currently, more and more housing complexes are being built close to coastal areas, around 400-500 m from the beach. This cannot be avoided because residents have land certificates and the right to build settlement there, according to stake holder in one of qualitative interview. This shows the need to increase

the understanding of residents in this area regarding spatial planning, mitigation and disaster preparedness. This can be achieved through outreach from the government.

From a comparison of the latest map of the Baitussalam District area in 2022 with the map of the impact of the Tsunami disaster in Baitussalam District in 2004 (BNPB, 2024), it is known that most of the housing complexes in Baitussalam District being built right in areas that have been affected by the tsunami disaster and have high risk of tsunami disaster. Therefore, disaster mitigation facilities in this area should be improved. The growth of settlements in this area implies a high risk in the event of a disaster in the future (Utami, 2021).

Looking at this result, there is also need of action from local governments to increase awareness and knowledge of people in this tsunami prone area. They need to get more information about tsunami mitigation and preparedness, besides information about spatial planning. Further cooperation between government, college and spatial, housing or public work office is needed to get these things done.

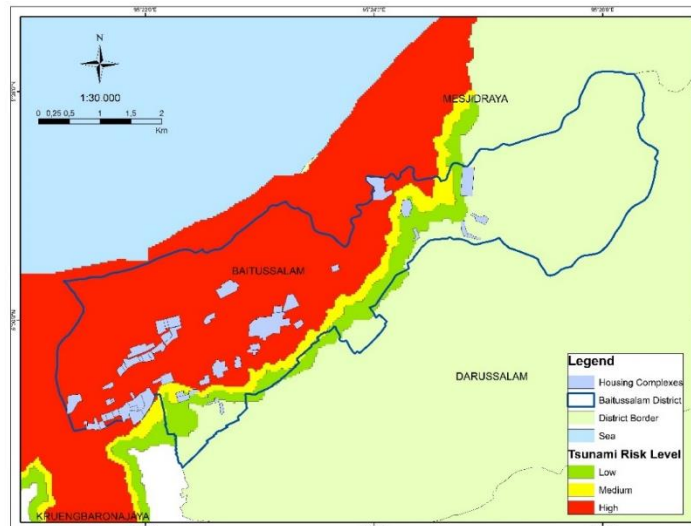


Figure 2. Comparison of research area to Map of Tsunami Impact *Perceptions of Housing Complex Residents Regarding Mitigation, Choice of Residence, Spatial Planning and Tsunami Disaster Preparedness*

Mitigation is a series of efforts made to reduce disaster risk. In this research, the focus is on the tsunami disaster. Choosing a place to live is also a form of mitigation. To avoid the risk of being hit by a tsunami, residents must choose a place to live that is far from the risk of the disaster or build houses that are disaster resistant. For most residents of housing complexes in Baitussalam District, the main factors in choosing a place to live are cheap purchase or rental prices and proximity to places of work or activities. These two factors can be found in areas that have been affected by the tsunami disaster, where land and building prices are relatively cheap when compared to areas that were not affected by the tsunami disaster. The safety factor from the tsunami disaster was only considered by some of the residents of the housing complex who were respondents to this research.

The Aceh Besar Regional Spatial Planning Plan is still quite unfamiliar among the respondents of this study. Many respondents did not know or receive socialization regarding the Aceh Besar Spatial Planning. Most respondents also did not know whether the preparation and control of the Spatial Planning had involved the community. However, some respondents believed the current preparation of the Aceh Besar RTRW had taken into consideration the interests of the community, such as protecting livelihoods and determining disaster evacuation routes.

Tsunami disaster preparedness is very important for people living in tsunami-prone areas such as Baitussalam sub-district. However, tsunami preparedness at the residential level in Baitussalam District is still lacking almost 20 years after the 2004 Aceh tsunami disaster occurred. There are still many residents who do not know about the tsunami disaster preparedness and mitigation programs that exist in the villages where they live. This is a concern that could cause many victims if a disaster occurs one day.

## **CONCLUSIONS AND RECOMMENDATIONS**

From qualitative interviews, it can be concluded that the process of building development of housing complexes in the area affected by the tsunami disaster in Baitussalam District, has followed the applicable regulations and permits. However, in the construction realization in the field there are still shortcomings that are not in accordance with the initial planning design. The spatial layout of most of the housing complex in Baitussalam District follows the Aceh Besar Spatial and Regional Plan. But most of the housing complexes are built on areas with high potential of tsunami disaster. The tsunami disaster mitigation system in housing complexes in Baitussalam District is still inadequate and needs to be improved. For example, there is still a lack of evacuation directions, local roads inside the complexes are not wide enough, lack of drainage, and the absence of permanent evacuation facilities in the local area. These things need to be improved as these housing complexes located in tsunami prone area. From the quantitative questionnaire it can be concluded that the Price factors and strategic location are important considerations for respondents in choosing a place to live. Most of the respondents had a good understanding of tsunami disaster mitigation. Some respondents believe that the Aceh Besar Spatial Planning has considered the interests of the community, but it is still less known about involving the community in its preparation. Meanwhile, most respondents still do not understand the implementation of tsunami disaster preparedness in the environment where they live.

It is necessary to improve the obedient of housing developers in implementation of regulations and supervision of the construction of housing complexes, especially in disaster-prone areas so that they pay more attention to spatial planning and disaster mitigation. Disaster mitigation facilities and infrastructure in housing complexes in tsunami-prone areas need to be increased in quantity and quality. Residents' preparations for tsunami disasters need to be improved. More education about disaster mitigation and spatial planning in disaster-prone areas needs to be done. Local governments like Head of Village

and Head of District need to do more work on this matter to increase awareness and disaster preparedness of community who live in hazard prone area. Further cooperation between the government, college and other stakeholders is needed to get these things done

### **FURTHER STUDY**

The development of residential areas in tsunami-prone coastal regions such as Baitussalam District, Aceh Besar, requires a holistic approach that integrates regulatory frameworks, disaster mitigation, and community participation. Previous research reveals that although the construction of these settlements has complied with existing regulations, field implementation still exhibits significant shortcomings—particularly in tsunami preparedness, including inadequate evacuation infrastructure, poor drainage systems, and low public awareness of disaster mitigation. Therefore, this follow-up study aims to evaluate and strengthen the tsunami mitigation system through an integrated approach combining spatial planning policies and active community engagement. The goal is to develop adaptive and sustainable solutions that not only enhance the safety of Baitussalam's residents but also serve as a reference for other vulnerable coastal areas.

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