The effect of morphology of post-tsunami coastal physiography on sustainability system of relocation settlement. Case study: Gampong Saney, Lhoong sub-district, Aceh Besar regency

W Elysa¹, ², A Fahmi³, Z Evalina¹, ³ and A Myna¹, ³

¹ Department of Urban and Regional Planning, Syiah Kuala University, Aceh, Indonesia
² Regional Planning and Coastal Development Laboratorium, Syiah Kuala University, Aceh, Indonesia
³ Urban Planning and Design Laboratorium, Syiah Kuala University, Aceh, Indonesia

Email : elywa_wulandari@unsyiah.ac.id

Abstract. Development after the 2004 tsunami in Aceh province included the relocation of housing to disaster-safe areas, and the community can continue their lives, especially in the northern and western coastal regions of Aceh. A few years after the tsunami that damaged the beach, there was a change in the physiography of the coast (growing land), so that people returned to their original activities. This paper aims to describe the changes in the management of the area and patterns of community living that adapt to changes in coastal physiography in a sustainable manner. This discussion is essential, related to the new knowledge needed as a reference for post-disaster settlement development so that the synergy between national policies and local wisdom. The Approach of the studies is interpretative phenomenological research with case studies in Gampong Saney, Lhoong sub-district, Aceh Besar District. The research method is in the form of qualitative inquiry by describing the symptoms of residence (location of housing, place of livelihood activities) and interpreting it on aspects of community life, the natural environment, and regional development factors. The results showed that relocation housing was located on a dynamic, ecologically developed hill. Regional infrastructure development has a perspective on local disaster and wisdom. Society is more sensitive to natural changes and seeks to empower. The old life is slowly reawakening to adjust to the current conditions. The observation concludes that there is a change in the pattern of settlement space, which is oriented back to the sea, and economic activity becomes more diverse between land and sea. Disasters that change the coast's physiographic have increased the diversity of natural resources and made more effectiveness to village spatial arrangements that improve the sustainability system of community life.

1. Introduction
At the beginning of the 21st century, there has been a tendency for an increase in natural disasters around the world from various causes that are allegedly due to global climate change [1]. The islands and coastal regions, especially in the third world and Sumatra in particular, are more threatened by a variety of disasters such as flash floods, landslides, storms, coastal erosion, tsunamis and so on, which cause loss and damage to coastal areas and threaten the existence of life on it [2]. In the history of the coastal geomorphology of the North Aceh region which is part of the northern tip of the Indonesian
island of Sumatra, there were several disasters that have eliminated civilizations like the city of Banda Aceh [3] and coastal settlements [4].

Aceh Besar Regency is located at the northern tip of Sumatra Island, most of its area is part of the Bukit Barisan mountain that contains with many faults, facing the Indian Ocean, and it is very vulnerable to tectonic and flood hazards [5]. Developing rural settlements are scattered around rivers, coastal areas, and hillsides that utilize natural potential as the primary source of life for their communities so that they develop as land-based traditional communities. During the 2004 tsunami, the northern coast of Aceh Besar District in Lhoong sub-district suffered severe land damage, causing many lost settlements on the beach. One of them is Saney Village in the coastal village area in the West of the city of Lhoong. See figure 1, the location of Saney Village in the geography of Sumatra Island.

![Figure 1](image_url)

**Figure 1.** (1) Aceh Province, Indonesia; (2) District of Aceh Besar; (3) Gampong Saney.

Geographically, Saney Village is one of three coastal villages in the West of the city of Lhoong, besides the Utamong Village and Gapuy Village which damaged during the tsunami. The damaged change conditions physiographically such as cape hills in the form of coconut plantations separated from the mainland into the island. The housing of Saney Village that extends on the coast is lost, and pond areas also damaged. After 15 years of tsunami the physiographic conditions relatively changed, it appears that the growth of land again, and cape hills merge back with the mainland. See figure 2 physiographic changes in the Saney Village area before and after the tsunami.
Figure 2. Physiography of Gampong Saney before and after tsunami. (1) 2005; (2) 2003; (3) 2018.

Based on the picture above, it appears that the tsunami disaster damaged the low land with the surface of the land peeling, and the hilly areas still green of trees.

In 2007, the Government relocated Saney Village about 500 m from the coast, located in the hills of Utamong Village. In terms of land ownership, the plantation is owned by the people in the three villages, so the relocation process is relatively easy. Besides that, the government also rebuild coastal areas because it is strategic for economic activities and settlements. The development occur with various patterns such as making coastal embankments and planting crops in buffer zones (BRR Report, 2010).

After 15 years of the tsunami, the coastline has seen changes in the shore that increasingly jutted into the sea, especially along the coast which has under rehabilitation. In general, the Lhoong sub-district area appears to be more fertile, and rural infrastructure is better than before the tsunami. In several developing places, some dwellings were built by the community. It seemed that the community had begun working on the newly developed land with multiple forms of activities. Based on the description of the above phenomenon, it appears that the community performs various forms of life activities in the space of the coastal region as a form of a new system of life sustainability. This paper
examines the phenomenon of changes in people's lives and spatial arrangements of the region that adjusts to the physiographic changes in coastal areas.

2. Theory review and study method
An area as a human settlement system introduced by Doxiadis as an Ecological theory, has five interrelated aspects [6], namely the natural environment system; human, social, shell, structure, and network. In traditional societies, human settlement systems develop naturally as a process of human interaction and the environment as well as space experiences in activities, so that specific spatial patterns formed. Based on these daily experiences, the creation of social work practices is in by following environmental problems, so that a sustainability system is developed in people's lives [7]. The natural environment system will always proceed to create a natural balance so that the perspective of natural disasters is a new process of balance.

The tsunami is a giant ocean wave event that hit the mainland causing the surface layer of the land to peel off and be swept away. The tsunami can damage the coastline and physiographic terrain that causes changes in landscape elements [5]. This phenomenon disrupts potential sources of life so that the area is not livable. Over time, natural processes create a new equilibrium in the former disaster area, which instead creates new living resources, with all the potential and constraints. According to Alberti and Maezluff [8], the resilience of an artificial environmental system is related to the ability to maintain human life and ecosystem functions simultaneously. Forman says that there are three critical categories of factors affecting the economy of the (urban) region that can be adopted into rural areas, namely: 1) Time, stability, sustainability; 2) spatial arrangement; 3) ecological food footprint [9].

Understanding the phenomenon of community behavior in regional space is an activity that observes, examines, and interprets the give-and-take process between humans and the environment that carried out continuously. Terrible natural disasters such as tsunamis will change demographics and social conditions so that people will return to learning about the history and character of the new natural environment. Therefore it examines community changes related to the longitudinal approach (community history and location) and the accompanying processes.

3. Discussion

3.1 Illustration of falling up SGampong Saney due to tsunami disaster

3.1.1 Gampong Saney prosperity before the Tsunami. The Gampong Saney area is a small hilly area with a bay beach. The village is a part of the West Coast region of Aceh which is at the foot of the Bukit Barisan mountain range and faces the Indian Ocean. This area is very fertile with high rainfall, so this place has high biodiversity. Communities in this region have a diversity of livelihoods including activities on land, beach, and sea, such as capture fishermen, added fishers, rice farmers, clove farmers, and seasonal fruit gardening. According to the informant, the people of this region are relatively prosperous. The evident in the design of residential houses is in Malay style dwelling. The housing environment is developing on a coastal hillside, as a traditional Aceh village that has a large house yard.

3.1.2 The impact of the tsunami on the ecological study. The tsunami that struck the village area of Gampong Saney reached about 1 km inland which removed the coast 50 meters away, damaging the sloping land and hills. According to information from the head of the local village (2018), the number of people affected by the tsunami reached 400 out of 500, leaving around 83 people with various conditions of family status, such as orphans, single families with one child, single family without children and others. The settlements above the hills was destroyed so that it was not suitable for habitation, agricultural land and aquaculture. It destroyed and eliminated the daily livelihood of the population as fisherman and farmers. The community lived in Barak for around four years, and then
came to the help of rebuilding the village area by non-governmental organizations, such as World Vision, Torch, Mamamia, and Genesis.

3.1.3 Post tsunami development and housing relocation. Capture the initial tsunami construction using the village planning approach, relocating 60 units of type 36 housing complexes with an area of 200-300 m², on a clove plantation area in the hills about 750 meters from the coast. Neatly arranged housing construction with grid space patterns and well-developed regional infrastructure makes the relocation housing area better conditioned than traditional housing before the tsunami. This phenomenon has an impact on people's mental readiness to live a better life for the future. Community optimism for the future has appeared after 15 years of the tsunami. The community develops their dwelling and plants a variety of yard plants and their residential environment.

![Figure 3. Landscape, environment and grounds condition of house relocation.](image)

3.2 Morphology of Beach Physiography and Life Adaptation Patterns
After 15 years of the tsunami, the former coastal hillside residential location reunited with the mainland. At present, the community starts to cultivate it into a cultivated plantation garden land seasonally, by building a cottage for resting, which also often stays in the garden. The mainland has grown back with lush beach plants. The community has been going to the sea with the help of boats since 2009. At the hugged beach location, the community has made it as a boat berth. In 2017, a wave protection dike was built, so that the land was increasingly protected and developed into a non-permanent boat base with a variety of fishing facilities in the form of semi-permanent buildings. Fish catch is relative surplus, so it is marketed up to Banda Aceh. This phenomenon shows the start of improving people's economic life.

The development of fishing activities in the coastal area has led to the construction of a shaft road to the old hill of the old village. This phenomenon has encouraged the growth of several houses on the side of the shaft road.

| No. | Life source | Current conditions                      | Future hope conditions               |
|-----|-------------|----------------------------------------|--------------------------------------|
| 1.  | Fishing     | A traditional fish landing place.      | It is developed as a permanent fish landing place. |
|     | a. Fisherman|                                        |                                      |
|     | b. Fishpond | Not all well organized. It has help to develop fish ponds | |

Table 1. Development of life source condition
shown an increase in yield because of the broad market prospects.

2. **Agriculture**
   a. Rice field
      - Land improved
      - Need community coaching to increase results
   b. Coconut farm
      - Start planting
      - Become a coconut-producer of region
   c. Mixed farm
      - Naturally developed, poorly managed due to a lack of population
      - The desire of the community to empower again
   d. Yard
      - Limited development, due to livestock disorders
      - Possible land intensity for various plants

The development of fishing activities in the coastal area has led to the construction of a shaft road to the old hill of the old village. This phenomenon has encouraged the growth of several houses on the side of the shaft road.

![Figure 4. Distribution of land use pattern before tsunami dan post-disaster.](image)

Based on the picture above, it appears that land use for ponds is getting wider. The garden area has reduced because it has become a place to relocate residents' housing.

3.3 **Regional stabilization process and settlement sustainability: time, space, and footprint**

3.3.1 **Basic pattern of regional sustainability.** The existence of old rural settlements has shaped the living system. The community has understood the geographical characteristics of the area beyond its residential area, namely the Lhoong area in general, which is prone to floods, storms, large waves, and landslides. Natural instability creates a secure attachment in the kinship system across the surrounding villages. The natural disasters that occur to them continue to provide life expectancy because of the willingness of other relatives to accommodate until they can rebuild their homes temporarily. After the tsunami, the government built temporary barracks around the village but did not reduce the concern
among the surrounding settlement communities. It allowed the community to work on disaster-free farms and community gardens, while the land in the settlement area was not suitable for cultivation until five years after the tsunami. This phenomenon makes possible to build the sustainability and the flexibility of the basic economic system and the livelihoods of the population, which is beneficial for the sustainability of life.

3.3.2 Post-disaster space management and ecological balance. Damage to the mainland area of Saney changed the pattern of the arrangement of the village and the surrounding area. Administratively, the relocation of Gampong Saney dwellings is included in the Gampong Utamong area where the land previously used as community clove gardens that have been under-maintained. Agricultural land can be managed again after ten years of the tsunami, the fishing boat anchorage system built after fifteen years of a tsunami after the sea wall built. Part of the area of the former location of housing began to be as a seasonal plantation agricultural land. This phenomenon shows that the community is slowly carrying out adaptation processes to create a new balance by regulating the use of regional space to create food sources. The growth in the diversity of land-based livelihoods, leading to other activities in the field of fisheries agriculture services, appears to emerge, such as for the sale of agricultural equipment and capture fishers, tool storage warehouses, stalls, cottage rest and so on. The economic function grows in two places. The first is at the fork in the road between the housing environment and the village axis road. The second is on the beach near the fishing boat mooring location which also connects to the beachside hill.

The economic center of the village seems to be developing around the village axis road, due to the location of the area surrounded by hills which causes separation from the surrounding village. Access to the main provincial road as far as 1.5 Km. In this case, the hilly landscape has functioned as a village growth control. Therefore the community builds a sustainability system independently by looking at the obstacles and potential locations. See Figure 4 in the diagram of the growth pattern of the village economic activity center below:

![Diagram](image)

**Figure 5.** Diagrammatically the concept of the future growth pattern of the economic center.

Based on the diagram above, the growth of the economic center in the junction of the relocation housing area appears to function as an entrance to the coastal area. This economic activity also serves a nearby kampong, namely: Utamong Village. Socially Utamong Village and Gampong Saney have strong ties as part of a kinship system in one settlement area (a collection of several villages).
Geographically, the surrounding hills imaginatively form the gates of the kampong area. Rice fields have been seen to be re-managed extensively, further emphasizing that this area will develop as an area with surplus rice compared to the population of the two villages.

4. Conclusion
Changes and physiographic morphology of the coastal area of the Saney area due to the tsunami have affected the life, demographics, community economy, and changes in the area's land use. Using the Forman [9] approach, the sustainability of the Saney Village area is characterized by an increase in people's lives that is affected by three things. The first is the time aspect for a long time and continuing time. There is a visible physiographic rehabilitation of the beach with embankments so that disaster can be reduced especially seasonal storms. The second is regional regulation such as relocating the housing environment which occupies the land of the former clove plantation. At this time, the paddy farming land has started to be cultivated, and the pond is maintained, while the area of the former housing area seems to be slowly developing into a new garden. The development of regional infrastructure seems to support the existence of gampong as agricultural and fishing zones with village axle to paved beaches and the construction of coastal embankments. The last is to build a foodprint with a diversity of land-based economic sources in accordance with the latest conditions. It might impact to the sustainability of the relocation community settlement system. In theory, all elements forming human settlement in Saney Village synergistically synergize to adapt to new conditions that support the sustainability of regional life

Acknowledgments
This work was supported by the grant of Urban Planning and Design Laboratory from Syiah Kuala University. This article is a study of observations when making a family trip to Lhoong District in 2018. Thank you to the head of the village of Gampong Saney, Mr. Zahrinur, and Mrs. Martini, SPd., as the guest speaker. Observation results are processed in an Urban Planning and Design Laboratory.

References
[1] Smith K and Petley D 2009 Environmental Hazards: Assessing risk and reducing disaster Routledge, London the fifth edition
[2] Elysa W 2017 Ekologi Kota Rawan Bencana Geofisik Pesisir Barat Sumatera di Kota Banda Aceh dan Padang University of Diponegoro
[3] Desi S and Elysa W 2017 The historical and religious approach towards city park design in Banda Aceh, Indonesia Case Study: Krueng Neng Park IOP Publishing 352 102062
[4] Elysa W 2016 Konsep Pengembangan Kawasan Kota Pesisir Rawan Bencana Wilayah Kepulauan, kasus: Kota-kota di Provinsi Aceh
[5] Diposaptono S and Budiman 2007 Hidup Akrab dengan Gempa dan Tsunami PT. Sarana Komunikasi Utama, Bogor
[6] Doxiadis C A 1968 Ekistic: An Introduction to the Science of Human Settlements Oxford University Press, New York
[7] Budi, F Hardiman 2003 Melampaui Positivisme dan Modernitas Kanisius, Yogyakarta
[8] Alberti Marina 2008 Advances in Urban Ecology: Integrating Humans and Ecological in Urban Ecosystem Springer, New York
[9] Forman R 2008 Urban Regions: Ecology and Planning Beyond The City. Cambridge University Press, New York