The ecological influences in forming waterfront settlements in Pangururan Sub-district, Samosir Regency.

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Abstract. The process of forming a settlement is inseparable from the influence of ecology (the natural environment) and the influence of socio-cultural (human). Natural elements, namely the sun, climate, soil topography, and human way of life are synergized mutually so that a settlement could exist and developed. Such things also apply to waterfront settlements (habitation located on the water’s edge), even though that settlements located at the waterfront could face a rather distinguish climatology issues. This study aims to learn about the development of waterfront settlements and the influence of ecology, social and cultural elements in shaping waterfront settlements in Pangururan sub-district. The research method used by researchers is a qualitative method, using observation and interviews. The benefits of this research are to find the concept of waterfront settlements based on ecology, sociology, and culture that can support the lives of people living in these settlements so that the government can apply the concept in various regions that have the same environmental conditions.

1. Introduction
Ecological elements such as climate, water sources, sunlight, and soil must be considered in forming a settlement. Settlements always begin from areas around water, such as lakes, rivers, and seas [8]. The reason is that water is a very important source of life to maintain human survival. Also, the social and cultural elements of the community living in the settlements also influence the formation of the physical environment in these settlements. Pangururan is one of the sub-districts in Samosir Regency, North Sumatra Province, Indonesia. The topography of the Pangururan Sub-district generally consists of slopes and hills, so that it becomes a challenge for the Pangururan community in building settlements and maintaining their survival. The Pangururan Sub-district area is divided into 28 villages, of which 20 are scattered along the outskirts of Lake Toba. Meanwhile, there are eight other villages located on the hill.

Based on these factors, the topic of ecological influences in forming waterfront settlements in Pangururan sub-district becomes significant to find out how did ecology, social and cultural elements such as climate, water sources, wind, sunlight, and humidity took part in forming waterfront settlements in Pangururan sub-district both directly and indirectly. And also, the influence of social activities and Batak Toba Culture in forming waterfront settlements in Pangururan sub-district. Research limits for social and cultural influences of Batak Toba include livelihoods and norm values found in the community.

2. Literature Review
According to Frick (2006), in ecology, there is a mutual relationship between the organism (humans, animals, and plants) and their environment which includes sunlight, temperature, rainfall, humidity, and topography [1]. Frick states that there is a connection between the elements of the natural environment with these organisms. In the context of settlements, natural elements have a role in forming settlements. These natural elements are sunlight, temperature, rainfall, humidity, and topography. At the same time, the existence of settlements also had an impact on nature.

The theory is supported by Yohanes (2013) which states that settlements on the face of the earth were not formed practically, settlements could be formed because they were influenced by two factors, which are environmental factors (ecosystems) and human social systems [6]. The environment can be either natural or artificial. The natural environment in the form of contours, rivers, lakes, forests, and sunlight while the artificial environment in the form of building mass and accessibility systems. Meanwhile, the social system includes livelihoods, the way of life in the community, the interaction between the community and the culture. Both of these, social and environmental systems form synergies so that a settlement could exist and developed.

In the process of forming a settlement, humans must be very concerned about natural factors, for example in terms of building a house, the condition of the land is very important because the construction system of houses built near water settlements will be different from houses built on hills. Also, the source of water and sunlight is also considered, because they are related to the livelihoods and ways of life of humans in the environment. About unplanned settlements, the influential ecological elements are (1) water bodies, such as lakes, rivers, and seas, affecting livelihoods, building orientation, and home typology. (2) sunlight, influencing orientation building. (3) contours, affecting the typology of houses. (4) forests, natural ecosystems that contain abundant natural resources, one of which is wood, which is a building material, so that forests affect the typology of houses.

In the study of the theory above, it has been mentioned that in addition to the physical environment, social and cultural systems are also influential in forming a settlement. According to Marwasta and Priyono (2007) The better the social and economic conditions of a community, the better the type of settlement [2]. In the context of the formation of settlements, the socio-economic element is the livelihood and way of life of the community (culture). The need for material (money) is something that cannot be avoided by every human being, so the higher the income of people living in these settlements, the better the settlement. Meanwhile, the majority of the Batak Toba tribe people who live on the banks of Lake Toba choose their livelihood as fishermen and farmers due to the location of settlements that are close to Lake Toba. Therefore this also affects the condition of the Batak Toba tribal settlement.

Marpaung and Alip (2009) say that a group of people who settled in an area will form settlements [7]. In the process of living, the community certainly would develop a certain way of life. The unique way of life of the community is called Culture. The way of life of the community is revealed in the form of values and norms that are understood and applied by the community in daily life; hence, it becomes a habit. Meanwhile, according to Antariksa (2010), there is a correlation between history, social activities, and cultural systems in forming settlement patterns [3]. In addition to the theory, Setiawan (2010) describes the settlements of the Batak Toba tribe as follows: (1) Houses are built in one row and face to face. (2) between the two rows of the house, there is a sacred field [4].

Social and cultural activities are religious and family events. For example, the Batak Toba tribe people who live in the sub-district of Pangururan and its surroundings. The Batak Toba tribe has several cultures (ways of life) that are derived. One of them is a culture of gathering with close family, which is usually held on the field. The field is considered sacred to the community because it has cultural values. The Batak Toba community always carries out traditional ceremonies in the field. Thus, the existence of a field that has these cultural values indirectly affects forming Batak Toba settlements. Based on these theories, the researcher concludes that Social and Batak Toba culture can influence the form of settlements by: (1) In terms of Social, livelihoods also form the pattern of community settlements, because the economic level affects the quality of settlements, (2) in terms of
culture, the way of life and habits of the community can also influence the form of settlements, for example, the existence of traditional ceremonies that must be held on the field. Consequently, the existence of a field inside the settlement is compulsory.

3. Methodology

This study used a qualitative descriptive approach, in collecting data researchers conducted observations at the research site and brief interviews with the community. In determining the location of the study, the researcher chooses locations with the following criteria: (1) The research location is a growing waterfront settlement, (2) Research locations are integrated with the surrounding natural environment, (3) The research location has a social and cultural system that can traced and influence the form of settlement. In this case, waterfront settlements located in Pangururan sub-district have met these criteria. The process of determining the variables is obtained from the interpretation of the literature review. Meanwhile, the research variable is the basis of the object of observation. The variables obtained from the results of the study of the theory of ecological influences in forming waterfront settlements are: (1) the natural environment can influence the way of life and living place of living beings, (2) environmental factors and social systems can affect settlements. The data needed from the two variables are (1) influence of Sunlight, (2) Existence of Lakes and Mountains, (3) Topography of the land, (4) Direction of Wind. Therefore, observations and brief interviews were conducted by researchers to obtain the data.

Furthermore, the variables obtained from the results of the study of the theory of social and cultural influences in forming waterfront settlements are: (1) the social and economic systems of the community play a role in the quality of settlements, (2) the way people live in a settlement The particular culture contained in a society has an impact on the form of settlement indirectly. Therefore, the data needed for these variables are (1) community livelihoods, (2) conditions of community settlements, (3) Culture in settlements that affect the form of settlements. The data collection methods are brief interviews and observations.

4. Results and Discussions

4.1 Influence of the State of Nature in Establishing the Physical Waterfront Environment in Pangururan Sub-district

Every settlement created in any part of the earth has its uniqueness because the creation of a settlement is influenced by ecological factors, social activity factors, and cultural factors [6]. Ecological factors related to natural elements which certainly have significant differences from one place to another. Climate is one of the natural elements that are very concerned by humans when they first build a house. With the unique climate of a place, humans build a house that could solve problems that arise from the climate. Thus, climate as part of the ecology can affect the shape of the physical environment of a settlement. In this sub-chapter, researchers will discuss and analyze how the influence of ecological factors on the waterfront environment of Lake Toba, namely sunlight, soil topography, and the presence of lakes or mountains on the physical form of the environment, which includes building orientation, building location and settlement.

4.1.1 Study of Sunlight Facts in Establishing Building Orientations and Residential Areas

In architectural ecology, the ideal orientation of buildings is in the direction of East and West, at the same time located perpendicular to the direction of the wind, namely North and South [1]. Buildings that follow this orientation benefit more in terms of environmental quality. Traditional communities of the Batak Toba tribe in ancient times have noticed the natural conditions in which they live. Thus, the community tries to implement the facts of the natural conditions into traditional buildings. This can be seen from the arrangement of buildings located within the traditional settlements of the Batak Toba tribe.
Sialanguan Village
The influence of the position of sunlight on one of the villages found in the village of Sialanguan led to the orientation of four-square buildings facing East and West (Figure 1). Buildings with these positions standing on the ground lined up north and south. One row of house buildings lives side by side with a row of other residential houses forming an outer space-oriented towards North and South. Yohanes (2013) states that settlements on the face of the earth are formed because there are influences of environmental factors (ecosystems) and factors of human social activities that live in them [6]. In terms of placing the position of a house on the shores of Lake Toba, the inhabitants of the village are very concerned about the environment, namely the direction of the sun. The ancient Batak Toba tribe community realized that the East was the direction of the sun's rising. Hence it was implemented into the building by building houses in the East and West direction. This is parallel to the building orientation affected by sunlight theory [1].

The impact of sun rise direction caused the pattern of building, it lined up in a row while facing East and West.

Figure 1. The Influence of Sunlight on The Settlement

4.1.2 Study of Wind Direction in Establishing Building Orientations and Residential Areas
The process of forming a waterfront settlement in Pangururan sub-district is significantly influenced by natural conditions. Settlements located on the edge of the water can experience significant weather...
changes every time because the waterfront environment is located between the land element and the water element. Therefore, people living on the water’s edge must be able to adapt to natural conditions well, ranging from daily life activities to the process of forming a settlement. One of the natural conditions that can affect a settlement located on the edge of the water is Wind. Frick (2006) states in architectural ecology, residential buildings should have a direction perpendicular to the direction of wind flow, which is the direction of North and South [1]. Meanwhile, the water edge environment of Lake Toba is traversed by the wind with an average speed of 10 kilometers/hour with the direction of movement from South to North [9]. Traditional communities of the Batak Toba tribe were aware of the facts of these natural conditions since ancient times. Therefore, the buildings in every traditional settlement of the Batak Toba tribe located in Pangururan Sub-district is perpendicular to the direction of the Wind flow.

Huta Bolon Village

Huta Pardamean is one of the Huta (kampung) located in the village of Huta Bolon. There are nine residential buildings (Figure 2) inside Huta, five of which are traditional Batak Toba tribal buildings, while the other four are non-traditional buildings. Five traditional buildings stand in a row in the west, while four non-traditional buildings are located in the east. The two rows of houses are separated by approximately 10 meters, thus forming a large courtyard oriented towards the North and South.

Wind (Figure 3) with an average speed of 10 kilometers/hour in Pangururan sub-district which generally blows from the south to the north [9]. In the presence of winds through these traditional settlements, the community creates a large field. Hence, it creates a positive air circulation in the settlements.
4.1.3 Study of Topographic Condition in Determining Position of Residential Area

The topography condition in Pangururan sub-district is a challenge for the ancient Batak Toba tribe in building settlements. Pangururan Sub-District (Figure 4) has different land contours for each village. It caused several villages located on the edge of the water had significantly different heights and slopes. However, this does not prevent settlements from appearing even in extreme terrain. What needs to be studied in this sub-chapter is how do topographic conditions and soil contours influence the Batak Toba tribe to determine the position of the residential area.

Figure 3. The Influence of Wind Flow to Building Orientation and Living Space
Pardogul village

Pardogul village (Figure 5) has a contour of land that tends to be flat (parallel to the surface of the lake Toba). Based on the observations from researchers, the waterfront villages in Pangururan sub-district with flat topography conditions tend to have denser settlements, more varied buildings, and very wide paddy fields. In contrast, villages with contoured land tend to have lesser settlements and paddy fields. This is related to the selection criteria for a location to be used as a settlement. Priyono (2009) states that topography, altitude, and natural resources are environmental factors that are the main criteria in choosing a settlement location [2]. The topography and altitude of the site are related to the accessibility of an area. These two factors, accessibility and availability of natural resources mutually support the forming of a settlement.

Pardogul village has a flat topographic condition (slope of 10%) which tends to be flat with Lake Toba and has natural resources in the form of abundant springs. These conditions make the village of Pardogul an ideal place for a settlement to develop. The topography of Pardogul Village, which has a slope of 10% allows the development of a variety of buildings, such as hospitality near Lake Toba. Also, there are also extensive paddy fields close to people’s settlements.

Figure 4. Contour Key Map of Pangururan Sub-District
Study of the Existence of Mountain or Hill in Determining Building Orientations and Residential Areas

One of the facts of the natural/environmental conditions that the Batak Toba tribe considered in building a settlement was the existence of the Mountain or Hill. According to the results of interviews of researchers with several dwellers who inhabited the villages in the research site, it was found that there was a belief that developed in the community, where the Batak Toba tribe always built houses oriented towards Pusuk Buhit (Figure 6). Pusuk Buhit is a mountain located to the west of Pangururan Sub-District.

The reason is that Pusuk Buhit is considered very sacred to the Batak Toba tribe community. According to folklore revolving in Pangururan, Pusuk Buhit is believed to be the origin of the emergence of the Batak Toba Tribe. Parallel to the statement, Setiawan (2010) also said that the Batak
Toba tribe building was oriented towards Pusuk Buhit because Pusuk Buhit was considered a Qibla for the Batak Toba tribe.

Sialanguan Village

One of the traditional Batak Toba villages located in Sialanguan Village (Figure 7), namely Situngkir village, was built oriented towards Pusuk Buhit. Situngkir village located on the East side of the main road consists of 10 buildings, with six houses facing West, and four houses facing East (Pusuk Buhit). According to information from the interviewees who was one of the descendants of the King in the village, every traditional village of the Batak Toba tribe always had one King's house. The King's house is said to be the largest house in the village and was first built when a village was formed. Furthermore, the descendants and relatives of the King can gather together and build a residential house facing each other in the area to create traditional villages as we can view today. It was said that the first built King's House was oriented towards Pusuk Buhit.

Setiawan (2010) states that the traditional village of the Batak Toba tribe is always built with an orientation towards the nearest hill or mountain [4]. The traditional village of the Batak Toba Tribe, located in Pangururan Sub-district, is flanked by one Mountain, namely Pusuk Buhit in the West and Bukit in the east of Pangururan Sub-district. The researcher concluded, the traditional community of Batak Toba tribes in the past did build settlements oriented towards hills or mountains, where a row of houses on the right facing Pusuk Buhit mountain, while a row of houses on the left facing the Hill in the east. This can be seen clearly in any traditional village in Pangururan Sub-district, starting from Kampung Situngkir in Figure 7.

![Location of Pusuk Buhit](image-url)
4.2 Study of the Impact of Social and Cultural Activities in Establishing Waterfront Settlements

According to Marwasta and Priyono (2007), social activities are closely related to the conditions of settlements, where the better the condition of a society's social activities, the better the quality of settlements [2]. In this case, the intended social activity is community livelihood. Meanwhile, according to Marpaung and Alip (2009), culture is the result of a way of life that is inherited from generation to generation, so it becomes a habit [7]. Both of these, livelihoods and cultures that develop in the community are factors that influence the shape of a settlement. In the context of this research,
the majority of the population is in the waterfront environment of Pangururan Sub-district, Batak Toba ethnicity. The traditional Batak Toba community living in Pangururan Sub-district highly upholds cultural values, so that it also contributes to various aspects of daily life, one example being the traditional form of a community settlement.

4.2.1 The Influence of Community Social Activities in Forming Waterfront Settlements

There are various kinds of community activities, but activities that are important in influencing the growth of settlements in the Pangururan village on the edge of the water are livelihood activities. Most of the people living in Pangururan Sub-district have livelihoods related to water sources (Figure 8).

![Fishing Activity](image1)

![Paddy Field](image2)

**Figure 8. Social Activities of Resident at the lake side**

The location of settlements on the edge of the water allows residents to work as fishermen and farmers. As for the other types of work the community in this village is as an inter-island crossing service provider. Community social activities, namely livelihood activities are one of the factors that make up the waterfront settlements. Yodsurang and Yasufumi (2016) stated that fishing activities are important and must be carried out by people in the waterfront environment [5]. According to researchers, this is still based on the fact that water is a very important resource, hence people who live in the waterfront environment should make the best use of these resources. Meanwhile, Antariksa (2010) states that there is a correlation between history, social activities, and cultural systems in forming patterns of community settlements [3].

These three factors, namely history that exists and develops, social activities and culture of a society are factors that can influence the form of a settlement. The traditional social activities of the Batak Toba tribe, namely the activity of earning a living related to water bodies indirectly affects the orientation of residential buildings on the water's edge. Community residential areas that have fishermen's livelihoods or those related to water (Figure 9) tend to be close together and face Lake Toba.
Figure 9. Social activity of Resident Influences the Orientation of Building
4.2.2 The Influence of Community Culture in Establishing Waterfront Settlements

In general, traditional settlements of the Batak Toba tribe found in Pangururan Sub-district have the following characteristics: (1) there is a large and flat land, with two rows of houses facing each other. (2) The two rows of houses are separated by approximately 10 meters, thus forming a large yard that extends north and south. Both of these characteristics are rules derived from the culture of the Batak Toba tribe. Although not all traditional settlements have these characteristics, the Batak Toba people always try to implement these rules when building a settlement. According to the results of interviews with several communities living in the Sub-district of Pangururan, in a traditional Batak Toba village, there is always a King's house. The King's house (Figure 10) has different characteristics from the houses in the village. In terms of size, Rumah Raja has a wider façade and is higher than in other houses.

Based on the researchers' interviews with local leaders, the flat land that was used as the location of the settlement was granted if there were two Batak Toba tribes who were married. The land was granted by the Men to the families of the Women. Next, the two families worked together to build a King's House. The Batak Toba tribe community highly upholds cooperation and family culture. After the first house in the village was completed, a new settlement was created by two families who had formed the bond. The family culture of the Batak Toba tribe is also implemented into daily life in settling so that the houses in the villages are built in line and facing each other to strengthen family relations in the traditional Batak Toba village. Furthermore, the broad field (Figure 11) which is located between the two rows of houses is also formed because there are cultural elements. The field has several functions, namely as a place to dry the crops of the community, as a gathering venue and place for traditional events to be held, as well as the place for the ceremony to farewell people who will travel.

Marpaung and Alip (2009) stated that a group of people who settled in an area would form settlements [7]. Thus, the community will certainly develop a way of life. The way of life is carried out constantly to become a habit. These habits will be passed on to the next generation to become a culture. The culture that developed in the community is a result of the habits carried out by the Batak Toba tribe since ancient times. The desire to strengthen family relations in an environment has resulted in people building houses that are close together. The culture of kinship and cooperation has continued for several generations to create a settlement pattern that appears today, namely a row of houses facing each other. The impact of these cultural influences is that each individual in a village certainly has a relationship with other individuals.

The existence of a gathering culture to strengthen family relationships also influences the traditional settlement patterns of the community. Communities need a place that can accommodate various activities and functions. Therefore, there was a large field that lay between rows of houses facing each other. Through this field, a culture of gathering together in the traditional community of
the Batak Toba tribe can be carried out. The community can hold customary and religious events on the field.

![Figure showing residents using the field](image1)

Local works as ulos craftsmen. Figure shows a resident make use of the field as a working space.

![Figure showing residents using the field](image2)

Residents make use of the field as a gathering and socializing space.

![Residential field as an activity space](image3)

Residential field as an activity space

**Legend**
- Tree
- Non Traditional House
- Paddy Field
- Traditional House
- Location Description
- Main Road
- Environment Road

**Figure 11.** Field as Social Activities and Cultural Space

**Findings**
Based on the discussion above, the researcher obtained several findings. It is known that the direction of the movement of the sun has an impact on the building, which is, the building stands in line with the orientation of East and West. Furthermore, the wind that blows in Pangururan sub-district also
influences the orientation of buildings and residential areas. The community builds dwellings perpendicular to the direction of wind flow, namely North and South. In terms of residential areas, there are large courtyards in traditional settlements that are rectangular in shape oriented towards North and South. With the existence of this field, the air circulation in the village becomes clean. Thus creating a positive space in the middle of the village. Traditional communities of the Batak Toba tribe since ancient times were very concerned about both the facts of the natural conditions in creating a settlement. Hence it can be said, traditional settlements located in Pangururan Sub-district are built with ecological concepts.

Furthermore, the topography of the land is the criteria for the selection of residential areas for the people in Pangururan Sub-district. Locations that have a slope of 10% tend to be more attractive to the community to be used as residential and paddy fields, because of the ease of access towards the location. Meanwhile, locations with land slopes above 10% are very difficult to reach so that the people of Pangururan Sub-district are not interested in being used as residential areas. Then, the existence of lakes and mountains or hills also affects the orientation of buildings in traditional settlements. The Batak Toba tribe community always builds a residence oriented towards the nearest Mountain or Hill. In line with this, traditional settlements located in Pangururan Sub-district are located between Mount Pusuk Buhit in the West and the Hills in the East. Therefore, residential buildings located in traditional settlements always face Mount Pusuk Buhit and the Bukit. In terms of social and cultural activities of the community, it is found that the social activities of the community can indirectly influence the orientation of the community’s occupancy. Most of the people in Pangururan Sub-district have a livelihood as fishermen or farmers. For people who make a living by fishing, residential buildings tend to be closer and face Lake Toba. Meanwhile, the culture that develops in the community will be implemented in daily life and affect the residential area. With the culture of gathering together, the community in the village needs space to carry out this culture, so that the existence of a large field becomes mandatory in traditional villages.

5. Conclusion
The natural environment in Pangururan Sub-district plays a role in the formation of settlements. The impact of the direction of the sun influences settlement patterns, where buildings in settlements are arranged in a row and face to face. A row stands in the East, while another row stands in the West. The state of the land topography is also very much considered by the Batak Toba tribe in terms of choosing a residential area. The researcher found that people tend to choose areas with flat topography and less contoured conditions to be used as residential areas and rice fields. Meanwhile, the area that has a flat topographical and the highly contoured topographical condition tends to be less attractive to the community to become a residential area. This is related to the selection criteria for residential areas, where the topography of the land is very important [2]. The condition of land topography is related to accessibility because the area that has a contoured land is very difficult for the community to reach. The wind direction in Pangururan sub-district also plays a role in creating residential areas in Pangururan sub-district. The traditional community of the Batak Toba tribe maximizes the function of the natural state by creating a large field thus it creates an open space and well air circulation in the settlement. Furthermore, buildings in the traditional settlement of Pangururan sub-district tend to be built oriented towards the nearby Mount Pusuk Buhit and Bukit.

The majority of the people living in the waterfront area of Pangururan sub-district choose their livelihood as fishermen or farmers. The impact is the residential area inhabited by people who earn their living by fishing to be oriented towards Lake Toba. The culture of gathering together and working together is highly respected by the Batak Toba tribe. The community needs a space (place) to carry out this culture so that the existence of large courtyards in settlements becomes important in the life of community settlements in Pangururan Sub-district.

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