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Local wisdom of *Aek Latong* society for mitigation and adaptation of soil movement disaster in North Sumatra, Indonesia

Zainal A Haris^{1,2}, Agus Irianto¹, Heldi¹, Dedi Hermon³ and Yulnafatmawita⁴

¹ Department of Environmental Science, Post Graduate Program, Universitas Negeri Padang, Prof. Dr. Hamka Street, West Air Tawar, Padang-West Sumatera 25131 Indonesia

² Universitas Putra Indonesia, Lubuk Begalung, Padang Indonesia

³ Geographical Department, Universitas Negeri Padang, Prof. Dr. Hamka Street, West Air Tawar, Padang-West Sumatera 25131 Indonesia

⁴ Soil Science Department, Andalas University, Limau Manis, Padang Indonesia

*zainalabdulharis@yahoo.com

Abstract. Lately, due to advance technology, some of natural disasters could be forecasted, therefore the people can decide where to go to avoid the disasters. However, people in *Aek Latong* North Sumatra did different thing. They just stayed in their villages or regions without moving to anticipate the impact that might happen. This research was aimed to identify the local wisdom of *Aek Latong* society in facing, mitigating, and adapting the disaster, especially soil movement disaster in their region. This research was conducted through 3 steps (preparation, main survey, and data analyses). At the first step (preparation) was conducted to get secondary data about *Aek Latong*, such as geographical position, natural condition, type of natural disaster, society and the tradition. The second step (main survey) was conducted by directly interviewing the people in *Aek Latong* how they face, mitigate, and adapt the disaster happening. The third step was data analyses. Based on data resulted, *Aek Latong* society has a strong belief inherited from their ancients that everything come from the almighty God, therefore they have to face it. They believe that God has specific purposes to do so for them, they do not have to easily give up. Then, they also mitigate and adapt the disaster by earlier checking the signs of disaster and following the advice given, besides they did not construct building and do farming activities in sloping area and in the river bank. It could be concluded that *Aek Latong* society was able to face, mitigate, and adapt to the natural disaster in their region by their belief, knowledge, as well as by following the advice given.

1. Introduction

Indonesia is known as a multiethnic and multicultural country. There are hundreds of original ethnics living in Indonesia, one of which is Batak ethnics living in North Sumatra Province. This ethnics is considered as very strong and very brave toward living challenges. There are many Batak people going away from their hometown to look for some jobs without any knowledge, but they just put their hope into their strength.



On the other hand, Indonesia is considered as a country getting many disasters along the year, either natural or man-made disasters. Sumatra is an island having many disasters, this is due to the fact that it has an a geological fault across the island from the north (Aceh Province) to the South end (Lampung Province). Therefore, potential natural disasters that can happen among which are soil movement under soil surface (tectonic process). This soil movement will cause earthquack, soil surface dislocation, soil surface reduction or subsidence, and some others. One of areas in Sumatra island having high soil movement is *Aek Latong*, North Sumatra Province, Indonesia.

The area being affected by soil movement in *Aek Latong* was about 60% of the total area of 5.42 km² [1]. This location is considered as an area (\pm 60%) having highly susceptible soil movement. This is due to the geologic factors, such as topography. This condition actually had been mapped, however, it was not yet used as an basic information in building either some infrastructure such as streets, bridges, green space, or for other public infrastructures.

Indonesian Government Law No. 24, 2007 [2] on Natural Disaster Control defined disaster as a series of events affecting society life either due to human itself or nature around them causing death, environmental damage, loss of materials, and psychology impact. Disaster is simply defined as a result of hazard due to earth quake, taifun, landslide, meet the vulnerable condition in a community. Main component of disaster is due to interaction between vulnerability and hazard.

Land sliding happens if a movement force is higher than the resisting force. The last force is determined by the the strength of the lithosphere as well as the soil solidification. Slope, water, burden, soil or rock densities affect soil movement force. Landsliding is a kind of soil movement.

Based on planning guidance for landslide susceptible area in 2007 [2], process accelerating landslide was due to water absorption during heavy rainfall and steep slope. The water absorbed was accumulated above the sliding area causing the soil above the area easy to slide down. Furthermore, land slide is also caused by slope instability.

Generally, land slide is caused by 2 factors, controlling and enforcing factors. Factors controlling soil movement is divided into 2 parts, natural (geology, slope, and vegetation condition) and non-natural (especially drainage canal, buffer building and hill, as well as terracing). Factors enforcing land slide are rainfall, steep slope, unstable and thin soil profile, less lithosphere strength, land use planning, tremor, water surface reduction of lake or water body, overburden, erosion, accumulated materials on sloping area, ex landslide, forest clearance, or geology discontinuity, or waste accumulation place [3].

Mitigation conducted on natural disaster could be done through some steps. Somantri (2008) [4] explained some steps of mitigation could be mapping the susceptibility level of the disaster, study the cause and effect of the disaster, identification the process happening during and after disaster, monitoring on susceptible regions especially on strategic areas, and socialization of the disaster and the impact to government or society in the specific regions through poster, booklet, leaflet, or directly through road show.

Lately, natural disasters going to happen can be predicted by using sophisticated information technology. However, *Aek Latong* society still keeps the local wisdom inherited by the ancestors. The local wisdom given and taught by the parents is in form of knowledge, the way of comprehending and acting on each disasters. What types of local wisdom being kept by the *Aek Latong* society are interested to study.

2. Research Methodology

This research was conducted by survey method through 3 steps from January to July 2018. The first step was preparation by collecting secondary data (map, rainfall, lithosphere, soil types, land use types, soil movement zones) from literatures and news. The second step was survey by visiting the location to collect primary data (the way of *Aek Latong* society to face, mitigate, and adopt the soil movement disaster) through qualitative-descriptive approach in May 2018. Some of the society and the heads of the tribes were interviewed about the natural phenomenon happened in their area. They were asked on

what kind of natural disasters they have, how they act during the disasters, how they anticipate, and how they adapt the condition after the disaster. The third step was data analyses and writing report.



Figure 1. Impact of soil movement in *Aek Latong, Tapanuli Selatan, North Sumatra Province*



Figure 2. *Aek Latong Village Area, Tapanuli Selatan, North Sumatra Province*

3. Results and Discussion

3.1. Research Site

Location of the research was in Aek Latong village, South Tapanuli Selatan Region, North Sumatra Province, Indonesia. This village is an area being passed by cross country road in Sumatra island, especially from Medan toward West Sumatra, Riau, Jambi etc. However, the soil is very susceptible to degradation especially during rainy season. This is due to the topography of the area having steep slope. In 2000, a natural disaster happened on which the village of Aek Latong was collapsed and the people houses were felt down (Figure 1). The phenomenon is called “Suhul” (gempa) by the society. The frequency of the “Suhul” phenomenon increased by time.

3.1.1. Lithosphere and Soil Order. Lithosphere in North Sumatra Province was dominated by Bahorok and Toba tuff, alluvium, and Klue and Kuantan formation. Bahorok formation was dominated by brecci conglomerate rocks which formed Lithosol at the first step, and then Podzolic soil as they were extensively weathered. Conglomerate materials formed Regosol having medium to coarse textured soil. Toba tuff formation was dominated by volcanic ash which developed into Andisols. This soil has fine to coarse texture. Alluvial landscape found along the east coast formed Alluvium, Regosol, Organosols. Klue and Kelantan formation dominated by sasak, tubidite, sand, and gamping stones formed Lithosol, Podzolic and Lithosol having generally coarse soil texture. Other soil types found in this area were Ultisol (16.35%), hidromorphic, glei humic, and Regosol (11.54%) [5].

3.1.2. Slope. It was about 50% of the research site having mountainous topography which lied down between 800-1,915 m above sea level with $> 40^\circ$ slope [1]. The research area as a whole was a a-steep high land. If there was a flood disaster, then it used to be followed by landsliding phenomenon. The classification of slope in North Sumatra Province is presented in Figure 3.

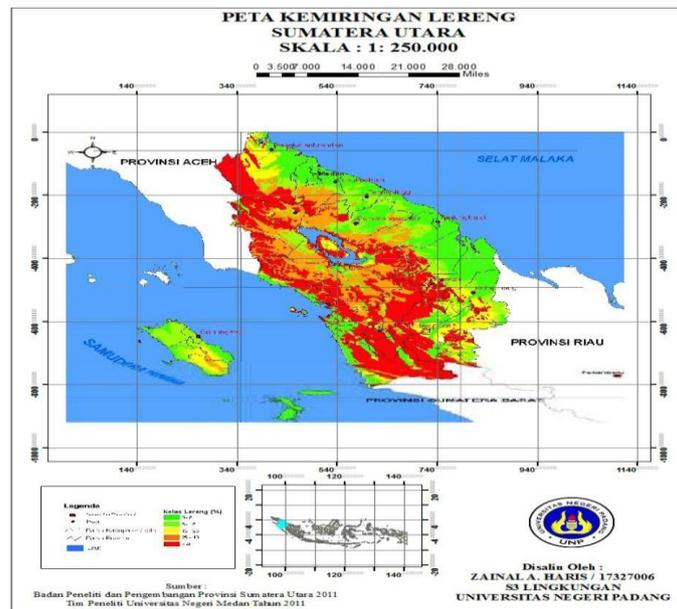


Figure 3. Slope degree of North Sumatra (Source: Research and Development Institute of West Sumatra Province)

Based on Figure 3, approximately 50% of North Sumatra Province has steep slope (red color). An area having steep slope was very susceptible to degradation, especially under wet region. As found by Yulnafatmawita *et al* (2013) [6] that the steeper the slope was the higher soil loss due to water movement (erosion) under super wet tropical region in West Sumatra.

3.1.3. Land Use. Land use in Aek Latong region is divided into residential, agricultural (seasonal crop farming, plantation), and public facility (road/street, drainage) types of land use [1].

3.1.4. Geological Structure. Geological map of Aek Latong region in Sipirok Subdistrict is presented in Figure 4. Due to some cracks formed after earthquake, water is easily getting into the rock system causing the rocks are intensively weathered. This causes the geological formation becomes soft and easily moved as the small force is performed. Therefore, the soil movement is readily happened in this region. Based on Table 1, the total rainfall received by Aek Latong region was approximately 2,625 mm/y, with the difference between the driest and the wettest month was 171 mm. The variation of temperature was 0.9°C along the year. According to Smith and Ferguson (1959) [7], the climate of Aek Latong is classified into Af (=very wet). Sloping area under very wet climate is highly susceptible to degradation, especially if the land is not managed based on conservation rules.

3.1.5. Demography of Aek Latong. Based on survey conducted, Aek Latong is a sub-sub district in South Tapanuli Region, North Sumatra Province. In 2014, Aek Latong had 237 people, with low education level. Almost half (46%) of the society was just elementary school, 25% was uneducated. There was only 29% having junior and senior high school degree, and there were only 2 people having bachelor degree. According to their occupation, there was 80% of family working as farmers, the rest were as pensioners and the civil servants, non-government job, as well as non-job people. The majority of the society is moslem [8].

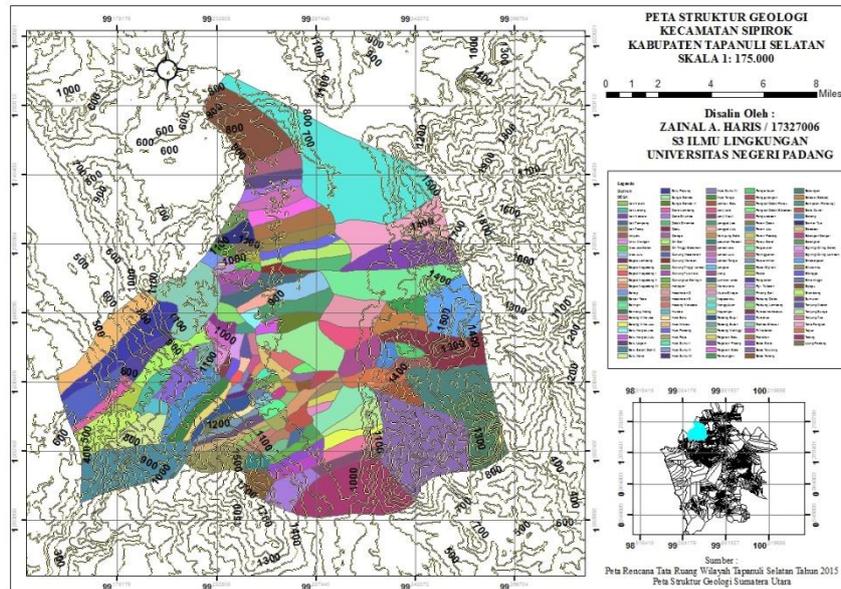


Figure 4. Geological structure of Sipirok, Tapanuli Selatan Region (Source : *Elevation Analyses of North Sumatera Province, 2010*)

Table 1. The climate condition of Aek Latong*

Parameter	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Avg. Temp (°C)	22.5	22.5	22.8	23	23	22.4	22.2	22.1	22.1	22.1	22.3	22.3
Min. Temp (°C)	17.1	17	17.5	17.9	17.8	17.1	16.9	16.9	17.2	17.5	17.6	17.4
Max. Temp. (°C)	28	28.1	28.2	28.1	28.2	27.8	27.6	27.3	27.1	26.8	27	27.3
Avg. Temp. (°F)	72.5	72.5	73.0	73.4	73.4	72.3	72.0	71.8	71.8	71.8	72.1	72.1
Min. Temp. (°F)	62.8	62.6	63.5	64.2	64.0	62.8	62.4	62.4	63.0	63.5	63.7	63.3
Max. Temp (°F)	82.4	82.6	82.8	82.6	82.8	82.0	81.7	81.1	80.8	80.2	80.6	81.1
Precip. (mm)	247	217	263	280	179	125	115	152	208	276	277	286

Source: *Iklm Aek Latong*

3.1.6. *Zone of Soil Movement in Aek Latong.* Based on evaluation conducted toward slope, lithology, geological structure, and land use planning, Aek Latong in Sipirok subdistrict was classified as an area having high soil movement, with the scoring data were 22. Zone map of soil movement in Aek Latong is presented at Figure 5. Based on Figure 5, all part of Aek Latong area is considered susceptible on soil movement disaster.

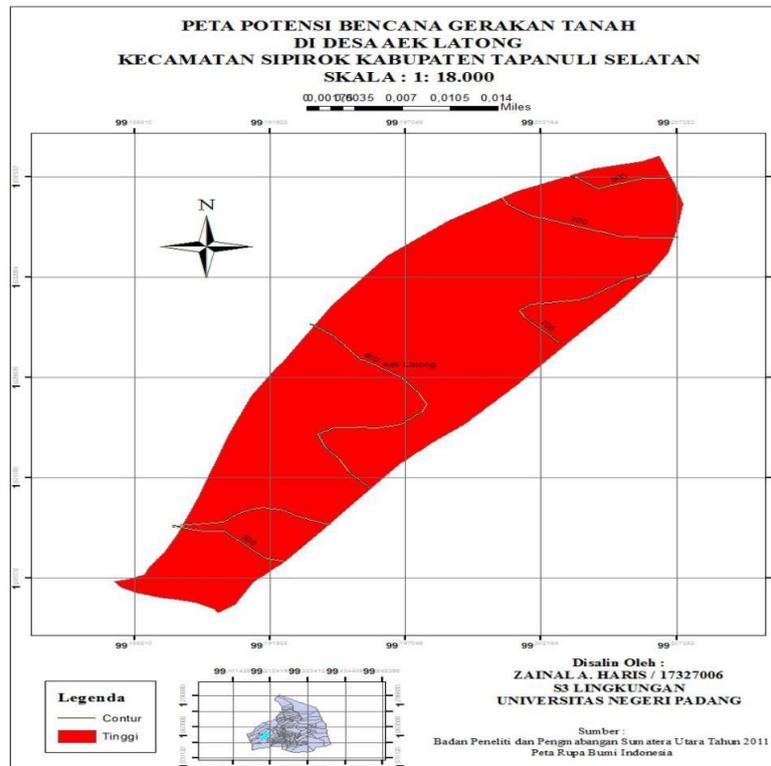


Figure 5. Zone map of soil movement in Aek Latong (*Source: Secondary data analyses, 2017*)

3.2. Mitigation and Adaptation

Mitigation and adaptation are conducted in Aek Latong in order to reduce natural disaster due to soil movement below ground surface. Mitigation is any efforts conducted to anticipate or to lessen the impact of disaster going to happen. However, effective effort that could be done before disaster was not well done yet. The action, actually, is very important to minimize more victims in susceptible area of disaster. Mitigation paradigm in controlling disaster was meant as efforts by introducing disaster susceptible areas, and preparing self-sufficient and self-reliance society. In addition, mitigation was also defined as efforts to increase capacity of society inhabiting in disaster susceptible area to anticipate or to lessen the impacts level.

Among types of mitigation which can be conducted are by changing the labile society behavior through settlement planning, building requirements, building structure having earthquake resistance, and spatial planning having perspective for mitigating disaster impacts. Furthermore, awareness for the disaster impact must be developed and activated among the society. Therefore, it is hoped that the society will not only be the target, but they also become the helper for themselves as well as for the environment during disaster. People awareness being developed among society is a kind of social awareness including earlier notice system, disaster anticipation, response at disaster happening, and ability to handle post disaster. These types of awareness are a kind of social capital to develop mitigation habit in its life of each individual of the society [9].

Land sliding area in Aek Latong is matched with the map of soil movement susceptibility in Sipirok, on which the soil movement is highly active and never stops. Soil movement types in Aek Latong are considered as soil slow movement and fast movement (land sliding) which were happened in two points in Purba Tua sub-subdistrict [10].

There were some factors affecting and accelerating soil movement in Aek Latong. The first factor is steep slope. Since it is on high land having mountainous topography, the slope become steep to very steep.

The second was geo-hydrology factor. Based on data derived from geo-hydrology regional map, it was known that Sipirok region has highly productive water resource. The lithology arrangement was easy to transmit water. The water was easily to come out due to uncompressed aquifer during heavy rainfall. Water functions as lubricant to faster soil degradation and as energy source to push big materials that can open hill wall producing several types of soil movement.

The third factor was earthquake tremor. This factor is really important to consider in Aek Latong for building some public facilities such as streets, housings, offices, etc. Based on pedology map, the soil materials which arranged the road foundation of new Aek Latong road was a kind of residue of vulcanic rock weathering from Nabirong, Sibual-Buali, and Toba Purba which was proved by none hard rock found.

The fourth factor was rock stratigraphy and elastic rebound landslides. This factor was due to continuous rock degradation zone, therefore the stable zone becomes under stressed. The old soil movement needed to be covered, so it causes soil movement in Renun Toru segmen, especially in Aek Latong fault. Then, if earthquake happens, it will shake soil into mud. As a consequence, there will be always areas being increased, disrupted, weathered, or cracked in Aek Latong and the surrounding.

The fifth ecological factor of soil movement is due to no vegetation along the street in Aek Latong. This condition causes that water easily comes out of the soil. Therefore, the wall to resist landslide is susceptible to be cracked. Soil and water movement cannot be separated. Therefore, to conserve soil and water in Aek Latong was conducted by planting some vegetation. For this condition, it is suggested to plant vertifer grass having long roots along the wall sides of the streets or hills.

3.3. Local Wisdom

Local wisdom belonged to Aek Latong society was derived from disasters coming all the time to the society. Since the ancestors did not move or leave their village they had been living for hundreds of years, they had to find out the best way to mitigate and to adapt to the condition. Therefore, they always seek the appropriate methods to solve the problem. The methods are always improved by the time to fix the specific condition.

3.3.1. Types of Local Wisdom for Mitigation and Adaptation to Disaster. Aek Latong society had tried some efforts in controlling soil movement to reduce the impact on their life and their environment. Among the efforts are:

1. Planting vegetation. Planting vegetation having long roots in bare area for buffering the susceptible soil movement, or cutting down the sliding area of the usual soil movement. This is aimed to strengthen the soil by using the vegetation roots. Then, the roots are also able to transmit more water to deeper soil profile. This is due to the fact that the dead roots provide soil macropores continuing from the soil surface into deeper profile. This will increase soil water recharge and reduce water movement on soil surface (runoff) causing soil movement. Furthermore, more vegetation on soil surface causes more water can be transpired from the soil, as a consequence, the soil surface becomes drier. As the soil is drier, it becomes more solid and strong. Therefore, if there is tremor the soil is not easily moved.
2. Constructing Dam. Constructing dam is aimed to cut the sliding area or to reduce area impacted by the soil movement. The type of dams can be derived from stones arranged in a wire or sand put in container and then arranged together to create a buffer to the soil movement.
3. Avoiding very Susceptible Area. The Aek Latong society did not want to leave the village but they just moved to the least risky area, and used land for agriculture which is away from the very susceptible one.
4. Building Strong House against Earthquake. The Aek Latong society used to build their houses from wood in order to get less impact during earthquake.
5. Praying (Istighosah). The Aek Latong society were dominated by moslems. They believed that they could not go any where to avoid the disaster except they have to be closer to the Almighty

God. Therefore, besides conducting physical efforts, they also prayed to the Creator to be out of the disaster.

6. Socializing and Educating the New Generation. Since they did not want to move from their own village, the elder socialized the types of disasters they were used to face along the year. Then, young generation will be educated how to recognize indicators of disasters and what types of impact will come out, and what the action or how to solve the problem. Those types of knowledge are always delivered to the new generation all the time.

3.3.2. The types of Local Wisdom in Facing the Disaster. Aek Latong society had some knowledge from nature indicating natural disaster phenomenon. There are some notices generally being recognized by people in Aek Latong before the disaster happens, such as:

1. Strange sound like thunders. If the Aek Latong inhabitants hear some strange sounds, they have to take some action to save their life directly.
2. Unusual animals comes out of forest or their habitat. Animals are much more sensitive than human being in recognizing the natural phenomenon. Therefore, if people see some unusual animals around them, it means that something will happen.

Some Actions conducted by the Aek Latong society in facing the disaster are

1. The leader of the tribe announces to the society that something will happen
2. They all together runs out of the villages to remote and safe areas for about 6-10 km away
3. They will come back to their villages or houses if they do not see the unusual animals anymore around them, in other words, the animals have come back to their habitats such forest.

4. Conclusion

Aek Latong society conduct the disaster mitigation based on the local wisdom. This wisdom is created due to the local condition they are facing along the time. They always look for the best way to anticipate as well as to adapt with the condition. As they do by time, from one generation to the next, the people habitual turns to be the local wisdom. The wisdom is different for the different location having different natural problems. Socialization about disaster as well as the impact being faced after the disaster, has made the society to become the self-reliance people all the time.

Types of local wisdom of Aek Latong society for mitigation and adaptation to soil movement disaster are planting some vegetation, constructing dam, avoiding highly susceptible area, building wood houses, praying, socializing and educating young generation.

The types of local wisdom of Aek Latong society in facing the soil movement disaster is divided into 2 parts, their knowledge in recognizing (predicting) the disaster will happen (such as strange sound and unusual animal in the surrounding) and their way to act against the disaster (such as announcing to all the society, being away from the susceptible area, and staying in the remote and safe area otherwise the unusual animals have come back to their habitats).

Beyond all of the local wisdom types they have, the spirit left by their ancestor has strengthened their principal that they will never leave their village.

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