

# The Prevention Of Landslide Disaster Along The Balikpapan-Samarinda Road In Soeharto Hill Forest Park Area (Taman Hutan Raya Bukit Soeharto)

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**Abstract:** The occurrence of a landslide disaster is one of the most frequent disasters in Indonesia, including in East Kalimantan on roads connecting Samarinda Balikpapan especially in Bukit Soeharto Forest Highway km 38 Sungai Merdeka district Samboja and km 69 Batuah district Loa Janan, it is necessary to take a research steps to determine the causes of landslide disaster and to know how to tackle the causes of the landslide. Based on the analysis at the location of the research that the land texture in Soeharto Hill Forest Park area is yellow Podzolic soil type, Latosol and Litosol (15%) and Alluvial soil (10%) with parent material in the form of folds of hill and the structure of the soil is clumped and its consistency is flat. The topographic state of the field is bottom to bumpy to the slope of 10-45%. Referring to the general nature of soil chemical physics, most soil types in the Bukit Soeharto Forest Park area have a high degree of erosion sensitivity with very low land productivity, so it is appropriate to be designated as a conservation area. The potential for ground motion on the slope depends on the soil condition and its composition and one of the geological causes of soil movement is rock weathering, because it is in high intensity of rainfall and sun irradiation makes the rock weathering process more intensive. Rocks that often weathering will cause a decrease in rock strength that ultimately forms a layer of weak rock and thick residue soil. If this happens on the slopes it will be critical. The location of the study is a hilly area that forms a slope of land with an average slope of 25 to 75 degrees and is composed by a pile of soil formed by physical and chemical weathering on rocks or more compact soil has the potential to move or landslides. The cause of a landslide disaster along the Balikpapan-Samarinda road in Soeharto Hill Forest Park is due to high rainfall and deforested land cover deforestation.

**Index Terms:** road axis, Soeharto Hill Forest Park Area, rainfall, landslide disaster.

## 1 INTRODUCTION

THE existence of a Balikpapan-Samarinda axis road through Soeharto Hill Forest Park Area, at this time has been a deterioration of road conditions, and a lot of disturbances such as critical land, big trees have been disappeared, and landslide those has been a surge of road users such as motorist, cars, or truck which in turn can occur violation events and traffic accident Based on the condition above it is necessary to rebuild certain road points that have been damaged, so that the shaft road condition can be recovered as usual and can be used for the road users with full comfort and repositioning on the right path. Based on observations in the field, it showed the occurrence of a surge of road users of all types of vehicles and certainly it will have an impact on increasing the pressure of the road body resulting decrease of road bodies and and causing cracks in asphalt concrete so as to accelerate the process of landslide especially when it rains, because the rift is easy to filled by the rain water that will carry grains of sand of soil resulted erosion and landslides on the road.

## 2 RESEARCH PURPOSES

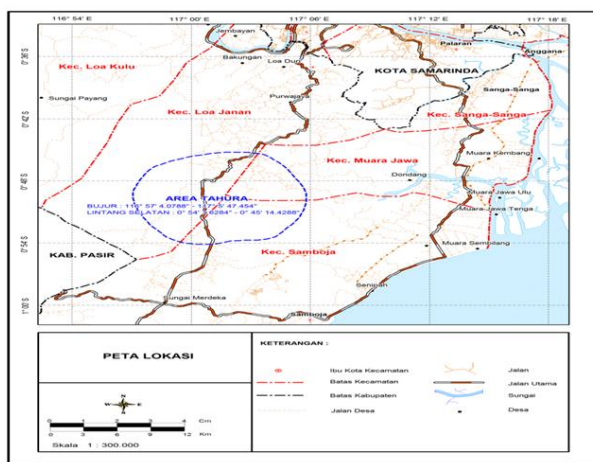
- To ensure the characteristic of the shape and identify the land that potentially landslide along the axis road of Balikpapan - Samarinda Km 38 Sungai Merdeka Samarinda Subdistrict Samboja up to Km 09 Batuah subdistrict Loa Janan.
- To Know the factors of landslide disaster.
- To Know the potential landslide hazard relate with the condition of vegetation and shrubs.
- To analyze the role of vegetation in anticipating landslide disaster.
- To determine the measures taken to control the landslides

## 3 CITATIONS

### 3.1 Status and Location of Soeharto Hill Forest Park Area

Area Name	: Taman Hutan Raya Bukit Soeharto (Soeharto Hill Forest Park Area)
Decree of Reference	: Minister of Forestry of the Republic of Indonesia Decree
Number	: 419/Menhut-II/2004
Area	: 61,850 hectares
Quotation decree	: Minister of Forestry of the Republic of Indonesia Decree
Number	: 577/Menhut-II/2009
Date	: September 29, 2009
Area	: 67.766 Hectares
Geographical Area	: 00° 46' 00" LS up to 01° 00" LS 116° 48' 00" BT s/d 117° 06' 00" BT

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Location based on government administration:

Kutai Kartanegara (Loa Kulu, Loa Janan, Muara Jawa and Samboja districts) and Penajam Paser Utara (Sepaku subdistrict)

Location by Watershed:

Watershed : Sanga-sanga, sungaiwain, Bambang, manggar, Samboja  
Watershed sub : Loa haur, Palaran

### 3.2 The Condition of Bukit Soeharto Forest Park area

- The Forest land of Soeharto Hill Forest Park Area consists of forest area (20,890 hectares), rice field (50 hectares), reeds and shrubs (25,691 hectares), farms and fields (3,782 ha) of reforestation plants (5,449 hectares) (1,460 hectares). The Vegetation type consists of four groups namely lowland forest less than 1.000 mdpl, mangrove forests, shrubbery with reeds and fields, fields and moor or yard residents.
- The type of soil in Soeharto Hill Forest Park Area is red yellow Podzolic soil type, Latosol and Litosol (15%) and Alluvial soil (10%) with main material in the form of folds of hill and the structure of the soil is clumped and its consistency is flat. The topographic state of the field is bottom to bumpy to the slope of 10-45%. Referring to the general nature of soil chemical physics, most soil types in the Bukit Soeharto Forest Park area have a high degree of erosion sensitivity with very low land productivity, so it is appropriate to be designated as a conservation area.
- Height: 60 – 120 metres above the sea level. Climate according to Scmidt Ferguson (1951) classification includes type A with annual rainfall of 1,682-2,134 mm, with 75-157 days of rainy days and 73.5% monthly relative humidity including high rainfall intensity.
- The average annual temperature of 26.7 °C with various of wind direction and the average speed of 4070 km / hour. The light intensity of the upper regions of 17.155 with the middle area of 15.455 and the lower regions of 16.50%.
- The distribution and extent of the Soeharto Hill class is 0-8% of 8,365 hectares (40.57%), 9-15% of 6,509 hectares (31.56%), 16.25% of 5,571 hectares (27.02%), 26-45% covering 148 hectares (0.72%) and more than 45% covering 26 hectares (0.13%).
- Physiographically, the water catchment area of the hills is mostly included in the Teweh land system with Paleodulcs dominance, which is susceptible to erosion. The main rock

formation of the land in the form of sandstone cause the land has a high sand content, nesting and stable.

### 3.3 Infrastructure in Soeharto Hill Forest Park Area

The axis road stretching from Balikpapan Samarinda Km. 38 Sungai Merdeka Samboja up to Km. 69 Loa Janan. Between Km.38 Sungai Merdeka Samboja Sub-district up to Km.51 there are residential areas with various facilities such as school buildings, places of worship, community health centers, security posts, as well as places of rice fields and plantations.

### 3.4 The Flora Forest Soeharto Hill Forest Park Area

- Young secondary forests dominated by pioneer vegetation such as *Macaranga* sp, *Arthocarpus* sp, *Baccaurea* sp, and *Eugenia* sp, ferns such as *Pterydhoppytha* sp and *Imperata* (*Imperata cylindrica*).
- An old secondary forest with several species of Meranti tree (*Shorea* sp) growing spreading.
- Former swidden and pepper plant (*Piper* sp)
- In some areas, it still has Ulin/ iron wood (*Eusidoroxylon zwageri*) and Bengkirai wood (*Shorea laevis*).

## 4 THEOREMS AND PROOFS

### 4.1 The Research and Analysis of vegetation role to control avalanches and the causes and its mitigation

The loss of cover plants can make grooves in certain areas. The erosion of the land will increase and eventually there will be a landslide (Pangalar 1985). Under these conditions also contributes to the erosion factor. The location or position of the cover of perennials and their density affect the safety factor of the hillside. The planting of hardwood vegetation on the foot of the hillside makes the stability of the hillside, on the contrary, planting hard crops at the top of the slope will actually lower the safety factor of the hillside, thus weakening the stability of the hillside itself (Hirawan 1993), thus the planting of certain types of clump vegetation is very appropriate in an effort to minimize the landslide, according to the degree of land slope associated with the role of Soeharto Hill Forest Park Area (Taman Hutan Raya Bukit Soeharto). Another cause of landslide events is internal disturbance coming from within the body of the hillside soil itself especially the water factor in the hillside soil itself.



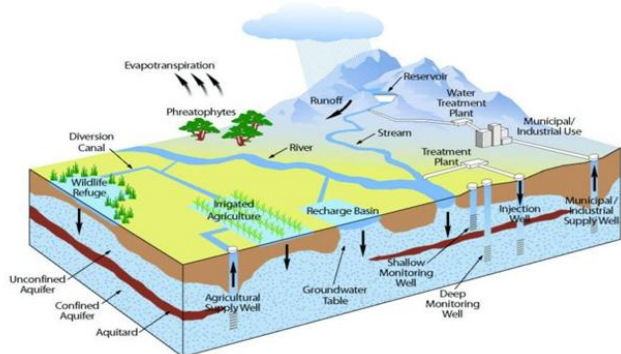
*Image: The vegetation planted on the slope of the soil*

### 4.2 Management of the environment

Environmental management is intended to reduce, prevent and mitigate negative impacts and increase positive impact. The study is also based on a feasibility study of engineering or geological studies covering engineering geology, soil mechanics and hydrogeology. Thus the approach in dealing with landslide hillsides prone to landslides other

than based on the recommendations of feasibility studies of engineering or geological studies, also based on the management of the environment. Thus, it is expected that the existence of axis road in Bukit Soeharto Forest Park area along 31 kilometers between Km. 38 Sungai Merdeka Samboja Sub-district up to Km. 69 Batuah Loa Janan Sub-district crossing slopes of hill-prone landslide can be identified furthermore so as to anticipate the strength and racket of a hillside. The relationship between factors affecting the deterioration of physical and mechanical conditions needs to be known. Effect of increase in aft rate, placement of load, vegetation planting and vibration conditions to the hillside soil. In general, the prevention of landslide slopes is to try to control the factors causing and the trigger. However, not all of these factors can be controlled unless they reduce the trigger factor. Several ways to prevent or stabilize the hillside in order to save the pavement stretch of Soeharto Hill Forest Park Area. They are:

- Reduce the load at the top of the hillside by means of trimming the hillside, slope cuts are usually combined with filling or fill at the foot of the mountain slope, the making of the steps- steps and so on.
- Adding weights at the foot of the hillside by:
  - planting perennials
  - planting a certain type of vegetation at the top of the hillside so that evapotranspiration increases. Falling rainwater will enter the hillside, then infiltration can be done that way.
  - The coverage of the grass. the same way to reduce infiltration of rainwater into the hillside and with the coverage of grasses accompanied by drainage will also control run-off.
- Controlling surface water in the following manner:
  - Planting vegetation and grass coverage also reduces run-off runoff water so that surface erosion can be reduced.



**Image:** Planting vegetation to control erosion

In agricultural areas that have a high slope of soil, it is better to create terraces to reduce the drift of soil particles by the speed of water flow (supported by fertilization to increase fertility for plants).



**Image:** Making terracing to keep the soil from landslides

- Reforestation on critical land with economically valuable crops, the availability of foodstuffs, medicines and the tree sap so that the roots of trees to keep the soil erosion and keeping the soil water availability.
- Rehabilitation in order to improve the land
- The closure of vegetation in a hilly areas, plains, and valleys in the Soeharto Hill Forest Park Area is closely related to soil and water conservation issues. In this case forest as one of the main buffer system of water valley area. Therefore, good forest management action is also an effort to conserve soil and water conservation. The destruction of forests and vegetations, soil erosion, the emergence of degraded land, reduced groundwater supplies, and decreased land productivity are natural problems that are interconnected with one another. Generally it happens scientifically and because of human activities in the exploitation of forest resources and agricultural resources regardless of its sustainability.
- It is important to realize that the population growth in Soeharto Hill Forest Park Area and the rising standard of human life has also increased the need pattern. Automatically human activities in the exploitation of natural resources including forest resources and agricultural resources are also increasing. The number of human activities if it is not accompanied by efforts to rehabilitate forest land and agricultural land then the existence of these resources will not be sustainable, it means that the damage will continue to occur. Those problems will be resolved by maintaining a still intact nature balance. Without the effort of land rehabilitation and awareness of maintaining the balance of land, the damage will continue to occur both on a large and small scale.
- All damage of the vegetation of soil protection within an area of the watershed region area of Soeharto Hill Forest Park Area must be improved through reforestation activities must be done seriously to tackle and improve the forest specially on the depletion of plant species and deforestation species, as well as avoiding threats to the stretch of the area.

Reforestation activities as a step to improve critical land area through tree plantation, produce or enrich the plants, crop removal from weeds and secure to residual stands. It is aimed to preserve and increase the value of stand both in quality and quantity.

The main aims of rehabilitation in the reforestation are:

- To repair hydro-ology condition of planting trees area. It is aimed to prevent flood, soil erosion, landslide, and to conserve water resource.
- To repair and preserve soil fertility of tree species planted in the forest area and it can be expected to repair soil fertility under a forest stand. This Plantation is executed in both the physic forest critical area and socio economic critical.
- To keep a tree species conservation
- The role of reforestation trees as land rehabilitation

According to the aims of reforestation itself there are many roles. The main role of trees results in reforestation activities is to improve the conditions of vegetation or plants, while some other roles of the reforestation tree are as follows:

- The reforestation trees are able to prevent erosion and landslides
- The reforestation trees are able to preserve and keep water system
- The reforestation trees are able to control the local climatic conditions
- The reforestation trees are able to keep fresh air
- The reforestation trees are able to increase the aesthetic beauty
- The reforestation trees are able to add to the aesthetic beauty
- The reforestation trees are able to add educational facilities. Tree as an educational facility because it can rise a sense of love for nature

Regarding the roles of reforestation trees in the hydrological process are:

- The tree as a part of vegetation has an important role in the process of water cycle tree of removal media.
- In the water cycle, trees as a medium of moving rainwater to the ground through temporary containment by tree canopy, stem stream, and canopy water, and as a medium of moving water from the soil to the vegetation and atmosphere through evapotranspiration (pudjiharta,1986)

The species of trees as an alternative choice to be planted in reforestation activities rehabilitation of land, should conform the various requirements or criteria as follows (Kadri et al 1992):

- Able to grow in the open air under full sunlight conditions. So this includes the type of intolerant and pioneer tree, which means it does not require many conditions of the growth factor, even has the ability to improve soil conditions.
- Be able to compete with weeds and other weeds, so we have to choose the type of tree that has fast growth so it can cover the soil and reduce the erosion.
- Easy to sprout again when pruned or burned
- Able to grow on the condition of skinny soil and drought soil.
- Seeds or vegetative parts as a breeding material are easily obtained.

These are the examples of tree species that can be selected as reforestation plants for rehabilitation of land include tusam (Pinus Merkusii), teak (Tectonagrandis) large leaf mahogany

(Swieteniamacrophylla), small leaf mahogany (Swieteniamahgoni), resin (Agathisloranthifolia), rasamala (altingia Excelsa), Sangon (Paraserianthes falcataria), Acacia (Acacia auriculformis), mangium (Acacia mangium), leda (Eucalyptus deglupta), eucalyptus (melaleucadendron) African wood (Maesopsiseminii), small acacia decurens (Acacia auriculformis), acacia auriculformis (Acacia auriculformis), candlenut (Aleuritesmoluccana), kelampayan (Anthocephaluscadamba), jabon (Anthocephaluschinensis), sonokeling (Dalbergialatifolia), sonosiso (Delbergiasisso), puspa (Schimarononhae), sungkai (Peronemacanesens), wareng (Gmelinaarborea), macadamia (Macadamia hildebrandia), kaliandra red flower (Caliandracalothirus), Kaliandra white flowers (Calliandratetragona), lamtorogung (Leucaenaleucephala), weru (Albiziaprocera). andkemlanding (Leucaenaglauca). And the types of trees for greening, such as turi flower (Sesbaniagrandiflora), white flower turi (Sesbaniabispinosa), gamal (Gliricidiamaculata), rosidi (Gliricidiasepium), cloves (Eugenia aromatica), cashew (Anacardiumoccidentale), cotton (Ceiba petandra), rubber (Hevea brasiliensis), jackfruit (Artocarpusintegra), kluwih (Artocarpussinensis), breadfruit (Artocarpuscommunis), sawokecik (Manikalkarakauki), Cinnamon (Cinnamomumsp), petai (ParkiaSpeciosa) durian (Duriozibethinus), rambutan (Nepheliumlappaceum), avocado (PerseaAmericana) and Tamarind (Tamarindusindica).

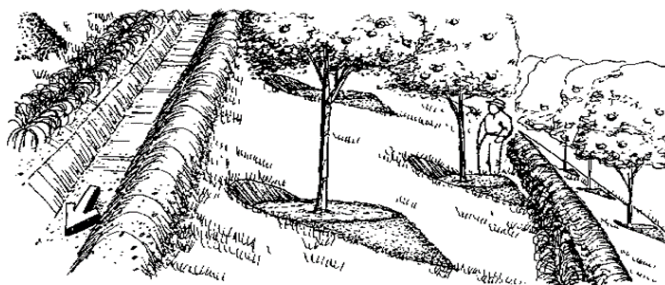
#### 4.2 Determine The measures of the vegetative aversion control

The Anticipation of landslides

To prevent slopes saturated with ground water or reduce soil moisture levels in the slope itself, groundwater and surfacewater levels usually appear during the rainy season, then the prevention by making some water distributor from bamboo or paralon pipe at the slope near the foot of the slope. This means that the rising groundwater level in the slope will flow out so that the ground water will be level down.

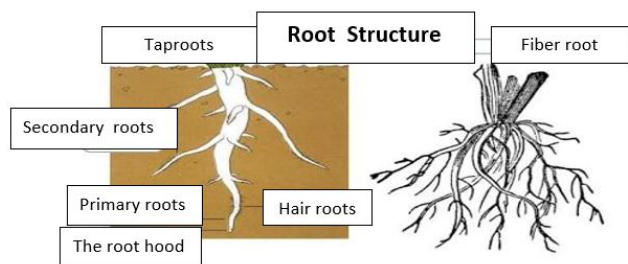
There are several ways to control surface water:

- Create adequate drainage design so that surface water from the top of the slope can flow smoothly and infiltration decreases.
- On the shoulder of the road as well as on the slope of the road resulting from increased road construction by doing land work, and cutting the hill to be made so the land is more sloping and land accumulation.
- Reduce the intensification of land treatment in landslide prone areas.



*Image: Terracing drainage design*

The three factors above are absolutely adapted to the conditions and problems of the land at certain points along the stretch of the axle road in the area of Bukit Soeharto Forest Park Area. The existence of a axis road that stretches into the Bukit Soeharto Forest Park Area by crossing the slopes and swamplands against landslide erosion can be clearly identified at certain points so that the handling is more specific, by looking at the characteristics of the area of the points primarily in its handling involves engineering vegetation that has various roles and can be combined with civil engineering engineering. Reduce logging of uncontrolled and unplanned tree species, clear-cuts and pillage The planting of vegetation with the type of perennials with intensive roots and can grip the soil and have tap the roots and fiber root is intended to prevent the rate of erosion.



**Root structure**

#### 4 CONCLUSION

- Identified landslide location and some factors known that influence the landslide.
- Analysis of avalanche control with treatment follow-up by planting vegetative and it can be integrated by constructing an avalanche retaining (infra structure)
- Provide input or recommend to the authorities, to take concrete policy steps based on the accuracy of data in the field, so as to create road conditions that meet the requirements and safe for road users and environmentally friendly.

#### SUGGESTIONS

- It is required more complete and accurate field investigation datas iin order to describe the actual and real conditions.
- To improve the stability of the slope and increase prevention by Bioenginerring or Bio Technical Stabilization, these two ways can be done by planting vegetation that has a root tap or fiber roots.
- The prevention of landslide disaster can be done by civil engineering.  
The efforts to reduce the vulnerability of communities in the activities of land exploitation in affected landslides by providing activities and socialization of the landslides impacts.

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