

Analysis of plant root properties, texture and porosity that affects landslides in Tangka Sub- Watershed

by Sikstus Gusli

Submission date: 19-May-2022 03:47PM (UTC+0700)

Submission ID: 1839708023

File name: Afriawan_2021_IOP_Conf._Ser._Earth_Environ._Sci._886_012093.pdf (2.79M)

Word count: 2313

Character count: 11595

PAPER • OPEN ACCESS

Analysis of plant root properties, texture and porosity that affects landslides in Tangka Sub-Watershed

To cite this article: A Afriawan *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **886** 012093

13
View the [article online](#) for updates and enhancements.

You may also like

- 8
- [Limited role of soil texture in mediating](#)
15 [rural vegetation response to rainfall](#)
[anomalies](#)
Surya Gupta, Sara Bonetti, Peter
Lehmann et al.
- 9
- [Granular and particle-laden flows: from](#)
[laboratory experiments to field](#)
[observations](#)
R Delannay, A Valance, A Mangeney et al.
- [Landslide Vulnerability Analysis with The](#)
[Application of Geographic Information](#)
[System \(GIS\) and Remote Sensing in](#)
[Purworejo Regency](#)
D Mahendra and L N Aini



ECS The Electrochemical Society
Advancing solid state & electrochemical science & technology

241st ECS Meeting

Vancouver, BC, Canada. May 29 – June 2, 2022

ECS Plenary Lecture featuring
Prof. Jeff Dahn,
Dalhousie University

Register now!

7

Analysis of plant root properties, texture and porosity that affects landslides in Tangka Sub-Watershed

A Afriawan, A Ahmad, and S Gusli

Soil Science Department, Agriculture Faculty of Hasanuddin University, Makassar 90245

E-mail: asmitha.ahmad@agri.unhas.ac.id

Abstract. Tangka Sub-Watershed in West Sinjai District is one of the sub-watersheds in South Sulawesi, which often experiences landslides. Factors causing landslides were divided into control factors and trigger factors. One of the triggering factors for landslides is the characteristics of soil and plant properties. Several previous research results stated that soil characteristics greatly affect the occurrence of landslides, while plant roots help stabilize soil bonds and slopes. This study aims to determine the triggering factors of the soil (soil texture and porosity) and the distribution of plant roots that affect the occurrence of landslides. Soil texture analysis using hydrometer method. Soil porosity and moisture content using gravimetric and pycnometer methods. The results showed that the soil texture was dominated by silty clay loam impact on low soil cohesion. Intensive land use decreases soil porosity to <50% and increases soil bulk density to 1.4 g/cm³. The soil quickly becomes saturated and could induce the rotting of plant roots. These characteristics increase the vulnerability of the soil, thereby increasing the potential for landslides.

1. Introduction

The Tangka River Watershed is located in West Sinjai and is one of the watersheds in South Sulawesi with a high intensity of landslide events [1]. Landslides are disasters that have a major impact on human life and safety. From 2008 to 2017, there have been 55 landslides in South Sulawesi which resulted in 38 deaths or missing [2]. This result is reinforced by Arsyad's research (2018) that the Tangka watershed is one of the watersheds that has the potential to cause natural disasters in the form of landslides, especially upstream of the watershed [3].

The potential for landslides in the Tangka watershed still raises questions about the factors that trigger landslides. The results of Arsyad's research in 2018 suggest further research, especially on the characteristics of porosity and bulk density of soil in landslide events [3]. These two parameters are expected to be able to answer the hydrological process of water to disaster events in the Tangka watershed. This is reinforced by the results of research by Rudyanto (2010) which states that the porosity and permeability of the soil affect the occurrence of landslides [4]. Water that enters the soil will reduce friction in the soil so that it will affect the level of vulnerability to landslides. This study aims to study the characteristics of texture, bulk density and soil porosity associated with plant root models in landslide events.



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

2. Methods

The research location is in the Tangka Sub-watershed, South Sulawesi Province (Figure 1). The soil sampling method used is a field survey method based on sample points determined in the field after reviewing the former landslide events at the research location. Soil samples were taken at the top layer (0-20cm), undisturbed soil samples were carried out by ring samples for bulk density and soil porosity analysis. Disturbed soil samples are used for soil texture analysis.

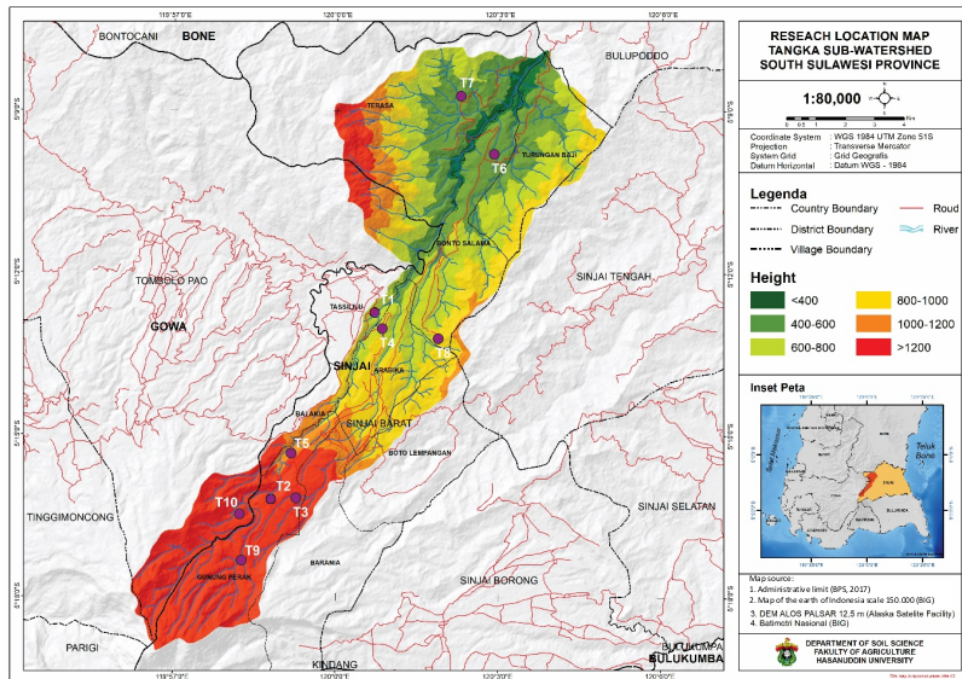


Figure 1. Research Location Map.

Soil texture analysis using hydrometer method. Soil porosity and moisture content using gravimetric and pycnometer methods. In addition, the results of the analysis of soil texture and porosity will be related to the landslide event based on the comparison of data in the area of the former landslide and the area that does not. Map creation with ArcGIS 10.8 (Figure 1).

3. Results and Discussion

At the research location in the Tangka Sub-watershed, West Sinjai District, there are two points where land landslides occurred and at the same time become a point for carrying out plant debris parameters in the landslide field which are then coded T1 and T2 (Figures 1 and 2). Both landslides have a concave slip plane, with the landslide material in the form of soil and rock with a slump model.



Figure 2. T1 (5°13'6"S 120°0'36"E)



Figure 3. T2 (5°15'35"S 120°58'48"E)

Table 1. Soil Texture Analysis Results.

Sample Code	% Sand	% Silt	% Clay	Texture
T1	21	54	25	Silty clay loam
T2	17	50	34	Silty clay loam
T3	23	57	19	Silt loam
T4	23	56	22	Silt loam
T5	10	55	35	Silty clay loam
T6	5	48	47	Silty clay
T7	1	46	53	Clay
T8	11	59	30	Silty clay loam
T9	20	56	24	Silt loam
T10	13	59	28	Silty clay loam

The table 1 shows that there are four soil texture classes based on USDA, namely clay which is in the fine category at one point, dusty clay, dusty clay, which is in the medium category at one point, and dusty clay at three points which is in the medium category. The dominant type of texture in the former landslide in the Tangka Sub-watershed is dusty clay loam where the dominant fraction percentage is the dust fraction. The more dust fraction of a soil texture, the more micro pore spaces are formed which are filled with water and air so that it is possible to trigger landslides..

The occurrence of landslides in the field which is dominated by dusty clay clay texture is supported by Ahmad et al. (2018) that the accumulation of dust in the subsurface layer also contributes to reducing the available pore space and triggers landslides [5]. The results of the analysis of soil texture correlated with the results of the analysis of soil porosity, where the soil that has a dusty clay loam texture is classified in the poor porosity class.

Table 2. Soil Porosity Analysis Results.

Sample Code	Bulk Density (cm ³ /gr)	Porosity (%)	Porosity Class [6]
T1	0.98	63	Moderate
T2	0.92	65	Moderate
T3	1.38	47	Low
T4	1.05	60	Moderate
T5	1,30	50	Low
T6	1.24	53	Moderate
T7	1.30	50	Low
T8	1.35	48	Low
T9	1.40	44	Low
T10	1.37	47	Low

The percentage of soil porosity values in the Tangka sub-watershed has a poor porosity class at six points and a good grade at four points. Soil porosity has an influence on the occurrence of landslides based on the percentage yield of bulk density (Table 2). This is in line with Bintoro's (2017) statement, indirectly the bulk density greatly affects soil porosity [7]. The smaller the bulk density value, the greater the percentage of soil porosity, on the contrary when the bulk density value is high it will reduce the number of pores so that the soil porosity will be low and classified as poor when > 50%.

Poor soil porosity also affects the slow rate of permeability. Achmad et al. in 2016 said the speed of water to enter the soil body is called permeability, the slower the water seeps into the soil body, the more water is stored in the soil body so that the slope load is higher and has the potential for landslides [8].

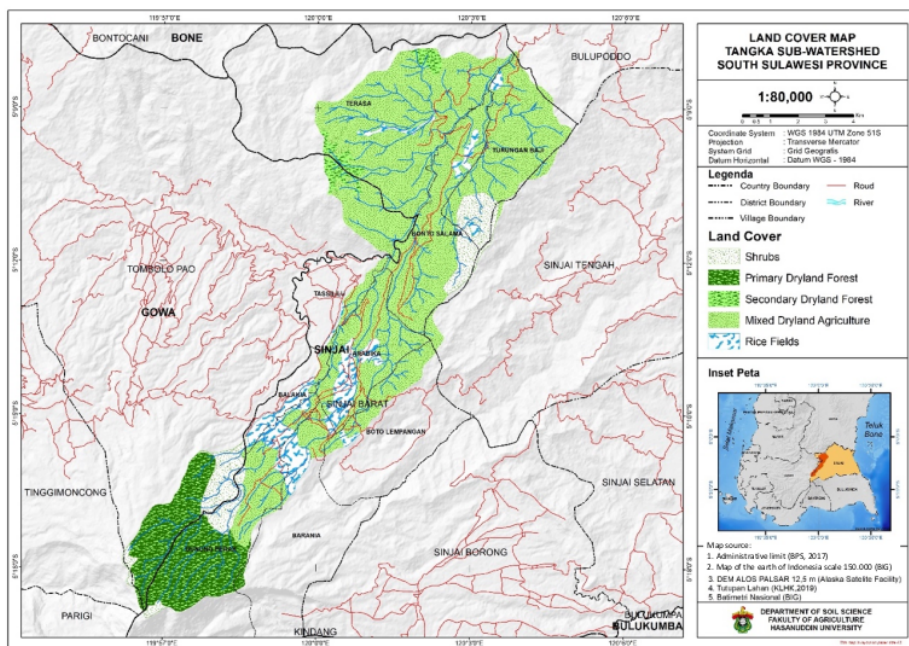


Figure 4. Land Use Map of Tangka Sub-watershed.

Tabel 3. Average Root Length and Diameter in ex-Landslide.

Sample Code	Root Type	Root Length (cm)	Root Diameter (mm)
T1	Ride vertical	60 -90	4 - 5
T2	Fiber Vertical	25 - 30	0.8 - 1

**Figure 5.** Plant Roots in Landslide Field (T1)**Figure 6.** Plant Roots in Landslide Field (T2)

The land cover plants at the location of the first landslide (T1) contained several types of woody plants which on average had taproots that grew vertically into the soil (Figure 5). In (Figure 2), it can be seen that the roots of a taprooted woody plant which have an average root length of 60-90 cm and an average diameter of 4-5 mm allow stabilizing the slopes and have a sufficiently large soil grip, but landslides still occur due to another factor, namely the physical properties of the soil, one of which is the texture of dusty clay loam at the landslide point. Hairiah in 2020, said that higher soil silt and clay content and lower water content led to higher soil shear strength because it allowed rotting of tree roots [9].

In terms of land use, the former land slide (T1) is a mixed garden managed by local land owners. The results of Hairiah's research also say that intensifying soil management after forest conversion can lead to soil compaction which means lower pore space and soil infiltration, increasing shear strength and runoff, along with reducing vegetation weight, these changes can reduce probability of slope failure with time after forest conversion [9]. However, loss of 'root anchoring' associated with gradual decay of tree roots in the first few years after conversion increases the risk of landslides.

The land cover plants at the location of the second landslide (T2) are grasses that have fibrous roots that grow vertically into the soil (Figure 6 and Figure 3). In (Figure 2), it can be seen that fibrous roots which have an average root length of 25-30 cm and an average diameter of 0.8-1 mm are considered to be unable to stabilize slopes and have low soil gripping power. The shear strength of the soil depends on the soil texture and soil moisture content, and we found spread in shear strength with low root length.

At the location of the second landslide (T2) there is a use of shrub land which is dominated by grass as land cover. This statement is in accordance with Arsyad's research in 2018 that the use of bush land is prone to landslides because the roots are not deep enough to bind or grip the soil [3]. the lack of land cover and vegetation, making the roots as a soil binder reduced in the dry season and in the rainy season water will easily seep into the soil layer through the cracks and cause the soil layer to become saturated with water, sooner or later this will cause landslides to occur.

4. Conclusions

Silty clay loam soil texture has a high percentage of silt fraction, resulting in a decrease in soil cohesion properties so that the soil is easily dispersed and triggers landslides. The value of bulk density in some land uses increases in line with the decrease in the value of soil porosity which can reduce the infiltration ability of the soil, making the soil saturated, thereby increasing root rot and triggering landslides and erosion.

References

- [1] Geological Agency 2009 *South Sulawesi Province Land Movement Vulnerability Zone Map [In Bahasa Indonesia]* (Jakarta: Ministry of Energy and Mineral Resources of the Republic of Indonesia)
- [2] The National Agency for Disaster Countermeasure 2018 Indonesian Disaster Information Data (DIBI) 2013-2017 [In Bahasa Indonesia] <http://dibi.bnpb.go.id/dibi/>
- [3] Arsyad U, Barkey R, Wahyuni K and Matandung K 2018 Landslide Characteristics in the Tangka River Basin [In Bahasa Indonesia] *J. Hutan dan Masy.* 203
- [4] Rudiyanto R 2010 *Landslide Hazard Potential Analysis Using Geographic Information System (GIS) in Selo District, Boyolali Regency [In Bahasa Indonesia]* (Surakarta)
- [5] Ahmad A, Poch R M, Lopulisa C, Imran A M and Baja S 2018 Identification of soil characteristic on North Toraja landslide *ARPN J. Eng. Appl. Sci.* **13** 8381–5
- [6] Arsyad S 1975 *Soil and Water Conservation [In Bahasa Indonesia]* (Bogor: IPB (Bogor Agricultural University))
- [7] Ahmad B, Danang W and Isrun I 2017 Physical Characteristics of Soil in Several Land Uses in Beka Village, Marawola District, Sigi Regency [In Bahasa Indonesia] *e-J. Agrotekbis* **5** 423–43
- [8] Achmad A, Suwarno and Sarjanti E 2016 The Relationship of Soil Physical Properties with Landslide Incidence in Logawa Sub-watershed, Banyumas [In Bahasa Indonesia] *Geo Edukasi* **5**
- [9] Hariah K 2020 Tree Roots Hold and Tie Soil: Reducing Landslide Risk in Indonesian Agroforestry [In Bahasa Indonesia] *Land* **9** 256

Analysis of plant root properties, texture and porosity that affects landslides in Tangka Sub- Watershed

ORIGINALITY REPORT

14%

SIMILARITY INDEX

11%

INTERNET SOURCES

11%

PUBLICATIONS

6%

STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Institut Pertanian Bogor Student Paper	3%
2	cyberleninka.org Internet Source	3%
3	www.sciencegate.app Internet Source	2%
4	Rizki Amaliah, Andang Suryana Soma, Baharruddin Mappangaja, Friska Mambela. "Analysis of the landslide susceptibility map using frequency ratio method in sub-sub-Watershed Mamasa", IOP Conference Series: Earth and Environmental Science, 2021 Publication	1%
5	Submitted to University of Queensland Student Paper	1%
6	I G Sudarman, A Ahmad. "Mapping of landslide-prone areas in the Lisu river basin Barru Regency based on binary logistic	1%

regression", IOP Conference Series: Earth and Environmental Science, 2021

Publication

7	repository.unhas.ac.id Internet Source	1 %
8	www.research-collection.ethz.ch Internet Source	1 %
9	agupubs.onlinelibrary.wiley.com Internet Source	1 %
10	infrastructure.planninginspectorate.gov.uk Internet Source	<1 %
11	Nurdin Dalya, Wahyuni, Andi Vika Faradiba Mui. "Utilization of community forest wood harvesting waste in Bone Pute Village, Burau District, East Luwu Regency", IOP Conference Series: Earth and Environmental Science, 2021 Publication	<1 %
12	S A Lias, M Safaat, M S Solle. "The soil characteristics of landslide in Manuju District, Gowa Regency", IOP Conference Series: Earth and Environmental Science, 2020 Publication	<1 %
13	helda.helsinki.fi Internet Source	<1 %
14	pertambangan.fst.uinjkt.ac.id Internet Source	<1 %

15

Surya Gupta, Sara Bonetti, Peter Lehmann, Dani Or. "Limited role of soil texture in mediating natural vegetation response to rainfall anomalies", Environmental Research Letters, 2022

Publication

<1 %

Exclude quotes On

Exclude matches < 5 words

Exclude bibliography On