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FOREWORD

Welcome for all respected scholars, researchers, post graduate studentsand especially Keynote Speakers to the 4 ICTVET. The theme of the conference focus on Technical and Vocational Education and Training for sustainable societies and consist of six subthemes. i.e Development of learning model on TVET, Workplace Learning and entrepreneurship, Innovationon applied engineering and information technology, Management and Leadership on TVET, Vocational and Technical Teaachers education, and Assessment and Evaluation on TVET.

Sustainable society shoul be followed by the improvement of various factors that have impacts to the quality of vocational and technical education and training, particularly to overcome the competitiveness of the world business. As we have already known the rapid change of technology as well as the change of demography, having a great effects to the life of peoples in this world, The competitiveness need a collaborativeness to survive the life of millions peoples who lost their jobs. Young peoples as aproductive generation have to be creative and innovative to face the competitiveness. So this prociding contents consist of various findings of research in the field of vocational and technical education as well as applied technology and mainly based on the subthemes of the conference.

Finally, we would like to thank a million for all participants of this conference and all parties who support the success of this conference. Hopefully the seminars and scientific work of this seminar can be a reference material for basic education and elementary school teacher education in Indonesia.

Padang, July 2, 2018

Tim Editor

CONTENT PROSIDING ICTVET 2017 REPOSITORY UNP

Optimize of Least-Square Inverse Constrain Method of Geoelectrical Resistivity Wenner-Schlumberger For Investigation Rock Structures in Malalak Districts of Agam West Sumatra

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ABSTRACT: Numerous studies have been conducted on an inversion method, focus on constraining factor, singular value, the speed of convergence. However, the result of inversion is not unique and bivalent. In this research, we optimize of Least-Square constrain by using damping factor. This method used for interpretation of the volumes and rock structure in Malalak District of Agam West Sumatra. This is undertaken because Malalak districts of Agam West Sumatra that passed by highway Padang and Bukittingi is a frequent area of the landslide. Furthermore, the frequency of the landslide depends on the type of rock and the angle of the slope. The depth of the slide surface can be predicted by using the least squares inversion constrain method of Geoelectric Resistivity. Landslides resulted in disruption of transportation between the city of Padang and another district in Sumatra. Based on the above, to determine the rock's structure, the depth, and tilt angle of the slide surface in Malalak districts Agam West Sumatra has to take place. Data obtained through Geoelectrical exploration using automatic resistivity meter equipment. Constrains were obtained using the Marquat inversion method. The result of the research is first, the damping factor for structures which have wide range resistivity is 0.02 and the smallest damping factor is 0.015. Second, the rock structure in Malalak of Agam consists of clay, sandstone, andesite, and limestone and dolomite. Implementation this research can be used to develop mitigation of landslide deserter.

Keywords: Investigation, Slide surface, Geoelectrical Resistivity, Least-Square Inverse, Constraint

1. INTRODUCTION

The Geolectrical resistivity method is one of the oldest geophysical techniques which is intensively used for the investigation of the deep and shallow structure of the subsurface. By introducing the electrical current directly into the ground through a pair of current electrodes, the difference of the resulting voltage can be measured between the other pair of potential electrodes. The apparent resistivity of the subsurface can be calculated in this way in order to get the resistivity variation with depth. The depth of the penetration depends on the distance between the current electrodes. Increasing the depth of the penetration can be carried out by enlarging the distance between the current electrodes from a small distance in the beginning to larger distances at the end of the array.

This problem needs to get attention and scientific studies to avoid landslide recurrence. If repeated how the distribution of rock point locations that have the potential of landslides. The research can be used for landslide mitigation study in West Sumatera. The boundary between an avalanche material and the hard rock beneath which acts as a base is called the slip plane. The soft layer acts as a landslide material. Avalanche material is characterized by low resistivity value and landslide fields characterized by high resistivity material [1]. Electrical slip is characterized by the presence of two soil layers of highly contrasting resistance values [2],[8],[4],[5]). The slip field usually consists of low permeability and solid rock. Assistance in the field of type resilient slip (200-100) Ωm [6]. Thus, electrically sloped field structures can be known based on the resistivity of these rocks.

In general, the slip surface has the following characteristics: first, the existence of the plating of the rock such as the surface of contact between the ground cover and the bedrock. Second, the presence of contact fields between rocks cracked with strong rocks. Third, the existence of contact fields between rocks that can pass water with rocks that cannot pass water (impermeable). The depth of the slide surface which is the boundary between the moving and the fixed mass of the soil surface is essential for the description of avalanches [6]. The depth of a plane is useful to know how big the risk of a landslide that occurred. Thus, the active landslide always moves on the plane at all times or throughout the season, while the old landslide can re-activate as long as there are trigger factors for landslides. The sliding surface is formed by the saturation of the water that accumulates and moves laterally above the surface of the soil layer or the rock that is difficult to penetrate with water called the waterproof layer [7]. If water penetrates to a waterproof layer, then the waterproof surface of the waterproof layer will decay, thus becoming slippery. This slippery layer is called the slide surface. Layers that located over the plane of the slip will move along the slope and out the slope. As a result, excessive volume of water will cause soil or rock instability on the slope.

The study used the geoelectrical method to map the landslide potential areas that many researchers did before this research. The study of rock various of resistivity each location can be used to determine the slide surface since the resistivity at the sounding point that contains clay can be related to the location where the weathered plane [8]. The surface of the slide surface is a layer of water-containing clay having a resistivity between (19.3 - 36.6) Ωm, there is at a depth between (1.7 - 17 meters) and at a depth (8,9 - 16,4) meters [9]. The 2D resistivity modeling [10], showed that the slide surface was at a depth between (6 - 8) meters in the form of rotted Breccias with resistance type (30 - 118) Ωm.

Slide surface structure using profiles Tomography Multichannel Geolistrik method and drill hole found the material to compose the slide surface has low Resistivity (i.e. ± <80 Ωm)[11]. Based on least-square inversion method optimized Geoelectric data interpretation found the slope of 33-6-45 ° and 19.3 meter depth with a translational slip type in Bukitlantik Padang[12]. The range of the rocks resistivity in situ in Bukitlantik Padang vulnerable areas between (4.55- 94.1) Ω m using a time-lapse approach[13]. The surface of a slope field having a 300 Ωm type of resistance is a limestone block surrounded by Clay and Clayed Soil (Marl) having a lower resistivity [27].

The obsolete part of the Cretaceous Rock block is where the mass of wheels (slip plots) or triggers of collapsed rocks [14],[15]. Zone with type resistance (<10 ohm-m) at the depth (1100 - 1500) meters is a combination of Clay's and Chinshui Shale is a fault zone [16],[35]. This shows that in the weathered zone has a low resistance type. The subsurface rock type resistance can be explored by the geometrical method of resistance of the Wenner-Schlumberger configuration type. Interpretation of field data measurement data can be done by an inversion method. Problems encountered in interpreting data by inversion method are unique of results [17],[18] and yield stability [19], but to date, the inversion method is still the best for interpreting the Geoelectric measurement data. In order for the results of interpretation to approach a unique and stable result need to be optimized factors that influence it, such as damping factor inversion. Inversions can display the same response from three or more different models. This can cause errors in the parameter interpretation. This problem can be significantly reduced by using the Joint Inversion methods [17],[18],[20] which are then perfected by providing a lateral constraint [21],[22], but the results are still not optimal. One alternative solution to overcome the above problem is to optimize the damping factor on the least-squares smoothness-constrain inversion method.

Geolistrik method can be used to estimate the condition of subsurface geology such as rock types in the form of rock type resistance values below the surface [23], [24], [25]). Earth is not a structure that has a calculated equation [26], [27]

$$\rho_a(x) = x^2 \int_0^{\infty} T(\lambda) J_1(\lambda x) \lambda d\lambda \quad (1)$$

which ρ_a is an apparent resistivity.
where s is half the current electrode spacing in Wenner-Schlumberger electrode configuration, J_1 denotes the first-order Bessel function of the first kind and λ denotes the integral variable. The resistivity transform function, T(λ), is given by the recurrence relationship[12], [28] as follows:

$$\boldsymbol{T_i(\lambda)} = \frac{\boldsymbol{T_{i+1}(\lambda) + \rho_i \tanh(\lambda h_i)}}{\left[\boldsymbol{1 + \frac{T_{i+1}(\lambda) + \rho_i \tanh(\lambda h_i)}{\rho_i}}\right]}, \boldsymbol{i = n - 1 \ldots 1} \quad (2)$$

where, n denotes the number of layers, ρ_i and h_i is the resistivity and thickness of the ith layer, respectively.Non-linear least-squares inversion scheme iteratively updates the model parameters in each step with the use of a correction vector which is the solution of a set of normal equations. Inversion of geoelectrical data is an ill-posed problem[[17],[29].Singular Value Decomposition (SVD) is a well-known technique used in many areas of applied sciences including the earth sciences [28]. It can be easily applied to small-scale geophysical problems.However, it must be noted that the use of SVD is not logical for large-scale problems. The large-scale problems can be solved either explicitly or implicitly using iterative methods like conjugate gradients to solve by using SVD in the inversion scheme. The damped least-squares solution has been modified by ([18]

$$\boldsymbol{\Delta m = V\ diag\left\{\frac{1}{\lambda_i^2+\varepsilon^2}\right\} V^T V S U^T \Delta d} \quad (3)$$

and the parameter correction vector can be expressed as:

$$\boldsymbol{\Delta m = V\ diag\left\{\frac{\lambda_i}{\lambda_i^2+\varepsilon^2}\right\} U^T \Delta d} \quad (4)$$

So, because of this correction was not getting the optimal result, equation (4) is modified by using empiric approach, we get damping factor as follow

$$\boldsymbol{\Delta m = V\ diag\left\{\frac{0.92\lambda_i}{\lambda_i^2+\varepsilon^2}\right\} U^T \Delta d} \quad (5)$$

2. METHODOLOGY

This research is an explorative research. Interpretation results using the least-squares smoothness-constrained inversion least-residence method Geolistrik Type Resistivity data are used to obtain the slope and depth of the slip surface area in the potential landslide area. The collection of exploration results is used to estimate the distribution of potentially landslide disaster areas in Malalak Agam West Sumatra. The location of the measurement is the long song-prone area in Malalak Agam of West Sumatra with coordinates (00.22.488 S, 100.16.593 E) - (00.25,496 S, 100,17,214 E). Perta location measurement as

Figure 1
Figure 1: Measurement Locations in Kecamatan Malalak Agam West Sumatra (Google Map, September 23, 2017, [5]).

The arrangement of electrodes in the Wenner-Schlumberger configuration is shown in Figure 2

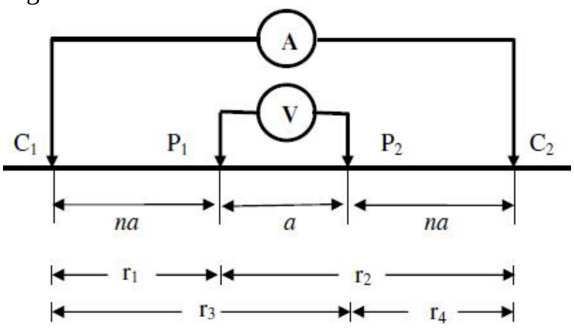

Figure 2. The configuration of Wenner-Schlumberger configuration electrode.

The apparent resistivity of measurement is calculated by the equation:

$$\rho_a = 2n\pi a(n+1)\frac{\Delta V}{I}$$

The main equipment used to obtain apparent resistivity is the multichannel Automatic Resistivity System GF Instrument (ARES) with the Ares-G4 model specification of Cheko production, belonging to the FMIPA UNP Padang. The analyzed data are interpreted by comparing the resistance value of the type obtained from the processed data with the type resistance table based on the reference and also compared with the geological condition in the direction of the measurement. The apparent resistivity data are interpreted using a Least-Square inversion in order to obtain a 2D resistivity cross-section. The 2D section of resistivity obtained is divided into several grids. The resistance types of some obtained are interpreted by the optimized Least-Square inversion method using damping. Based on the obtained 2D cross-section, it is known that the location where the layer has a true resistivity value is contrast. Based on the true resistivity price obtained, the geological structure of the disaster-prone area and the reference type reference table are estimated to be the type of rock or mineral prone area of the landslide. Based on the 2D cross-section, it is known to estimate the slope and depth of the slip-prone area in West Sumatera. Damping inversion used is a factor that has been obtained through cutting the value of singular (Equation 5)

3. RESULTS AND DISCUSSIONS

a. Damping factor. Damping factor to optimize the result of interpretation method Inversion least-squares smoothness-constrain Geolistrik resistivity data is designed using a method of intersecting singular (SVD). Base on equation (5), we get the damping factor for the wide and minimum range resistivity of 0.2 and 0.003 respectively. Then, the value of the damping factor for the first layer is 30 that we call (0.3, 0.003 and 30).
b. Characteristics of the slide surface at (00'22.259 S, 100'17,300 ') up to (00'25.488 S, 100'16,412', 100'16,318 '). 2-D cross-section resistivity in the first location as shown in Figure 3 dan Figure 4

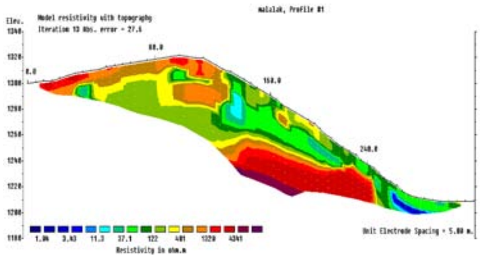

Figure 3: A 2-D cross section of the slide surface at (00'22.259 S, 100'17,300 ') up to (00'25.488 S, 100'16,412', 100'16,318 ') with general the damping factor ((0.02, 0.013 and 5)

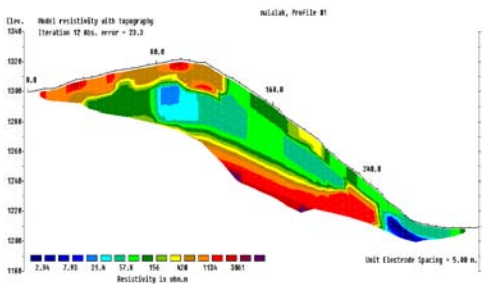

Figure 3.b
Figure 4: A 2-D cross section of the slide surface at (00'22.259 S, 100'17,300 ') up to (00'25.488 S, 100'16,412', 100'16,318 ') with optimization damping factor (0.2, 0.003 and 20)

Figures 3 and 4 show that the cross-section obtained through the use of optimized damping factors provides a description of the rock structure and clear boundary plane. However, both approaches produce the same type and structure of rocks. The rock structure in the Malalak Agam regency of West Sumatra consists of Clay, Limestone Sandstone, Andesite Dolomite, and Gravel. Clay (Resistivity = 22.3 Ohm-30 Ohm) is found between the Andesite rocks (Resistivity = 481 Ohm-meters - 3267 Ohm-meters, [24],[25]. This type of coating shows the presence of a slide in this position [30], [8]. The boundary between the mass of moving material and the stationary is called the slide surface [31]. The material that moves above the slide surface is called the landslide. So, Material movement is caused by disruption of soil stability or slope constituents.

The comparison of resistivity results allows us to determine the critical landslide criterion level, where this condition contributes to developing a landslide early warning system using the Geoelectrical method [32]. A low-type resistivity zone that forms a sloping arch consisting of clay and has a high degree of saturation is a plane, as observed in the borehole [33]. At the location of large avalanche possibility, if in this region washed down with a large volume [34]. Rock resistivity anomalies in this area are estimated due to Dolomite rocks. Dolomite is a rock solid and hard which is a waterproof rock, but easy to experience weathering. The sliding surface of this track has a slope of 43,420, with a layer thickness of 15 meters (Figure 3) [5]. Based on Figure 4, we got the slope of the slide surface was 42,350 and layer thickness was 13 meters. This data shows that slide surface that we found by high damping factor produced the clear of slide surface. The effects of Clay on Dolomite's aid areas sliding surface [35],[6]). This is what triggers this area is often landslide when washed down by heavy rain.

c. Characteristics of the slip plane at (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596'). 2-D cross-section resistivity at the second location as shown in Figure 4

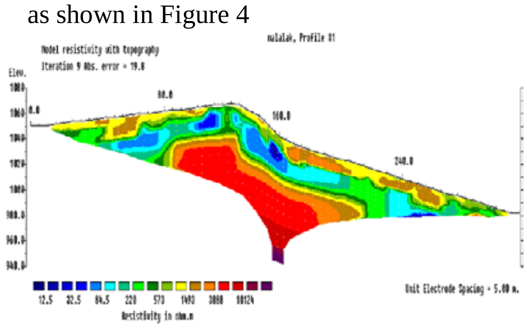

Figure 5: A 2-D cross-section of the slide surface at (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596') with general the damping factor ((0.02, 0.013 and 5)

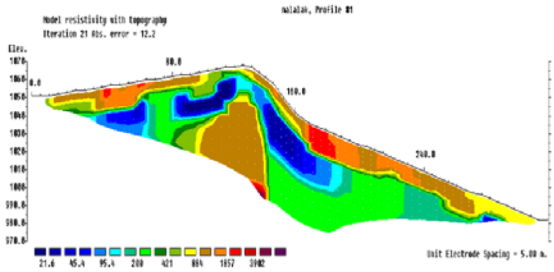

Figure 6: A 2-D cross-section of the slide surface at (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596') with optimization damping factor (0.2, 0.003 and 20)

Figure 5 and Figure 6 show that there is Gravel (Resistivity = 297 Ohm-meters - 1653 Ohm-meters) found between Andesite rocks (Resistivity = 481 Ohm-meters - 3267 Ohm-meters, Telford, et al., 1975, Reynold, 1997). At Figure 5, there is no slip field because it does not comply with the requirements of the landslide (Bari, 2011, Joab & Andrews, 2009, Akmam, et al., 2014, Akmam, et al., 2015). Landslides with large volumes are expected to occur rarely at this location. However, this field of inactivity is inactive because at this location which acts as a field of slip is Gravel is not water-resistant. Small-scale landslides may occur at this location because the hill at this location is quite steep. However, in Figur 6, the 2D resistivity cross-section is the result of least-square inversion with optimized damping factor resulting in a 2-D cross-sectional interpretation showing the presence of a slip plane. So, we can say that in there is the slip surface at (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596') which have the depth and the angle of slide surface are 43.210 and 23 meters. This is not the active slide surface.

4. CONCLUSIONS AND IMPLEMENTATION

a. Damping factor to optimize results of interpretation method Inversion least-squares smoothness-constrain data Geolistrik resistivity in this research earn respectively, for wide range resistivity and minimum factor damping are 0.2 and 0.003. Then, the value of the damping factor for the first layer is 30.
b. The rock's structure in Malalak Agam District West Sumatra consists of consists of Clay, Limestone Sandstone, Andesite Dolomite, and Gravel.
c. The depth and the angle of the slip surface at (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596') are 40.380 and 16.5 meters. This is the active slide surface. 4. The depth and the angle of the slip surface at (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596') are 43.210 and 23 meters. This is not the active slide surface.

d. The implementation of the results of this study is at coordinates (00'22.259 S100'17,300 ') to (00'24.576 S, 100'16,596') must be planned mitigation of the landslide disaster well. Mitigation that can be done is to make a landslide dam with a depth of 17 meters. Dams that must be able to pass water, so that the ground masses do not push the dam during heavy rain.

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