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Slope failures evaluation and landslides investigation using 2-D resistivity method

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ABSTRACT

Slope failure is a complex phenomenon that may caused to landslides. Buildings and infrastructure such as transportation facilities and pipelines located within the boundaries of a landslide can be damaged or destroyed. Slope failure classification and various factors contributing to the instability using 2-D resistivity survey conducted in Selangor, Malaysia are described. Six 2-D resistivity survey lines with 5 m minimum electrode spacing using Pole-dipole array were performed. The data were processed using Res2Dinv and surfer10 software to evaluate the subsurface characteristics. The 2-D resistivity results show that the subsurface consist of two main zones. The first zone was alluvium or highly weathered with resistivity value of 100–1000 Ω m and depth of >30 m. This zone consists of saturated area with resistivity value of 1–100 Ω m and boulders with resistivity value of 1200–7000 Ω m. The second zone with resistivity value of >7000 Ω m was interpreted as granitic bedrock. The study area was characterized by saturated zones, highly weathered zone, highly contain of sand and boulders that will trigger slope failure in the survey area. This will cause to low strength of soil, debris flow and movement of earth. On the basis of the case examples described, 2-D resistivity method is categorized into desirable and useful method in determination of slope failure and future assessments.

1. Introduction

Landslides and slope failure are always related to hilly areas and restricted essentially to the urban area. Development for tourism and residential is still rampant in these areas. The prevalence of failures is due to a combination of few factors; i.e. topography, climate, geology and land use. Some countries have similar soils but different rainfall patterns, or similar rainfall but different land use. Urban development including used of steep natural slopes for housing and road are potentially caused unstable areas.

The purpose of resistivity survey is to determine the subsurface resistivity distribution by taking measurements on the ground surface. True resistivity of the subsurface can be estimated (Fig. 1). The ground resistivity is related to various geological parameters such as mineral and fluid content, porosity and degree of water saturation in rock. Variations in electrical resistivity may indicate changes in composition, layer or contaminant levels (Telford and Sheriff, 1984).

2. Methodology

Six (6) 2-D resistivity survey lines were conducted in Selangor. Lines RL1-RL3 was conducted towards North-South direction as shown in while RL4-RL6 directed towards West-East (Fig. 2). The length for all the 2-D resistivity survey lines were 200 m except for RL1 and RL4 is 300 m each. RL1 was located outside the collapsed area while RL2-RL6 located in the collapsed area. The protocol used for 2-D resistivity was Pole-dipole with 5 m minimum electrode spacing and the data was processed using Res2Dinv software.

3. Results and discussion

From the 2-D resistivity method, the inversion model resistivity for potential area, RL1 (outside collapsed area) (Fig. 3) shows there are 2 main zones. The first zone is alluvium or highly weathered

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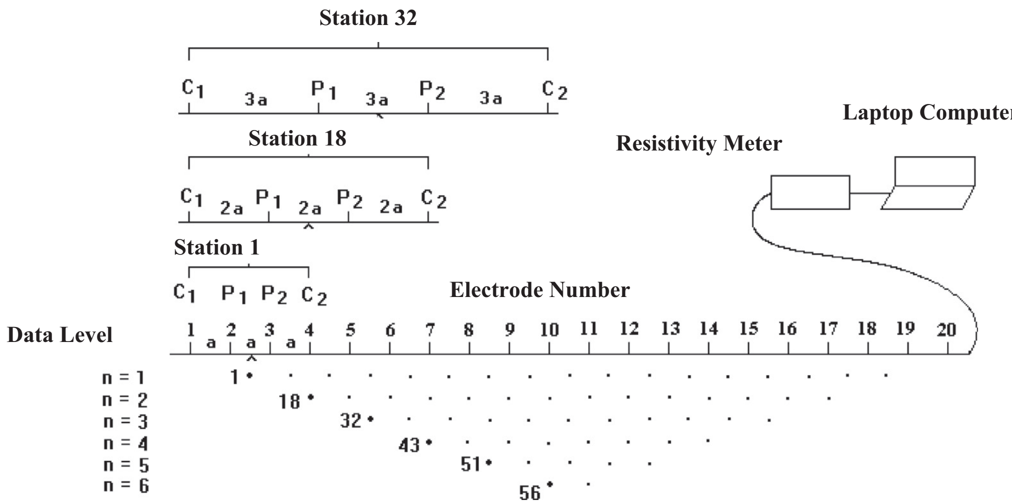

Fig. 1. The arrangement of electrodes for a 2-D electrical survey and the sequence of measurements used to build up a pseudo section (Loke, 1999).

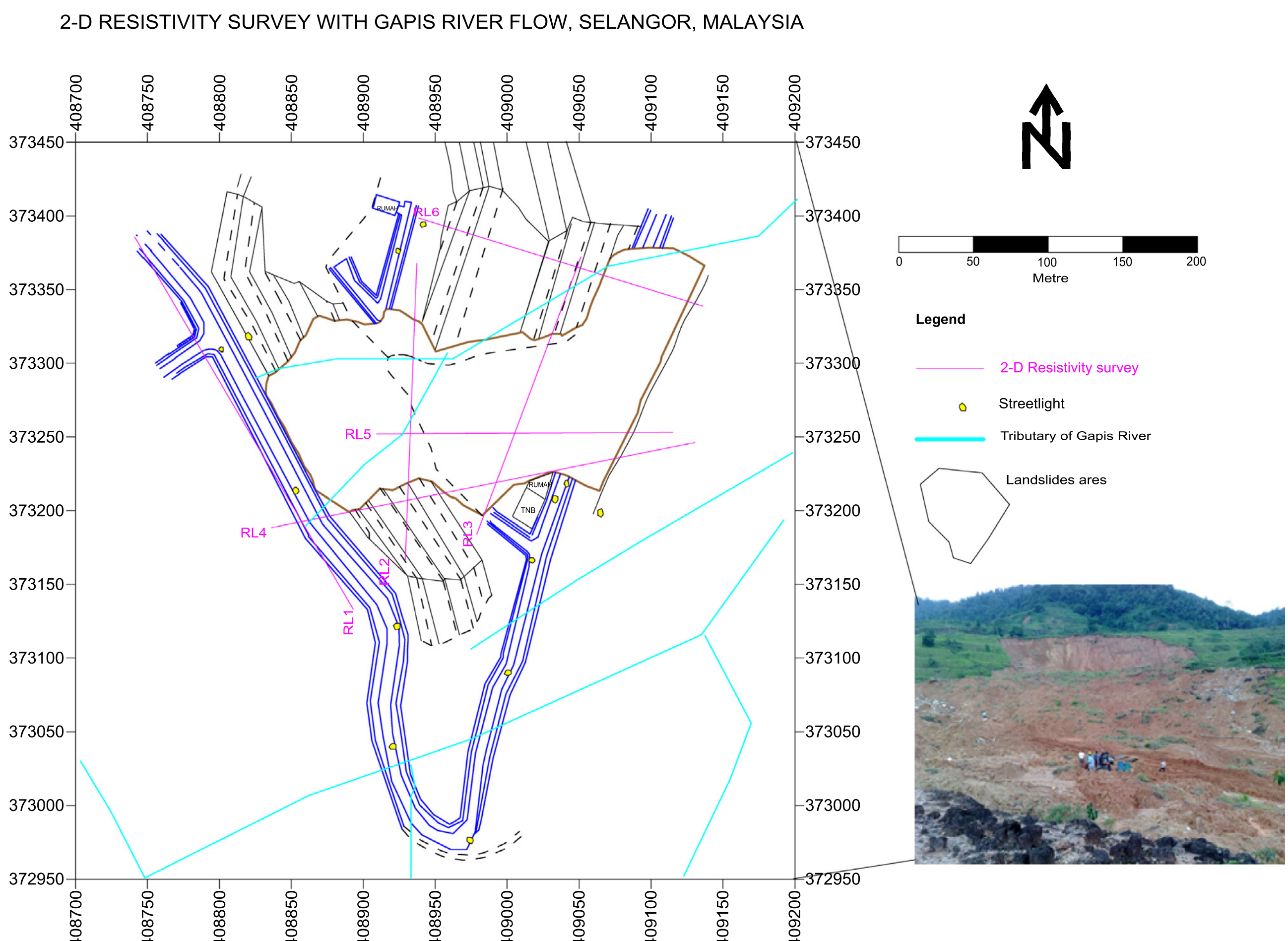

Fig. 2. 2-D resistivity survey in Selangor, Malaysia.

with resistivity values of 100–1000 Ω m and depth of 70 m. This zone consists of saturated zone (1–100 Ω m) and boulders (1200–7000 Ω m). The second zone with resistivity value of >7000 Ω m which interpreted as granitic bedrock. A lot of small fractures can be seen around the study area as shown in Photo 1.

Fig. 4 shows the inversion model resistivity of RL2 and RL3 which has two main zones. The first zone is alluvium or highly weathered with resistivity value of 100–1000 Ω m and depth of 30–70 m. RL2 shows saturated zone while RL3 consists of alluvium or highly weathered zone. Boulders and fractures were located outside the collapsed area with resistivity value of 1200–7000 Ω m. Alluvium may consist of clay, sand and silt. These types of soils indicate that for hillslopes containing both sandy and silty soils, failure can occur above water table under steady infiltration