Slope Field Mapping and Findings at Ulu Klang Area, Malaysia

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Abstract

At present, sufficient technology is available in Malaysia to prevent landslide from occurring if the potential danger was spotted or identified with sufficient time available for mitigation measures to be implemented. However the probability of spotting a potential landslide and performing appropriate mitigation works are very low. Hence many landslides occur without warning and often result in loss of life and property. This has led many researchers to initiate research on landslide early warning systems. The development in information technology has contributed a major role in providing or integrating the state-of-the-art technology needed to manage analyses, predict and respond to potential landslide events in order to minimize losses. The pilot project undertaken by Public Works Department (Malaysia), “The Slope Hazard Assessment and Mapping for Ulu Klang Area, Malaysia” was aimed at establish a well guided and documented, area based geomorphological mapping in Malaysia, with proper documentation system for field data collection and database recording. This paper will address the itinerary required to conduct the area based geomorphological or field mapping of Ulu Klang Area such as proforma preparation, quality assurance and quality control together with some of the findings from the field mapping works carried out.

Keywords: Field Mapping, Landslide, Geomorphological Mapping, Proforma, Geological, Geotechinical.

1.0 INTRODUCTION

The “The Slope Hazard Assessment and Mapping for Ulu Klang Area” aims at establishing an area based geomorphological mapping in Malaysia, and prepare proper documentation system for field data collection and database recording. The objective of this study is to identify various factors causing the landslides occurrences in Ulu Klang Area. Some of these factors are;

- Heavy prolonged rainfall with uncontrolled surface runoff
- Geomorphological factors
- Geological and geotechnical factors
- Hydrological factors
- Climatic factors
- Other factors such as vegetation cover and human activity

This paper addresses the itinerary and methodologies required to conduct geomorphological mapping to extract out impediments which could lead to a potential soil or rock slope failure.

2.0 GEOMORPHOLOGICAL MAPPING AND GIS DATABASE

The term geomorphology is explained as the science of the forms of Earth’s surface and the processes creating and reshaping them (National Encyclopedia, 1992). This incorporates parts of many different factors such as geophysics, sedimentology, geochemistry, hydrology, climatology, and engineering.

Geomorphology deals with the combination of these together with landscape configuration and development. Scientific attempts to understand and document the landscape since the late 19th century resulted in maps with emphasis on the geomorphology. To construct such a map the geomorphology first needs to be generalized into subparts of recordable data. A better method is to subdivide geomorphology into the descriptive parts: morphology, genesis, processes, lithology, chronology and hydrography.

Since the last decades before 2000 geomorphological surveys and mapping have emerged from mainly two different approaches. The first approach is the analytical, which base the map content on descriptive information on genesis, morphography, morphometry and chronology, while the second approach is the synthetic, where the geomorphological data are presented and combined with non-geomorphological parameters such as soils, vegetation and hydrology. Apart from these two comprehensive approaches, a third approach is the pragmatic approach, where only limited geomorphological information concerning a specific purpose is collected (Ten Cate, 1990). Early geomorphological investigations were published as verbal descriptions of landforms, including some profiles, photographs and drawings, and also thematic geomorphological maps were constructed (Klimaszewski, 1982 and Elvhage, 1983).

The descriptions of landscapes have changed over the years from simple illustrations with description to detail data collection with complex legend. With the development of Geographic Information Systems (GIS) which has huge data handling capacity, the description of landscape development has faded away. This has led to accurate development of field data collection method for GIS input and analysis. The geomorphological GIS developed in parallel with the mapping system are an attempt to connect the "traditional" geomorphological mapping with the modern GIS environment. The clear separation of descriptive and interpretative data in the new mapping system, GIS enables an easy transformation from the geomorphological map to an object based geomorphological geodatabase (Elvhage, 1983).

As for the Ulu Klang area, rapid development of urban areas has made the local government unable to establish adequate landslide or slope failure preventive measures. With this study in place, the Public Works Department would be able to identify the high risk areas and high light the relevant measures to be taken to prevent failures or loss of lives and properties. The measures taken can be considered as a program to manage failure prone areas and landslide mitigation using inspection records and spatial data (Inagaki and Sadohara, 2006).

2.1 Slope or Landslide Information

The slope or landslide information should comprise of information on slope management which consists of field survey slope information, past and present landslide information. The information collected is required to be updated periodically in order to integrate with landslide potential risk and prediction factors. Under the slope management scope of works it is critical to conduct continuous examination of slopes and information updating such as

- Slope inventory
- Past and present landslides
- Monitoring records of creeping land mass
- Real-time updating of precipitation data

The information present in GIS required to be extracted in a user friendly manner. As such the details of a particular slope are required to have the following information;

- Address of slope, by street name, land lot numbers, etc.
- Slope identification number and name, given as per GPS coordinates.

With the slope information system, on aerial maps indicating hazardous and high risk slopes for continuous observation, required to indicate:

- Areas of critical slopes

- Location of past and present landslide scars
- Areas showing signs of distress and movement

Hence the data input within the slope management database are required to be analyzed further to identify the hazards involved.

3.0 FIELD STUDY REQUIREMENT

The field study for this project requires the various factors which were involved in causing the landslides at Ulu Klang area to be identified. The study will take into consideration of the factors which requires recording such as:

- Site investigation (from past development record)
- Rain fall intensity and duration
- Geomorphological factors
- Geological and geotechnical factor
- Hydrological factor
- Climatic factor
- Land use
- Vegetation cover
- Human activities

In order to conduct the field study effectively, field log sheets (Proforma) were created, which will record general information, information related to potential soil or rock slope risk features and factors related defects to soil slope, rock slope and structures.

3.1 Proforma Preparation

For the project, field survey log sheets were created, the sheet (Proforma) will detail out geomorphological condition of the site. Some of the major information required and will be logged in the proforma will be as follows:

- Site location, slope condition, drainage system and the GPS location
- Slope features such as embankment, cut, natural slope etc.
- Slope geometry containing
  - Slope plan profile
  - Slope height and berm width
  - Distress location
  - Feature aspect
  - etc.
- Slope cover
- Pavement condition such as cracks, potholes, etc.
- Drainage system, drain sizes and condition
- Erosion condition
- Status of feature such as location of pass and present landslide scar, tension cracks, location of failure, etc.
- General comment and description of the site
- Sketch of the site
- Quality control check

Figure 1 shows legend for Geomorphological map used for the project.

Figure 1 : Legend for Geomorphological Map, used for the project

3.2 Geological and Geotechnical Factors Requires Recording

Geological factors required to be studied and presented are as follows:

- Soil/rock type, rock profile, rock exposures percentage, presence of colluvium/scree, corestone boulders, percentage of surface crusting, adverse geological features and fault line.
- Discontinuities
- Material and weathered grade percentage
- Geological features such as joints, faults, uniformity, tension crack, bedding, raveling slope (heavily jointed with fragile material)
- Evidence of distress such as surficial loosening, overhanging blocks, tension cracks along crest of the slope
- Joint information, Dip/dip direction, spacing, persistence, termination, shape, aperture, roughness, infilled material and seepage
- Potential failure type, planar, topple, wedge fall, rock fall
- Length and angle of slope
- Distress location on slope
- Slope cover
- Tension crack – Length and width
- Soil type

3.3 Hydrological Factors

In order to perform the hazard analysis to identify the hydrological factors causing the landslide; studies will be made using the GIS platform to evaluate the catchment size and the direction of surface runoff. In order to have the sufficient data for analysis geomorphological mapping are required to be done to identify the areas of seepage, saturated ground and water pounding zones.

3.4 Other Factors

Other contributing factors are also required to be identified and noted such as :

- Vegetation cover and infiltration rate
- Human Activity
- The modifications of slopes by cut and fill activities associated with construction, interference with or without changes to natural drainage system, the removal of vegetation, and excavation.
- Natural causes, saturation of slope material due to rainfall or seepage, erosion, loose rock masses from vegetation growth within joints, etc.

Based on the above study and evaluation made, it is recommended to outline the slope proforma as detailed as possible to support accurate input for Geographical Information System (GIS). The field study under the project covers the aspect of survey for slope, structural and geological mapping. Hence four field proformas were required to complete the geomorphology survey namely:

- Slope Proforma
- Structural Proforma
- Geological Discontinuity Proforma
- Incident Proforma

The proformas will record details of distress, defects, inadequacy of construction or design, assess the potential risk and hazard and also identity mode of failures and record the failure conditions and locations using GPS. The proforma proposed for this study will include GPS location of the slope and also the previous failure and tension cracks. The team members are required to sketch out the survey details within the proforma using a given geomorphological map legend in order to standardize the legend marking within the sketch. Figure 2 shows an example of field geomorphological survey done for a soil slope, with a bunglow on top of slope showing signs of distress, with cracks on apron slopes and columns.

4.0 Field Survey and Problems

The major difficulty in conducting field mapping is the lack of trained personnel to carry out the works. This could lead to:

- Inconsistency in the field recording and mapping
- Missing out critical elements

In order to overcome these impediments, training was provided to the field team members. Along with training quality control and quality assurance are required to be implemented.

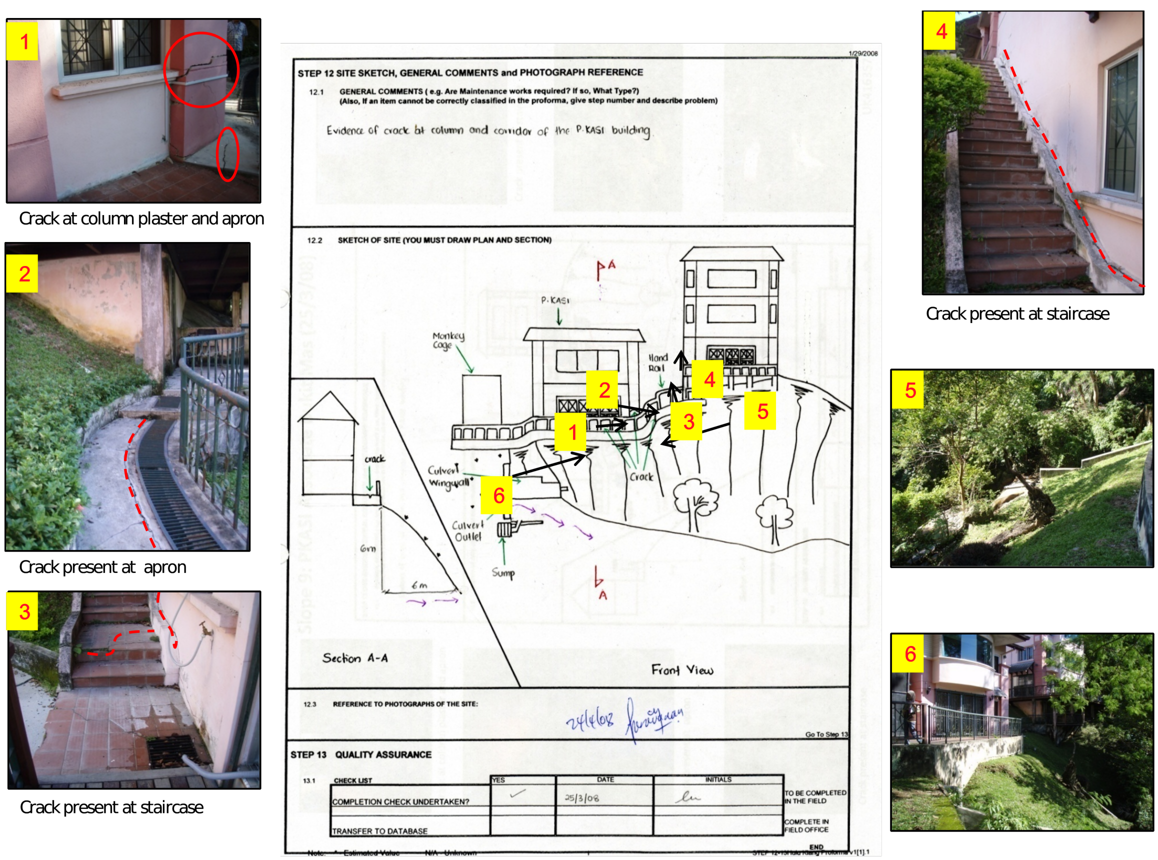

Figure 2 : shows an example of field geomorphological survey done for a soil slope, with a bunglow on top of slope showing signs of distress, with cracks on apron slopes and columns.

4.1 Quality Assurance and Quality Control

In order to ensure quality of work, quality assurance and quality control were implemented which were divided into three stages, namely,

Stage 1 – Screening of proforma by the team leader, After completion of field survey the Proforma(s) need to be completed, checked and endorsed by the team leader to ensure no blank fields

Stage 2 – Screening will be done by senior geotechnical engineers, senior structural engineers and senior geologist. Before the data are entered into the database by the team members are required to verify the quality of works is done by senior engineers.

Stage 3 – Screening by the experts by conducting expert judgment. Each and every proforma will be studied by QA / QC team and field survey will also be conducted for critical sites. Additional field survey will also be conducted for very critical sites by senior project engineer.

5.0 FIELD FINDINGS

The total number of slope, geological and structural proforma completed were 405, 82 and 77 numbers respectively for the field survey works. A total of 564 locations were recorded, covering 45 numbers of residential and developed areas in Ampang. Table 1 list out the areas covered by the field team

Table 1: List of Areas Covered for the geomorphological survey

i. Ampang Hulu Langat Hilltop Link Road	xxiii. Setiawangsa (MPAJ / DBKL)
(MPAJ & MPKJ)	xxiv. Taman Bukit Permai (MPAJ)
ii. Bukit Antarabangsa (MPAJ)	xxv. Taman Bukit Teratai (MPAJ)
iii. Bukit Bayu (MPAJ)	xxvi. Taman Cemerlang (DBKL / MPS)
iv. Bukit Belacan (MPAJ)	xxvii. Taman Desa Melawati (MPAJ)
v. Bukit Dinding (MPAJ)	xxviii. Taman Hijau (MPAJ)
vi. Bukit Indah (MPAJ)	xxix. Taman Hillview (MPAJ)
vii. Bukit Mas (DBKL)	xxx. Taman Kelab Ukay (MPAJ)
viii. Bukit Melawati (MPAJ)	xxxi. Taman Kemensah (MPAJ)
ix. Bukit Utama (MPAJ)	xxxii. Taman Keramat (MPAJ)
x. Desa Tun Hussein Onn (DBKL)	xxxiii. Taman Lembah Jaya Selatan
xi. Gombak (MPS)	xxxiv. Taman Melati (DBKL)
xii. Jalan Genting Klang (DBKL)	xxxv. Taman Melawati (MPAJ)
xiii. Kampung Bukit Sungai Putih (MPAJ)	xxxvi. Taman Mulia Jaya (MPAJ)
xiv. Kampung Kemensah (MPAJ)	xxxvii. Taman Nusa Kurnia (MPAJ)
xv. Kampung Pasir (MPAJ)	xxxviii. Taman Perkasa Indah, Hulu Langat (MPAJ)
xvi. Kampung Tengah Ampang (MPAJ)	xxxix. Taman Saga (MPAJ)
xvii. Karak Highway (MPS)	xl. Taman Sri Watan
xviii. Keramat Permai (MPAJ / DBKL)	xli. Taman TAR (MPAJ)
xix. Keramat Wangsa (MPAJ)	xlii. Ukay Heights (MPAJ)
xx. Klang Gate (MPAJ)	xliii. Ukay Perdana (MPAJ)
xxi. Kuari Wira Waja (MPAJ)	xliv. Wangsa Maju (DBKL)
xxii. Permai Jaya (MPAJ)	xlv. Wangsa Ukay (DBKL)

Based on the field findings the areas which would require both short and long term solutions were identified. As such the cases identified to prevent landslides are listed in Table 2.

Table 2 : Cases identified to prevent landslides

a) Geotechnical related matters : i. Areas of blocked drains ii. Areas of broken drains iii. Areas of undersized drains or no drainage system iv. Areas of surface runoff v. Areas of over grown bushes vi. Areas of steep slopes condition at developed area vii. Areas of steep slope condition with inadequate design (assumed) viii. Areas of steep slope condition due to ignorance of resident's cutting ix. Areas of heavy seepage x. Areas of saturated ground xi. Areas of inadequate buffer zone (< 6m) for old development (assumed older than 1995) xii. Areas of inadequate buffer zone (< 6m) for new development xiii. Areas with valley and stream facing development xiv. Areas of potential debris flow xv. Areas of serious erosion xvi. Areas of tension crack on pavement and gunite surface xvii. Areas of soil creep on slope xviii. Areas of ground anchors	b) Geological related matters i. Areas of potential rock fall ii. Areas of daylighting rock and soil slope iii. Areas of rock overhang iv. Areas of inadequate buffer zone (<6m) near rock slope v. Areas with rock surface runoff over joint vi. Areas with weak interface between soil and rock vii. Areas with seepage on rock slope viii. Areas with deep tree rooting in cracks or joints in rock c) Structure related matters i. Areas of structural defects on walls ii. Areas of weep holes requires services iii. Areas of seepage from wall iv. Areas of cracks on wall v. Areas of cracks on buildings vi. Areas with structural defects (on buildings)

Typical locations with defects or attention required are shown in Figure 3 as a geomorphological map.

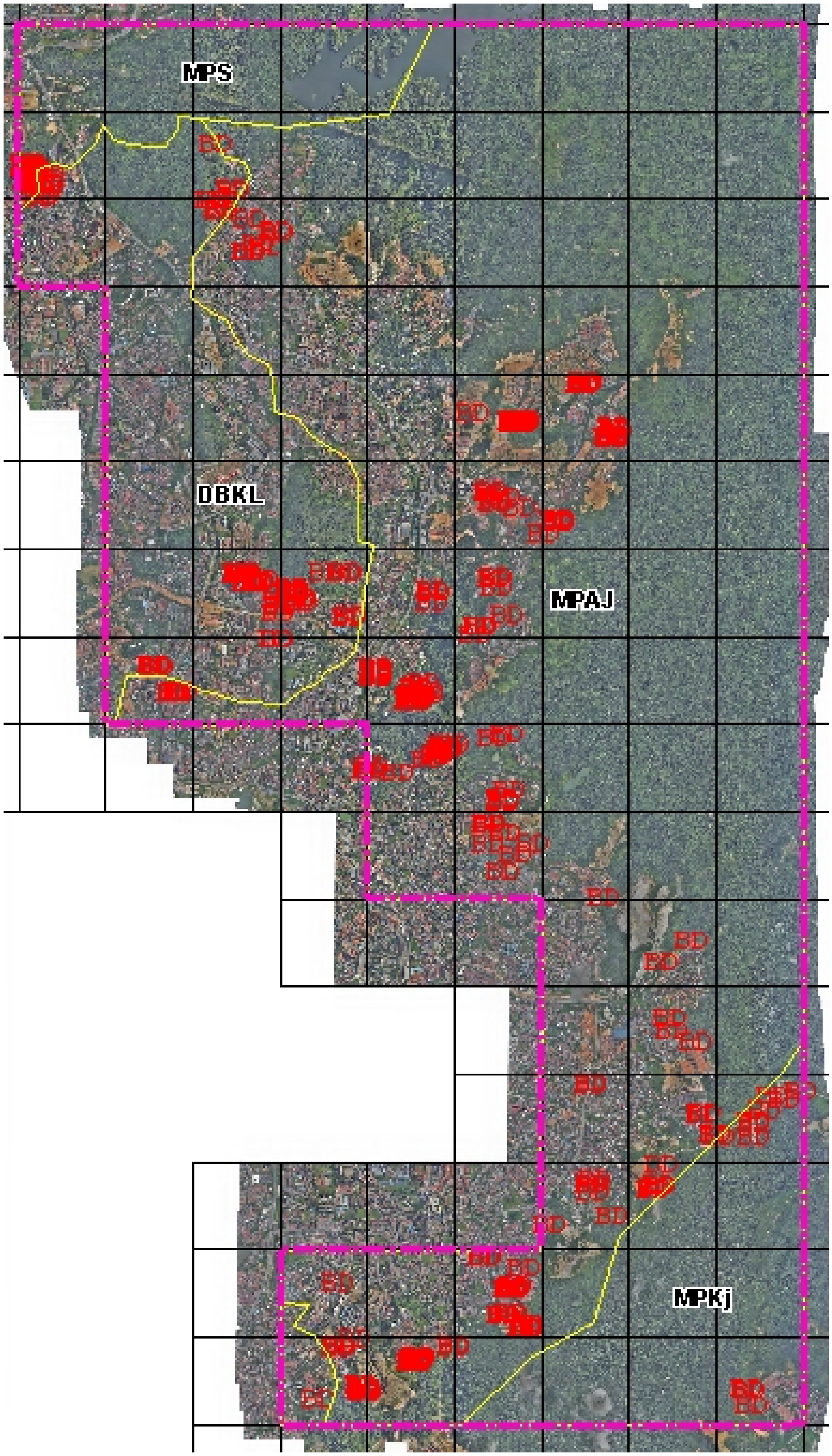

Figure 3 : Geomorpohology Map showing areas with blocked drain

6.0 CONCLUSION

Based on the field survey works at Ulu Klang area, following are some of the finding conclusions

- Major failures are related to rock falls of which the places involved are mainly in ex quarry area, developed without proper scaling and protection of loose rocks. The rocks falls are mainly due to discontinuity, daylighting effect and many other factors. Hence it is recommended that the rock slope areas need to be monitored carefully and perform stabilization works.
- As observed in Ulu Klang area, a total of 152 landslide scars of both soil and rock slopes were identified. Most of it have not been remedied and left unattended. These sites could become the potential slope failure site which could be fatal.
- Some of the slopes in Ulu Klang area have been stabilized using ground anchors, which left not maintained based on field observations. It is highly recommended for the respective local authorities to take actions, as some of the slopes are very steep and high next to road and residential area.
- Another main factor causing slope failures are due to poorly maintained drainage system for slopes, this study have also identified the areas which requires improvement in the drainage system. The needs to conduct regular maintenance and repair works are critical in Ampang area. There are areas with no drainage system to prevent surface runoff, water ponding and infiltration.

Hence based on the list of defects or matters related to geotechnical, geological and structural in Table 2 which could cause potential landslide or slope failures, the local authorities need to address the defects systematically. The field survey or geomorphological survey conducted were able to carefully identify the areas with problems or detects individually with reference to district, housing estate name, street name and GPS locations. This information will be useful for the local authorities to conduct rectification and maintenances works effectively.

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