Development in hilly areas induced slope stability – case history

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ABSTRACT
Malaysia's capital city, Kuala Lumpur, was developed on two different types of terrain—low-lying, flat areas for business centres and hillsides for residential and social activities. Kuala Lumpur started undergoing development in 1961 and gained city status in 1972. At the outskirts of Kuala Lumpur is a suburb called Hulu Klang, comprising residential developments in a very hilly area. Altogether the hills cover an area of approximately 100km². Since 1969, several landslide disasters have occurred on hills with a high concentration of housing developments. One of the major disasters occurred in 1993, when the 12-floor Highland Tower Condominium collapsed due to a landslide. The collapse claimed 48 lives. The latest landslide disaster happened in Bkt. Antarabangsa in November 2008, which destroyed 14 homes and took 5 lives. This paper provides a summary of actions that have been taken and measures that are to be implemented to reduce future landslide disasters in urban areas.
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RÉSUMÉ
La capital de la Malaisie, Kuala Lumpur, s'est développée sur deux types de terrains: sur des zones à basse altitude et des plaines pour les centres d'affaires et sur des coteaux pour les zones résidentielles et réservées aux activités sociales. Kuala Lumpur a commencé à se developer en 1961 et a gagné son statut de ville en 1972. À la périphérie de Kuala Lumpur se trouve la banlieue de Hulu Klang, constituée de zones résidentielles sur un terrain très vallonné. Les coteaux couvrent une superficie globale d'environ 100 km^2. Depuis 1969, plusieurs glissements de terrain ont affecté des coteaux accueillant de fortes concentrations de lotissements. L'une des catastrophes majeures s'est produite en 1993, lorsque le condominium Highland Tower de douze étages s'est effondré lors d'un glissement de terrain. Cet écroulement a coûté la vie à 48 personnes. La dernière catastrophe en date due à un glissement de terrain s'est produite à Bukit Antarabangsa en decembre 2009, détruisant 14 habitations et fauchant la vie de 5 personnes.
Cet article présente un récapitulatif des actions qui ont été enterprises et des mesures qui doivent être mises en œuvre pour réduire à l'avenir le nombre de glissements de terrains dans les zones urbaines.

1 INTRODUCTION

Kuala Lumpur is nation's Capital City and the biggest city in Malaysia. Kuala Lumpur City has become very important and conducts various activities including businesses, finances, administrations, educations, religions, cultures and sports. Kuala Lumpur development began 1961 and City status was obtained on 1st February, 1972. The municipality of the city covers an area of 243.65 km^2 (94.07 sq mi).

Kuala Lumpur, which is located in the Klang Valley, is divided into two areas, the low land area and the hilly area. The low land area comprises of Kuala Lumpur City Centre and the hilly area included Hulu Klang area which is located out skirt of Kuala Lumpur which was developed as a residential/social areas. The average elevation at Klang valley is approximately 75m and at the maximum elevation at the Hulu Klang is 250m from sea level. This area covers approximately 100km^2. It is believed that development in the area began in 1972. In year 1984 to 2000 this area was developed rapidly due to its close proximity to Kuala Lumpur city and its panoramic location. Developments and residential projects were taking place in Hulu Klang causing the hilly areas open to earthwork activities to make a platform without considering regulatory matters. As a result the development at those areas induced the slope stability and causing numerous landslides catastrophes.

One of the major landslides was happened on 11 December 1993, whereas Highland Tower was collapsed and since that several other major landslides was occurred in that area.

1.1 Describing landslide location

The following are major cases of landslides occurred in Hulu Klang since 1993 until 2008:-

- Highland Tower and Tmn. Hillview
- Wangsa Maju
- Kg. Pasir, Hulu Klang
- Bkt Antarabangsa

Figure 1 shows the location of Kuala Lumpur City Centre (KLCC) as well as the location of landslides.

Based on cross-section KLCC-A to KLCC-D, all landslide locations are located at 100m above the sea level except for Highland Tower which was located at 70m from the sea level. Figure 2 and 3 show cross-section of the level of landslide location for five major landslides.

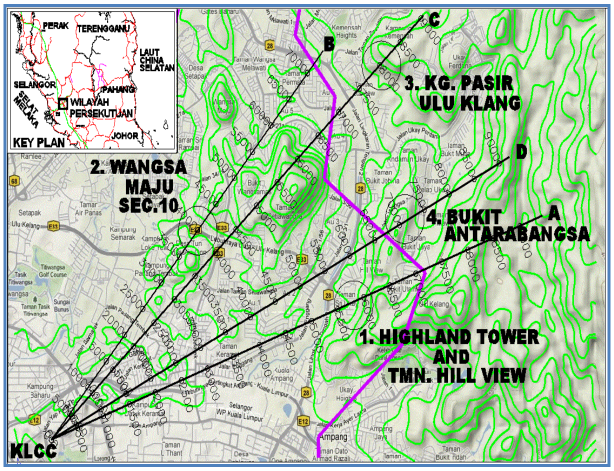

Figure 1: Location of landslide

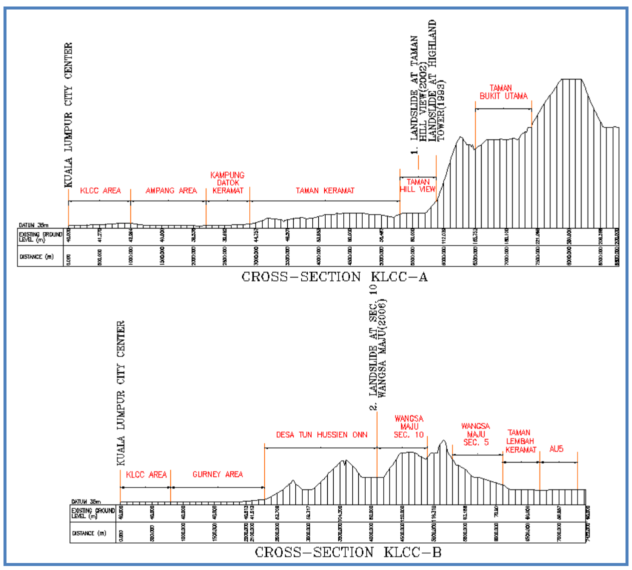

Figure 2. Cross-section KLCC - A refer to the collapse of Highland Tower and the landslide in Taman Hill View. In the essence of cross-section KLCC –B shows the location of landslide at Wangsa Maju.

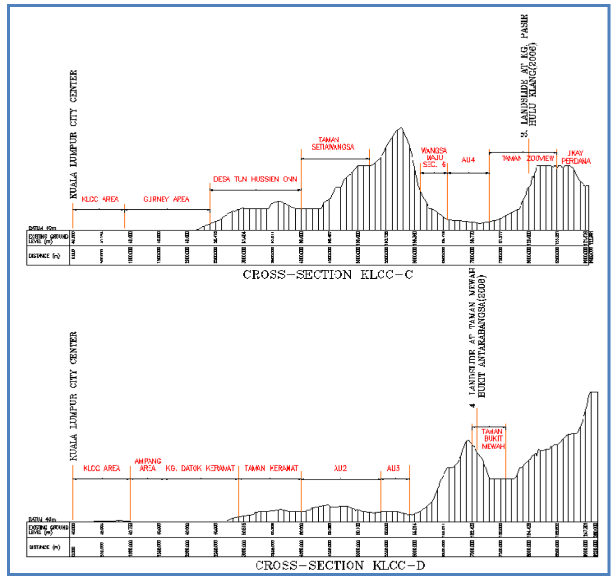

Figure 3. Cross-section KLCC - C refer to the landslide at Kg. Pasir Furthermore cross-section KLCC –D shows the location of landslide at Tmn. Bukit Mewah, Bkt. Antarabangsa.

In summary those cross-sections showed that landslide seemed to happen at hilly site. This paper will further present the causes of failure in that area and discusses several actions that have been taken and proposes actions suppose to be implemented to reduce the landslide.

2 LANDSLIDE HISTORIES IN HULU KLANG AREA

Most of the flat lands in Hulu Klang area underwent extensive development that had caused the development of available hilly terrain areas. Development in this hilly terrains area started rapidly in 1974. Such terrains development seems safe at that time, until year 1993 in which landslide started took place.

Table 1 summaries some of the major landslides at Hulu Klang area showing category of development;

Date of occurrence	Location	Category	Fatality
3 Dec 1993	Highland Tower	Residential	48
22 Nov 2002	Taman Hillview	Residential	8
31 May 2006	Kg. Pasir	Residential	4
5 Nov 2006	Wangsa Maju	Residential	None
6 Dec 2008	Tmn Mewah, Bkt. Antarabangsa	Residential	5

Table1. Major Landslide at Hulu Kelang area showing category of development.

2.1 The collapse of Block 1 Highland Tower Condominium, Hulu Klang – 1993

The Highland Towers Condominium comprised of 3 blocks of 12 storey condominium which was constructed between 1975 and 1978. Block 1 was completed and occupied in 1979 but was collapsed in 1993 that was 14 years after the completion and killed 48 people. The reduce level (R.L) for Block 1 is approximately 70m and located 6km from Kuala Lumpur City Center (KLCC) as shown in Figure 1. Figure 4 shows the collapsed of Block 1. It was happened after 10 days of continuous rainfall as recorded at rain gauge JPS Ampang. The cumulative daily rainfall intensity measured from 1st to 10th December 1993 was 177.5mm and the measured maximum daily rainfall intensity was 59.5mm.

Figure 4. Block 1 Highland Tower Condominium

The local authority for that area is known as Ampang Jaya Municipal Council (MPAJ) whose formed an Inquiry Committee on 14th December 1993 to investigate the collapsed. Subsequently, the Inquiry Committee set up a Technical Committee lead by Public Works Department Malaysia (PWD Malaysia) to carry out the technical investigation in order to investigate the causes of the failure. The technical committee has published a report entitled "Report of The Technical Committee of Investigation On The Collapse of Block 1 and The Stability of Blocks 2 and 3 Highland Towers Condominium, Hulu Klang Selangor Darul Ehsan" in 15th April 1994".

The investigation report explained that the most probable causes of the collapse of the Tower 1 were the buckling and shearing of the rail piles foundation induced by the movement of the soil. The movement of the soil was the consequence of retrogressive landslides behind the building of Block 1.

The slope and rubble walls behind and in front of Block 1 were also found to be improperly designed with an overall Factor of Safety of less than 1. Figure 5 shows the sequence of retrogressive failures that took place, causing large soil movement and increased in lateral pressure to the foundation of the building and the rubble wall in front of the Block until it collapsed and was followed by the toppling of the block 1 Highland Tower.

Investigation also found that inadequate provision of drainage system and the lack of maintenance of the drains aggravated the friable nature of the slope materials by increased surface runoff and infiltration rate that finally triggered the series of landslides.

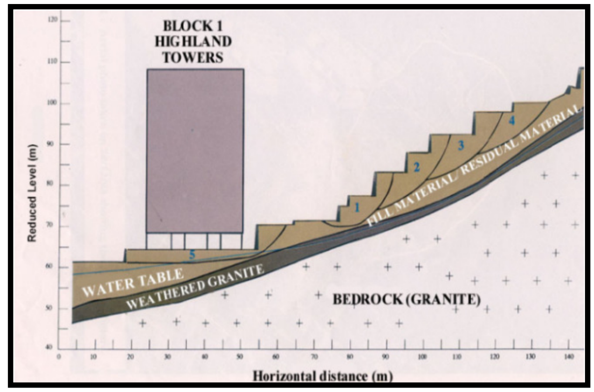

Figure 5. Retrogressive failure behind block 1 highland tower

2.2 Landslide at Taman Hillview, Hulu Klang - 2002

A landslide happened on a hill slope at Taman Hillview at 4.30 a.m. on 20th November 2002, destroyed a bungalow and killed 8 people as shown in Figure 6. The National Disaster Management in the Prime Minister's Department instructed the Public Works Department Malaysia (PWD Malaysia) to form a Landslide Working Group (LWG) to investigate the causes of failure and identifying areas with high landslide risks and to come up with mitigation measures.

Figure 6. Debris flow from top and hit damage the bungalow

Investigations found that development in the southern end of the land owned by Highland Properties had resulted in the filling of two former valleys above and to the east of damaging bungalow. The fill material is composed by the loose silty sand with gravels, boulders and organic material. Sometimes between 1996 and 1999, landslide debris from the landslide was deposited along the valley floor as well as on to the adjacent valley to the south (where the recent landslide occurred on 20th November 2002). Debris from the old landslide blocked the original course of water flow, diverting the surface runoff to the southern valley.

Terraces were cut and rubble walls were constructed on the upper reaches of the hill slopes within the land owned by Highland Properties. Analysis on seven rubble walls showed that all the walls were unstable and were susceptible to overturning and bearing capacity failures.

The annual maximum 30-days rainfall in the month of November 2002 in Ampang area was 675.5mm which is also the third highest in the last 51 years. Significant rainfall ranging from 46mm to 85mm was recorded three days prior to the incident. The exceptional heavy rainfall had increased the ponding area of some marshy ground on a cut platform in the upper reaches of the study area. Outflow of water from this marshy ground had resulted in some water seeping towards the filled valley where the recent landslide was located. The heavy rainfall had also saturated the fill material in the valley as well as the soil behind the rubble walls resulting in a reduction of the cohesion and the increased in the weight of the soil and fill material. The infiltration of the rainfall had also raised the groundwater level.

The above factors had triggered off the failure of the slope on 20th November 2002, bringing down rubble wall. The debris would then caused scouring on the landslide scar and with an abundance of water in the soil, the debris became fluid and flowed down hill then destroyed the bungalow.

Another situation that had happened was that the horizontal thrust of the soil behind rubble wall had increased due to infiltration of the rain water, causing the inherently unstable rubble wall to fail. Debris from the collapsed rubber wall was deposited on the slope below, causing additional loading, and together with an influx of surface and seepage water, a landslide was triggered off. The resulting fluid debris comprising of fill material and boulders flowed down hill to demolish the bungalow.

The investigation also found that the upper reaches of the hill slopes were stable when the groundwater level was low. However, during the rainy season, the groundwater level rises close to the ground surface and caused these slopes unstable (with FoS of 0.828 to 1.035).

2.3 Landslide at Kg. Pasir, Hulu Klang – 2006

Landslide at Kg. Pasir was happened on 31 May 2006 and destroyed 3 blocks of long house and 4 people were dead. It was happened at 4.45 pm in the afternoon which measure 70 meter in width at the crest, 320 meter length and 7 to 10 meter in depth. It was estimated that 30000 cubic meters of earth had translated and the maximum run out distance of the failure debris was measured at approximately up to 100m from the toe of the slope.

As usual, The National Disaster Management in the Prime Minister's Department instructed the Public Works Department Malaysia (PWD) to form a Landslide Working Group (LWG) to investigate the causes of failure and identifying areas with high landslide risks and to come up with mitigation measures.

Investigations found that the failure area was filling areas which fill up to 20m depth. The desk studies from topography map shown that the failure area indicated the small river and water path from Taman Zoo View to Kg. Pasir.

The landslide investigation found that the annual maximum 30-days in the month of May 2006 moving cumulative rainfall in Ampang area was 260mm which was also the 36 highest during the period from 1971 until 2006. Meaning that rainfall was not a significant influent to the incident.

Based on the investigation it was found that the cause of landslide was due to the failure of reinforced soil wall designed by developer as shown in Figure 7. Development activities next to the failure areas without planning the drainage system also contribute to the failure as shown in Figure 8.

Figure 7. Reinforced soil wall collapsed.

Figure 8. Development activity near landslide area.

2.4 Landslide at Seksyen 10, Wangsa Maju, Kuala Lumpur – 2006

On October 9th 2006, a landslide occurred at Seksyen 10 Wangsa Maju, Kuala Lumpur. No casualty was reported but all residents in 3 blocks of 5 storey apartments were evacuated and several cars were damaged as shown in Figure 9. All resident occupied the building one year later after remedial work has been carried out.

Figure 9. Landslide at Wangsa Maju

Based on landslide forensic investigation carried out by Landslide Working Committee lead by PWD Malaysia, the cause of failure was due to the disturbed at the toe of the slope in front of the apartment. The toe of the slope was excavated to construct the monsoon drain by the contractor who constructed the highway as shown in Figure 10.

Figure 10. The construction of monsoon drain.

The landslide investigation found that the annual maximum 30-days in the month of September 2006 moving cumulative rainfall in Ampang area was 241.1mm which was also the 33 highest since 1971. Meaning that rainfall was not a significant influent to the incident.

The investigation also found that the slope were stable when the slope was in original condition. However, the analysis showed that the factor of safety (FoS< 1) of the slope reduced significantly when the toe of slope was excavated.

2.5 Landslide at Tmn. Bkt. Mewah, Bkt Antarabangsa, Hulu Klang – 2008

On the 6th December 2008, a landslide was reported at Tmn Bkt. Mewah, Bkt. Antarabangsa, Hulu Klang. The landslide which took place at approximately 3.30am in the morning measure 109 meter in width at the crest, 120 meter length and 15 meter in depth. It is estimated that 101,500 cubic meters of earth had translated and the maximum run out distance of the failure debris was measured at approximately 214m from the toe of the slope.

Figure 11. Landslide debris at Bkt. Antarabangsa

The landslide debris completely blocked Jalan Bkt. Antarabangsa, the only road access to some other 2000 residents. 14 bungalow houses were destroyed by the failure debris. The landslide also resulted in 4 fatalities and injury to 14 people as shown in Figure 11.

This area started to develop in year 1974. The aerial photographs were taken in 1974 and 1975, it was quite clear that there had been massive earthworks activity at the crest of the failed slope. The aerial photograph that was taken in 1975 also shown signs of earth dumping around the perimeter of the landslide. The earth dumping in general was not compacted and loose in nature.

The aerial photograph of 1985 showed the progress of Wangsa Ukay development and the proposed development by developer. It can be seen in the photo that the platforms for the link house units were being prepared.

In 1992, the aerial photograph showed that three rows of abandoned houses were completed and two of the units of the link houses fall within the area of the landslide. However, the two units of the linked houses were not in the aerial photograph dated 1999.

Figure 12 and 13 show the progress of development activities from year 1974 till 2004.

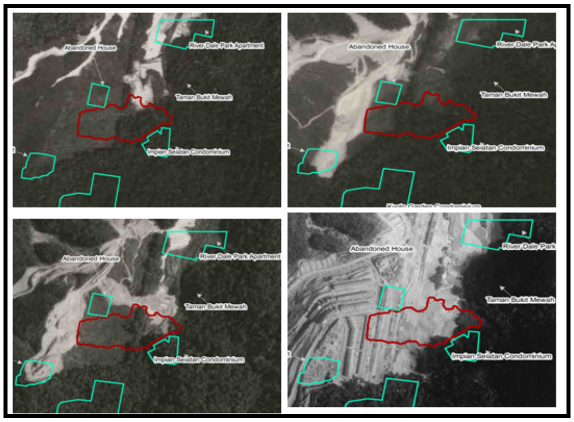

Figure 12. The aerial photo from 1975 to 1984

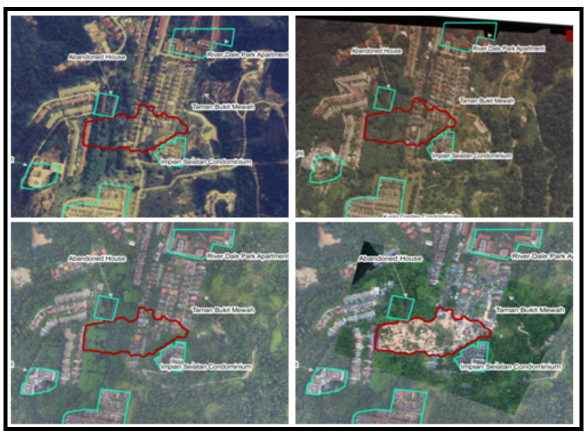

Figure 13. The aerial photo from 1985 to 2004

Based on the investigation carried out by Landslide Working Group lead by PWD Malaysia, the landslide can be classified as deep seated slide. It was found that the causes of the landslide had been contributed by combination of the following factors:-

i. Loose soil from earth dumping on the slope which took place during the development of the area.
ii. Prolonged rainfall during the months of November and December.
iii. Unmaintained/damaged drainage system on the slope.
iv. Damaged active water pipe along abandoned houses due to soil creep.

3 DESCRIPTION OF CAUSES OF LANDSLIDE AT HULU KLANG

All major landslides at Hulu Klang was occurred at manmade slope. Therefore a geological feature was minimize to contribute to the landslide in this area. However, geological study still implemented during investigation to understand the geological features such as rock formation and discontinuities.

Based on landslide investigation at Hulu Klang carried out by PWD Malaysia, most of the slope failure was due to human factor. Error in design, lack in maintenance, poor in construction and no thorough study during planning stage were major factors contribute to the slope failure.

No thorough study and made use of prescriptive method in slope design without detailing slope stability analysis was found during slope failure investigation at Highland Tower and Hillview. The rubble wall used at both locations did not properly design and no evident was found on those matters.

The engineers seemed took it easy and no detail study of the water regime and original flow path in that area. The failure investigation at Highland tower collapse, slope failure at kg Pasir and slope failure at Tmn. Bkt. Mewah, Bkt. Antarabangsa were the evidence of human factor in which the engineers ignoring the problem and did not respond to this maters. Therefore that area was filling without considering the effect of increasing of pore water pressure.

Subsurface investigation did not carried out to obtain representative of the soil parameters, soil profile, ground water level profile for slope stability analysis was other common mistake by engineers. This error was found during the failure investigation for slope failure at Kg. Pasir. Groundwater level used during design stage slightly lower compared to the groundwater level from SI carried out during failure investigation.

Other aspect in human cause was regarding construction error. The common error found in the slope failure at Hulu Klang done by the developer or contractor was tipping or dumping of loose fill down the slopes to form filled slope. This is the most familiar construction error for earthworks construction in Malaysia. Contractors carrying out the filling works on slopes found it most convenient and easy to dump or tip soil down the slopes to form the fill. The condition was worsened by the vegetation that was not removed from the slopes, causing the bio-degradable materials trapped beneath the dumped fill, forming a potential slip plane with the bio-degradable materials (vegetation). In the disturb sample taken during SI work carried out for Landslide investigation at Kg Pasir, it was found the evident of vegetation.

Mostly all slopes at Hulu Klang did not properly maintain especially the drainage system. During investigation, it was found that some of the drain was block and crack. This situation had contributed to the increased of water infiltration into the slope.

The causes of the 5 landslides that occurred in Hulu Klang are summarised in Table 2.

Location	Mode of Failure	Causes of landslide
Highland Tower	Circular	Poorly designed of rubble wall. Inadequate drainage system. Lack of maintenance. High groundwater level.
Taman Hill View	Flow	Fill material in valley area or existing water path. Poorly designed of rubble walls. Inadequate drainage system and water ponding. Heavy rainfall. High groundwater level.
Wangsa Maju	Circular	Toe disturbance.
Kg. Pasir	Circular	Fill material in valley area or existing water path. Poorly designed reinforced soil wall. Inadequate drainage system. Earthwork activity nearby.
Tmn Mewah, Bkt Antarabangsa	Circular	Earth dumping, Unmaintained drainage. Water pipe damage.

Table 2. Summary of mode of failure and causes of landslide in Hulu Klang.

4 IMPLEMENTED ACTION TO REDUCE INSTABILITY IN HILL SITE AREA

4.1 Guideline for hilly development

The first document on guidelines in hilly areas development was produced by Urban and Rural Planning Department in 1997. The guidelines address the issues of planning and development in highlands, on slopes, natural waterways, and water catchments areas.

In June 2002, Geology and Minerals Department of Malaysia produced guidelines on hill-site development. The guidelines considered the angle of the natural slopes and geology of the area. The areas were then classified into 4 categories which were termed as Class I, II, III and IV. Class I is the least severe in terms of terrain grading whereby slope angles are less than 15^o. Class IV - the highest risk, where, absolutely no development will be allowed in this classified area.

Environment Department of Malaysia also produced development guidelines for highlands in December 2005. Highlands is defined as areas which lie 300 m above the mean sea level. The guidelines were prepared in collaboration with Geology and Mineral Department of Malaysia.

At state level, the Selangor state, one of the states that has high landslide incidents, introduced a standard procedure of processing the application of development in environmentally sensitive areas and the highlands. The standard procedure for development in hill-site was introduced in October 2006.

The latest guideline was produce by Slope Engineering Branch, PWD Malaysia (CKC) which known as Guideline for slope design. In this guideline, CKC were stressed in 3 major elements such as data use, modelling of slope and the responsibility of designer in slope design. Based on data forensic investigation carried out by CKC from year 2004 until 2008, 57% of the landslide causes due to human factor such as error in design and construction. CKC hope by using this guideline, landslide due to error in design can be reduced significantly. Table 3 shows the development of guideline by government agency from year 1997 until now.

Agencies	Guidelines	Year produced
Town and Country Planning Department	Guidelines on Hill-Side Development	1997
Department of Mineral and Geosciences	Guidelines on Hill- Side Development	2002
Ministry of Science, Technology and Environment	Guidelines on Hill- Side Development	2002
Town and Country Planning Department	Kawasan Sensitif Alam Sekitar Negeri Selangor (KSAS)	2005
Ministry of Natural Resources and Environmental	Guidelines on Hill- Side Development	2005
State of Selangor	Standard procedure of processing the application of development in environmentally sensitive areas and the highlands	2006
Slope Engineering Branch, PWD Malaysia (CKC)	Guideline for slope design	2008

Table 3. Guidelines produced by Malaysia government agency.

4.2 Slope Management agency in Government Sector

After the second major failure happened at Hillview, government decided to create a new agency to manage the slope. All the while, the slope management was carried out by Road Branch, PWD Malaysia. PWD is a Government agency who responsible in all infrastructure project planning by the government. Due to heavy task need to be carried out by Road Branch, Government agreed and instructed the PWD Malaysia to create another branch to manage all slope in Malaysia which is known as Slope Engineering Branch (CKC) in year 2004.

CKC has 6 units that deal with slope management. They are the Slope Safety Unit that would coordinate and control the budget for the slope repair works; the Slope Management Unit that would collect spatial and non spatial data and produce hazard maps for slopes; the IT and Documentation Unit whose job is to archive and disseminate slope data and information through the website and archiving; Research and Development Unit that function includes research, initiating cooperation with universities (local and abroad) and conduct National Slope Master Plan study; the Forensic Unit is responsible for landslide investigation and prepare standards and guidelines for slope design, the Quality, Training and Public Awareness Unit is responsible for training personnel in PWD Malaysia and create public awareness amongst the public. Nevertheless the functions of CKC in slope management is not comprehensive as it covers only the slope under Ministry of Work which is not includes all slope for other government agency. At the moment, CKC is responsible in managing slope including planning of landslide preventive and mitigation measures of Federal roads as well as planning and launching the projects, managing financial resources, monitoring expenditure and progress. CKC had been upgraded more than 100 locations of slope under preventive measures and more than 20 locations under mitigation measures from 2006 until 2009 with cost of approximately RM 200 Million.

4.3 National Slope Master Plan

In May 2004, The Malaysian Government has instructed PWD to carry out the National Slope Master Plan (NSMP) study. The goal of NSMP Study is to provide detailed elements of a comprehensive and effective national policy, strategy and action plan for reducing loses from landslides on slopes nationwide including activities at the national, state and local levels, in both the public and private sectors. The Term of Reference for NSMP was partly based on USGS Circular 1244 (2003) and works by Committee on the Review of the National Landslide Hazards Mitigation Strategy Board of the United States National Research Council (2004).

The NSMP consisted of 10 key objectives which were translated into 10 components of the study. The components of the NSMP and the summary of their objectives are as follows:

i. Policies and institutional framework - improve policies and institutional framework
ii. Hazard mapping and assessments – develop a plan for mapping and assessing landslide hazard and also develop standards and guidelines for landslide hazard mapping
iii. Early warning and real-time monitoring system- to develop a national landslide hazard monitoring, prediction and early warning system.
iv. Loss assessment – assesses the current data on landslide losses and develop national plan for compilation, maintenance and evaluation of data from landslide.
v. Information collection, interpretation, dissemination, and archiving – evaluate the state-of-the-art technologies and methodologies for dissemination and archiving of technical information.
vi. Training - develop training programs for personnel involved in landslides.
vii. Public awareness and education – evaluate and develop education program related to predictive understanding of landslide.
viii. Loss reduction measures – evaluate and develop effective planning, design, construction and maintenance with the view for landslide hazard reduction.
ix. Emergency preparedness, response and recovery – develop a national plan for a coordinated landslide rapid response capability.
x. Research and development - develop a predictive understanding of landslide processes, threshold and triggering mechanisms.

The components and the objectives abovesaid, provide a very comprehensive coverage of issues pertaining to slope management.

The NSMP is to be implemented in 3 phases: the first phase is called the short term phase which would cover the first 5 years; the second phase is known as the medium term phase i.e. the period of implementation between 5 and 10 years; and the final phase which is known as the long term phase is the period of implementation of 10 to 15 years and beyond.

5 FUTURE NEEDS TO REDUCE INSTABILITY IN HILL SITE AREA

5.1 Stability studies for Hulu Klang area and others area which develop before 1997

Based on previous study, no guideline was provided for development activity in hill site before year 1997. It means that all previous developments were not followed proper guideline. Anyhow development activities for residential were active between year 1974 to 1997 due to demand. Based on aerial photo during landslide forensic investigation, many locations were tipping or dumping loose fill to form filled slope to make a platform for constructions. In that case, a detailed investigation should be conducted over the hill slopes of Hulu Klang area to identify areas which are susceptible to landslides and are unsuitable for development. The development of the entire area of Hulu Klang which is developed before 1997 should be reviewed and a master plan should be prepared. This study also should cover all development in hill site areas in Malaysia.

5.2 Policies and regulation

A standard comprehensive of guidelines, policies and regulations pertaining to hill site development and slope management should be published. That should cover all areas of slope such as the slope maintenance, design, construction and etc. including submission of geotechnical reports. All records and data involved must be properly documented and kept in a safe place and maintained for at least the design life of the asset by the agency involved.

5.3 Produce a national agency to manage the slope and implementing all components in NSMP

A national slope agency for development on hill slopes modelled after the Geotechnical Engineering Office in Hong Kong should be set up. At this moment several agencies involved in slope management and development in hill site area. Overlapping of obligation between agencies involved in slope management can be avoided by establishing a national agency.

The national agency should be responsible for all slopes in Malaysia and at the same times implementing all components in NSMP. At this moment, CKC is responsible for slope along Federal road only. The functions of CKC should be more comprehensive by covering all slopes in Malaysia. Among the reasons are, CKC had develop the human capacity and expert in slope manners. CKC supposes to implement all components in NSMP. The government are to allocate budget for the success of slope development in Malaysia.

6 CONCLUDING REMARK

Based on case histories of slope failures in Hulu Klang area, development in hill site without proper planning and thorough studies such as detailed SI, geological studies, detailed design and construct that can induce the slope stability. All development during those times (before 1997) was carried out without proper guidance from authority involved. The first guideline was produced by Town and Planning Department in 1997. It is concluded that all development at hill site in the past was not follow proper ruling. After major failures in 1993, the public began to become aware of landslide. Government has made significant action to reduce the landslide by creating guidelines to develop hill site. Malaysian government is proposed to setup a new agency to manage all slopes in Malaysia. Hopefully by producing guidelines, act and other relevant elements and finally establish a national agency to implement proper development in hill site areas therefore landslides can be reduced significantly in line with CKC motto SAFE SLOPE SAFE LIFE.

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