ASM Sc. J., 11, Special Issue 2, 2018 for SANREM, 19-28

An Overview of Sinkhole Geohazard Incidence Recorded in The Kinta Valley Area, Perak

Ahmad Khairut Termizi[1,2,3*], Tuan Rusli Tuan Mohamed[1] and Rodeano Roslee[2,3]

[1]*Minerals and Geoscience Department of Malaysia (JMG-Malaysia), Jalan Penampang, 88999 Kota Kinabalu, Sabah, Malaysia*

[2]*Natural Disaster Research Centre (NDRC), University Malaysia Sabah (UMS), Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia*

[3]*Faculty of Science and Natural Resources (FSSA), University Malaysia Sabah (UMS), Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia*

This paper is prepared to provide an overview of the sinkholes geohazards that occurs quite often in the Kinta Valley area. By fact, the phenomenon of the sinkhole is a common in Kinta Valley as its compound in karsts environment with limestone bedrock underlain about 80% of the area. The occurrences of sinkholes always affected badly on urban development and caused economic loses to the owner or landlord. The record regarding the sinkholes in pass days was started informally through shorthand in the log book and personal diaries. Since the cases arose, Minerals and Geoscience Department of Malaysia (JMG-Malaysia) started proper documentation in year 1970s and until February 2012 there were 161 incidents and 288 sinkholes were recorded surrounding Kinta Valley. Preliminary interpretation shows that the development of sinkhole associated to the factors of subsurface geology, historic of site activities which related to mining, current land used status, also seasonal drastic change between dry and wet spell in local climate.

Keywords: Sinkholes, Kinta Valley, Perak

I. INTRODUCTION

The Kinta Valley has undergone an experience of sinkholes in very long time. Among the main causes of this phenomenon is the Kinta Valley is based on more than 80% limestone from Kinta Formation (Chow, 1995). The soluble limestone properties have undergone natural corrosion processes to form holes or cavities and become more active in the tropical environment (Fournier, 1962; Douglas, 1969).

Smith (1999) defines the sinkhole as a hole formation at a certain size from the top of the ground to the base with a depth reading and a certain diameter. It is formed from the formation of a cave or underground cave in an area based on limestone. Recording made by the Department from 1970 until early 2012 indicates that 161 incidents have occurred with a total of 288 dimples of various dimensions have been formed (Table 1) (Figure 1 and 2).

*Corresponding author's e-mail:

Table 1. Sinkholes formation recorded from year 1970 to 2012

Year	No of cases	No of sinkholes formation
1970-1974	3	7
1975-1979	2	2
1980-1984	11	15
1985-1989	37	57
1990-1994	29	36
1995-1999	13	26
2000-2004	22	70
2005-2008	26	52
2009- Feb 2012	18	23
Total	161	288

II. RECORD OF SINKHOLE INCIDENT IN KINTA VALLEY

The occurrence of the sinkhole in the Kinta Valley has been documented before the advent of World War II, but it is more logical and private diaries. In line with that, the Department has taken the initiative by starting the information gathering process and recording it systematically from 1970 to now.

The current record until February 2012, states that 161 number of incidents with 288 infestation holes in various sizes have been formed (Table 1 and Figure 3). The most frequent area facing this phenomenon is the surrounding Ipoh City, which is about 70% of the total recorded events.

III. PATTERN OF SINKHOLE FORMATION IN KINTA VALLEY

Based on the record and distribution of sinkhole cases in Kinta Valley shows a certain pattern of formation. Chow (1995), made the interpretation of the formation of the sinkhole located in the north-southwest direction (Figure 3). Subsequently, the formation of the sinkholes was recorded more and more active with distribution plots in different patterns. The number of cases seen has an unsystematic distribution with frequencies occurring in certain places. This is shown by the distribution of the sinkhole records from 2000 to 2012 (Figure 4).

The pattern of sinkhole occurring before 2000 shows a series of incident scenarios with a north-south direction. Based on satellite imagery, the pattern of the incident hole is according to the pattern of mining activity density. This can be explained by the existence of pool mines that are also in the direction of north-south.

During the period 2000-2012, a series of large-scale earthquakes occurred around Sumatra, Indonesia, especially the mega earthquake in 2004, 2005 and 2006. The earthquake that reached its strength of 9.3Mw has let go of its power until it is felt in some places including Ipoh City and surrounding areas. It also has a close association with the occurrence of a buried hole at times. The record

Figure 1. Sinkhole disaster has destroyed residential homes

Picture A - Kampung Manjoi, Ipoh (26/02/2008); Picture B - Kuala Dipang, Kampar (29/03/2005)

Figure 2. Sinkholes cases in the vicinity of Kinta Valley, Picture C - SMK Kopisan, Gopeng; Picture D - Institut Latihan Tentera Udara, Jln. Lapangan Terbang, Ipoh; Picture E - Kg. Kuboi, Gopeng (happened on 26/12/2004 after Acheh Earthquake); Picture F - Jalan Lahat, Ipoh.

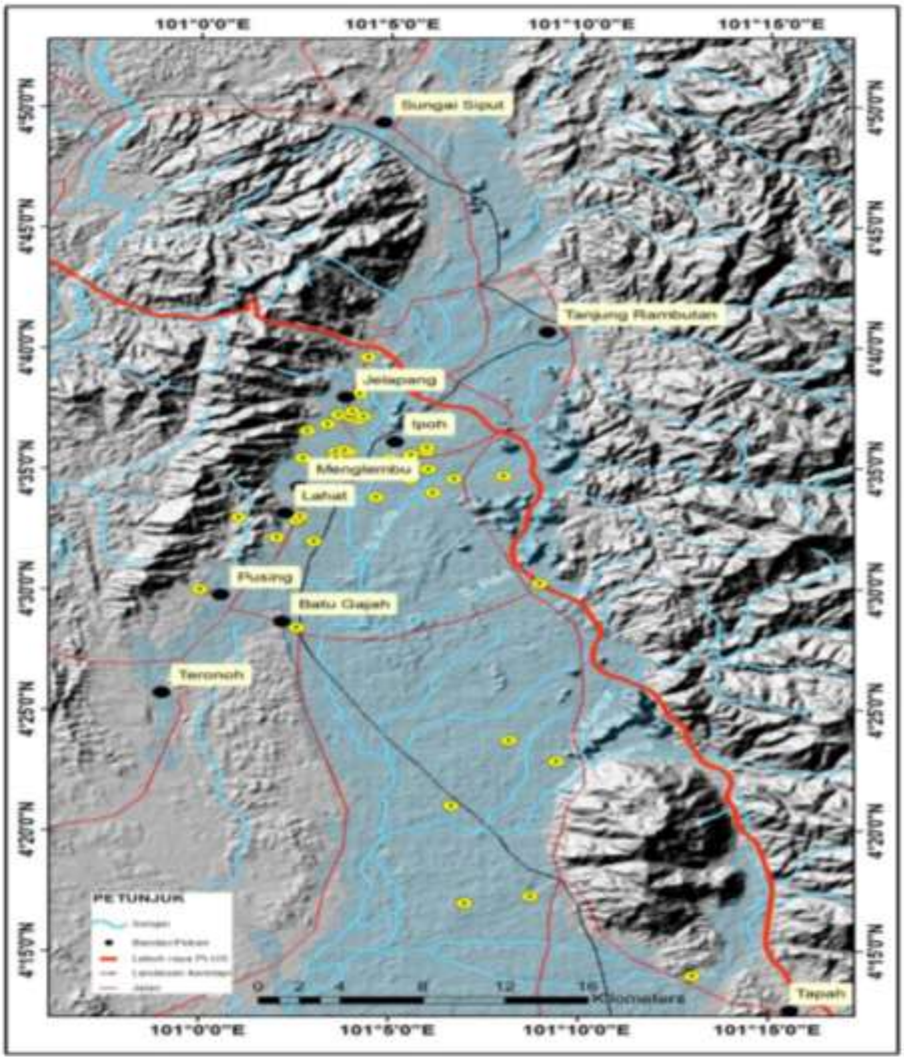

Figure 3. Overlay of the distribution layer of the case of the buried hole in the Kinta Valley and SRTM (Shuttle Radar Topographic Mission) image

shows that 45 sinkholes were formed in December 2004, which was a few days after the Acheh of the mega and tsunami of Acheh on December 26, 2012. In addition, 20 sinkholes were recorded around the Kinta Valley in March 2005.

IV. LOCAL WEATHER CHANGES AND SINKHOLE FORMATION

Climate change is identified as one of the factors affecting the formation of sinkholes surrounding the Kinta Valley. This situation is closely related to the process of groundwater level change. The summer and rain changes that take place play a role in controlling the groundwater level fluctuations. The presence of groundwater filling the cavities and caves in limestone bedrock has the hydrostatic power that can withstand loads on the upper surface. When a groundwater decline occurs, the cavity which should be filled with the water becomes empty so it loses the ability to hold the load on it. Groundwater decline is naturally occurring in summer.

During the rainy season, groundwater level increases will result in erosion and bonding between the grains in the subsoil layer becoming more active. Indirectly it will contribute to the formation of underground aggregates and when the covering layer becomes weaker then collapse will form a sinkhole. Bell (1999), explains that the rise in groundwater will contribute to the flow of groundwater flow and this will cause an increase in the velocity of the groundwater movement. The pressure generated from this high groundwater velocity will further accelerate the erosion process and disturb the stability of limestone caves.

According to the Department of Meteorology (MetMalaysia) reports, our country experiences summer and humid seasons throughout the year. However, we will experience an intermediate transition phase for the two, usually the rainy season to the dry season around April-May and the dry season to the rainy season around August-September. Throughout this transition phase, it is clear that the cases of sinkholes are recorded more frequently (Table 2 and Figure 5). This condition is interpreted as a sudden change in the groundwater level that causes ground grains in the upper layers of the friable and loss of hydrostatic support. This will cause the existing fracture in the limestone base of rocks to enter the sediment from the upper layers and make cataracts approach the surface. When the lining of the cap is getting thinner, there will be a loss of support and collapse to form the embedded hole.

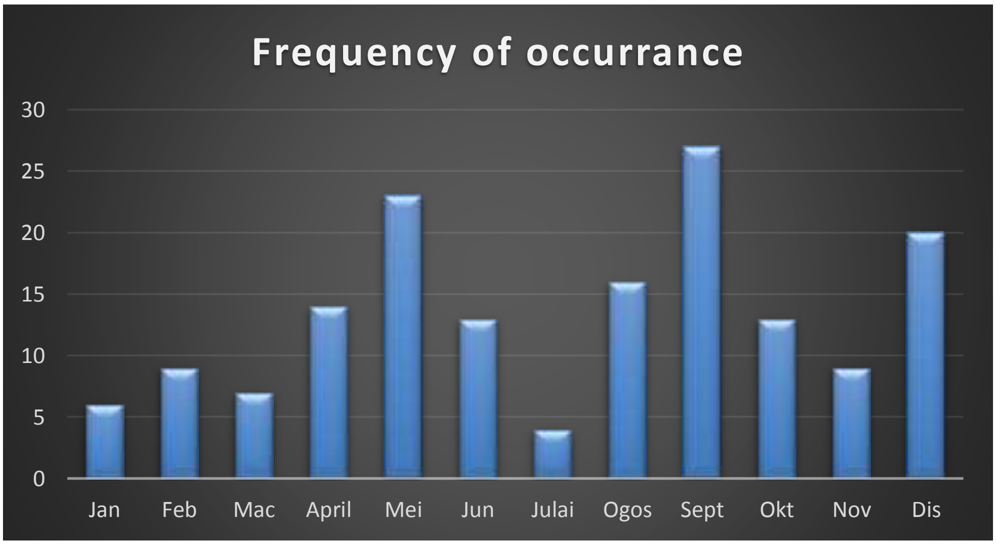

Figure 4. The comparison chart of sinkholes cases by months between 1971 – 2011

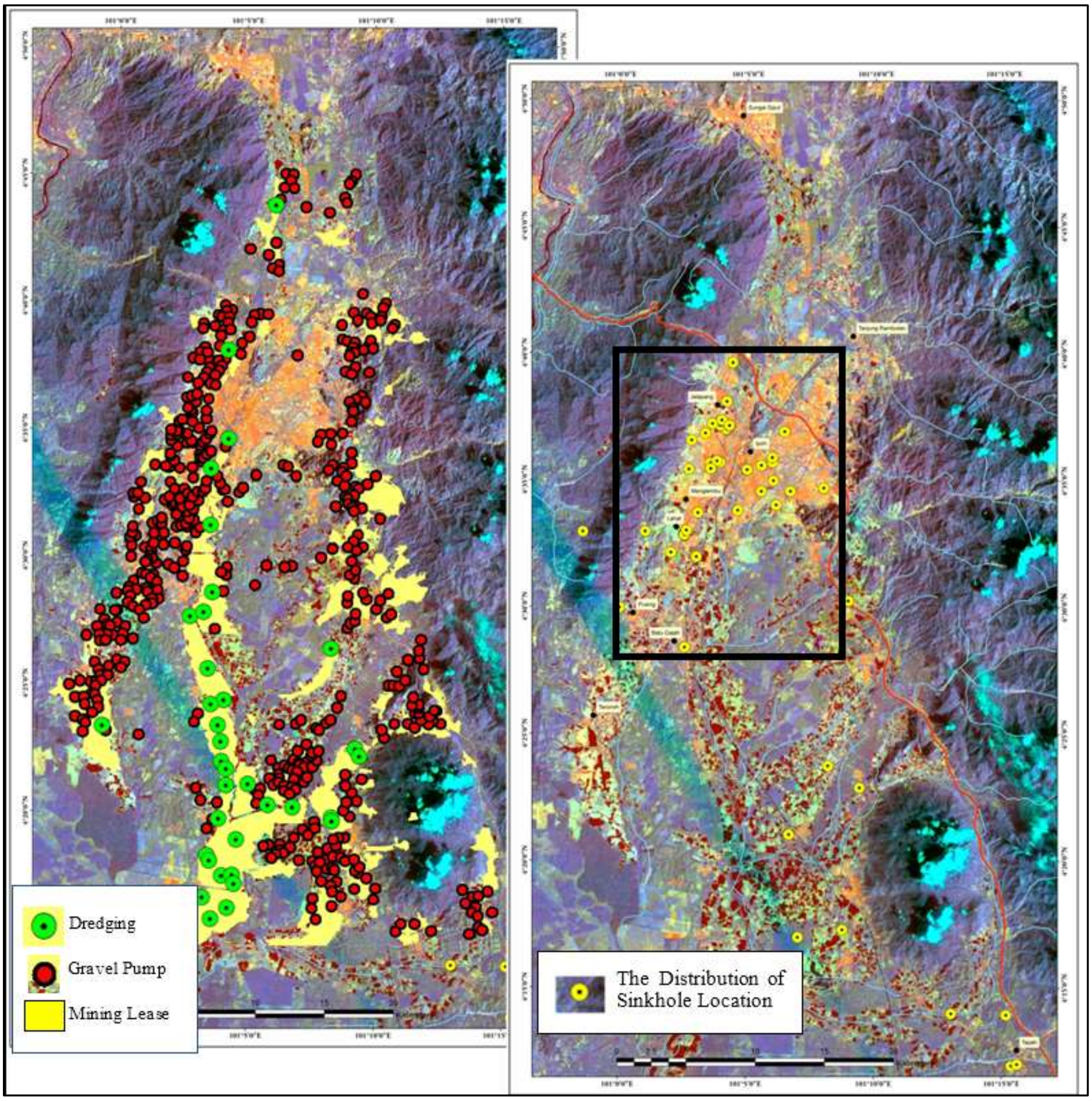

Figure 5. The distribution of mining lease area and active mining activities between 1971 – 1972 and the location of sinkholes cases in the vicinity of Kinta Valley

V. RESULTS AND DISCUSSIONS HISTORY OF LAND USE ACTIVITY AND SINKHOLE FORMATION

The sinkhole in the Kinta Valley is largely related to the land use history before it is developed. In general, 48% of the Kinta Valley area has undergone a dredging experience due to active tin mining activity since colonial times until around the 1980s covering 463,489 km^2.

Some of the former mining areas have been re-developed into municipal development sites, commercial and residential centers and agricultural activities. Of the 463,489 km^2 identified as 64% of the former mine site consists of agricultural sites, forests, and vacant land. While 22% are development areas such as residential, business and industrial premises and the rest are 14% of ex-mining ponds. The distribution of this mine ex-site activity can be observed in Figure 6.

However, the process for identifying land use history is one of the most complex processes, a great deal of work involving the extraction of minerals or mining does not record its existence after it is closed. This is not only happening in Malaysia but also a global problem when discussing land sediments and the formation of a buried hole. Bell (1999) states that the history of mining in Britain has begun for centuries but has only begun to be recorded in 1850 and in the event of a previous record it is still in doubt and inaccurate. A study on groundwater deposition in the former mine site in Britain conducted by Seawall in the 1980s found that land movements were actively involved in the area (Geological Hazard, Investigation in areas of old mine workings, 1999).

The Kinta Valley scenario shows that the ex-mining area has undergone a change where the ex-mining ponds are dumped and developed. The development of active state development accelerates the reclamation process of the ex-mining area, which in some instances can occur inadequate reclamation process. The record shows that the most frequent infiltration of the hole is more than 60% of the cases occurring at the site of the ex-mine, 30% on the site which cannot be ascertained of its history and only 0.1% occur on the site of the original soil. Figure 9 shows the relationship between active mining lease area coverage in Kinta Valley around 1971-1972 and the distribution of the location of the incident hole has occurred (Figure 5).

Table 2. Record of sinkholes cases by months between 1971 – 2011

	Jan	Feb	March	April	May	June	July	Aug	Sept	Okt	Nov	Dec
Frequency of occurrance	6	9	7	14	23	13	4	16	27	13	9	20

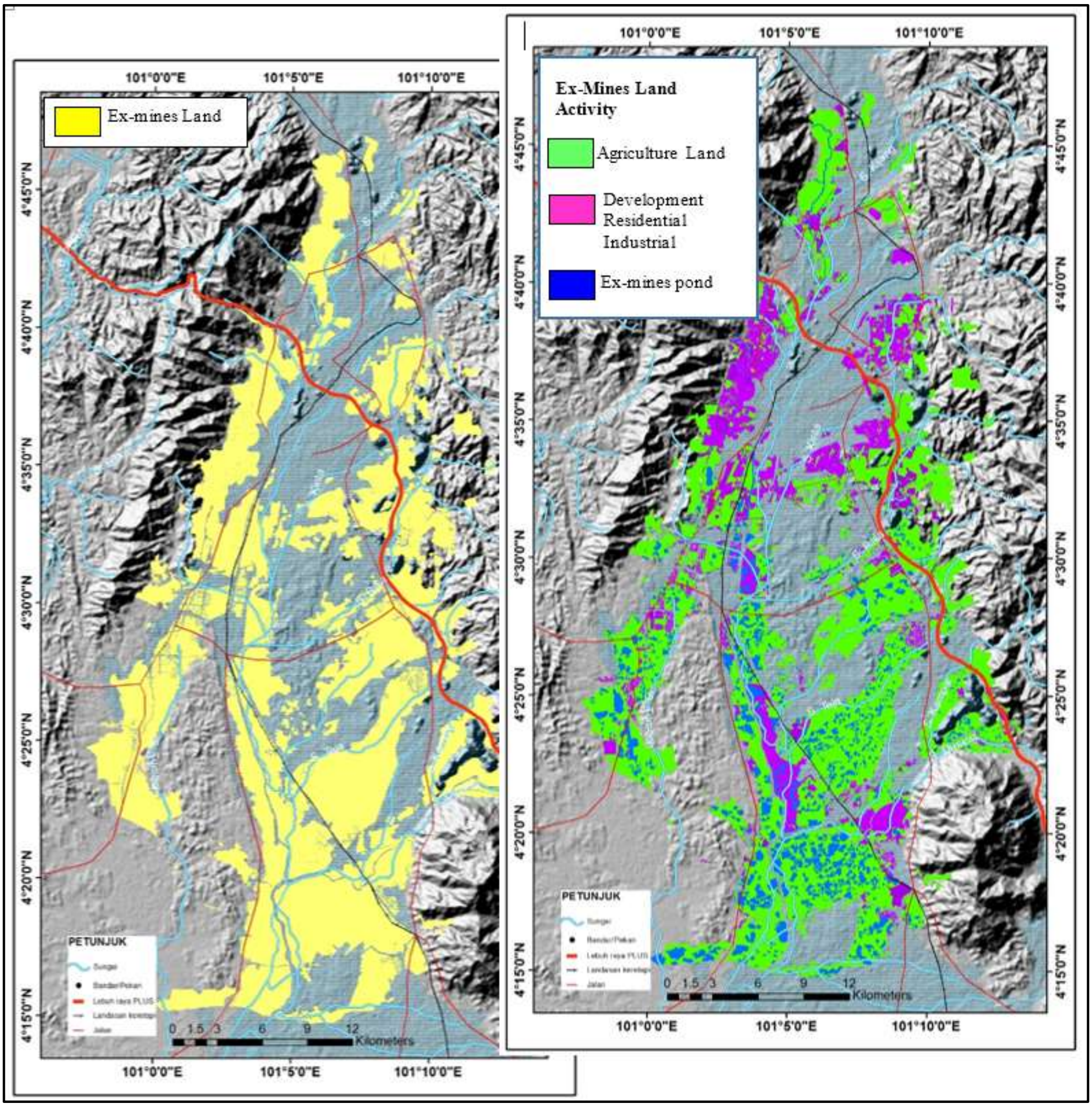

Figure 6. Ex-mines land and land use activities in ex-mines land in Kinta Valley

VI. CONCLUSION

The sinkholes hazard in the vicinity of Kinta Valley has been identified as having a link between geological characteristics and environment and land use activities. The occurrence of the sinkhole at a site of development or residence is often a disaster that results in economic losses to the owner or landlord.

Kinta Valley is located in the vicinity of the carvings and limestone hills naturally have a specific cavitation system where the divisions appear on the surface are known as caves, while the cavities under the surface are known as cavities. The process of the formation of cavities under the surface of the earth can occur continuously in view of the soluble limestone properties of water and is influenced by local geological and hydrogeological conditions. This existing cavity or cavity makes the carnival environment experience the phenomenon of the formation of a buried hole. In addition, the Kinta Valley also has a long history of mining activities and leaves the area of extensive ex-mining. Rapid development has led to reclamation and reclamation activities for all ex-mining land. The inert and sandy materials used in the reclamation work further accelerate the movement of subsurface granules to enter the existing cavity within the limestone base. Sudden fluctuations of groundwater levels make the layer of resin lose its durability and collapse to form the flushing hole. Among the triggering factors that caused the formation of the embedded hole were the tremors that were received by strong earthquakes occurring in Sumatra Island, local weather changes, and human activities. Both of these natural factors and human activities can occur simultaneously and it will speed up the process of forming a sinkhole.

The Kinta Valley is exposed to the risk of a buried hole that also threatens the safety of property and the lives of the locals. Any planned development activities should take into account the geological factors, site land use history and the history of the formation of a well-planted hole. Development projects involving the site of ex-mine sites should obtain detailed information on underwater strata developed according to best engineering practices. The awareness of planners, developers and the public on local criteria is to reduce the risk of flooding and the impact of their destruction in the future.

[1] Bell, F. G. (1999). Geological Hazards Their Assessment, Avoidance and Mitigation.

[2] Bell, F. G. (1988). Subsidence: a general review. Proceeding Symposium on Construction over Mined Areas, Pretoria, South African Institution of Civil Engineers, Yeoville. pp. 1-20.

[3] Chow Weng Sum. (1995). Sinkholes and Rockfalls in The Kinta Valley, Geological Survey of Malaysia.

[4] Douglas, I. (1969). The efficiency of tropical denudation systems Transaction of the Institute of British Geographers. 46, 1–16

[5] Fournier, F. (1962). Map of erosion danger in Africa south of the Sahara. Commission for Technical Cooperation in Africa, European Economic Community, Paris. France.

[6] Mohd Amir Asyraf B. Sulaiman. (2011). Aplikasi teknik-teknik geofizik dalam kajian lubang benam di Kampung Chabang Dua, Kuala Dipang, Perak, National Geoscience Conference 2011.

[7] Mohammad Farie Eddy Abdul Khali. (2011). Suevei geofizik dalam kajian lubang benam di Lapangan Terbang Sultan Azlan Shah, Ipoh, Perak, National Geoscience Conference 2011.

[8] Smith, J. L. (1999). Methods Manual for East Limestone Island: Research Protocol. Laskeek Bay Conservation Society.

[9] Tan Boon Kong. (1993). Urban Geology Ipoh and Kuala Lumpur, Department of Geology,UKM, Bangi.