GEOLOGY AND GEOSITE ASSESSMENT OF JELAWANG WATERFALL AT GUNUNG STONG, DABONG, KELANTAN.

BY

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A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Geoscience) with Honours

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DECLARATION

I declare that this thesis entitled **GEOLOGY AND GEOSITRE ASSESSMENT OF JELAWANG WATERFALL AT GUNUNG STONG, DABONG, KELANTAN** is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ____________________

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Date : **21st February 2023**

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"In memory of Muhammad Ibrahim bin Abd Aziz"

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Geology and Geosites Assessment of Jelawang waterfall at Gunung Stong Dabong, Kelantan.

ABSTRACT

Gunung Stong is an area in Kuala Krai, Kelantan have a diverse geological and geomorphological feature. Also, it is an area with developing geo-tourism. The Jelawang waterfall that was located at Gunung Stong has numerous geoheritage features, which tourist potential has not been discovered yet. The study area covered an area of 25 km2 with the coordinate of 5°21'16.49"N and 101°58'0.18"E with Kampung Sungai Batu was located at the center of the study area. The objective of the research is to is to produce geological map of Kampung Sungai Batu, Dabong in scale of 1:25000 and to identify the geosite potential at Jelawang waterfall at Gunung Stong, Kelantan. In making the geology map, the lithology, geomorphology, structural geology, sedimentology, and stratigraphy of the study area are observed. The Stong Migmatite Complex represents a cluster of rocks that are unique and rarely found in Malaysia. In the study area, these rocks are exposed to form mountain landscapes that are interpreted as young stage geomorphology based on the presence of several waterfalls and rapids at the steep sloped drainage areas. The Jelawang waterfall is located at Gunung Stong and is considered the highest waterfall in peninsular Malaysia. It contains unique geological characteristics and landforms to conduct research and surveys. The study area consists mostly of acid intrusive rock and metasedimentary. The modified Geosites assessment model (M-GAM) is a model for assessing recomposites that evolved from the Geosite Assessment Model (GAM) and shares the same structure of indicators and sub-indicators consisting of main and additional values. M-GAM is investigated from the perspective of two target groups whose divergent views on sub-indicators value can influence the position of geosites in the M-GAM matrix. The geological map of Gunung Stong has been revised, and the M-GAM assessment of high values indicates the suitability of the geosite with a high-value indicator of scenic and aesthetic view due to their unique geomorphological characteristics.

Kajian Geologi dan Geotapak air terjun Jelawang di Gunung Stong, Dabong, Kelantan.

ABSTRAK

Gunung Stong merupakan kawasan di Kuala Krai, Kelantan mempunyai ciri geologi dan geomorfologi yang pelbagai. Selain itu, ia adalah kawasan dengan pembangunan geo-pelancongan. Air terjun Jelawang yang terletak di Gunung Stong mempunyai banyak ciri-ciri geowarisan, yang potensi pelancongan masih belum ditemui. Kawasan kajian meliputi kawasan seluas 25 km2 dengan koordinat 5°21'16.49"U dan 101°58'0.18"E dengan Kampung Sungai Batu terletak di tengah-tengah kawasan kajian. Objektif kajian adalah untuk menghasilkan peta geologi Kampung Sungai Batu, Dabong dalam skala 1:25000 dan mengenal pasti potensi geosite di air terjun Jelawang di Gunung Stong, Kelantan. Dalam membuat peta geologi, litologi, geomorfologi, geologi struktur, sedimentologi, dan stratigrafi kawasan kajian diperhatikan. Kompleks Migmatit Stong mewakili gugusan batuan yang unik dan jarang ditemui di Malaysia. Di kawasan kajian, batuan ini terdedah membentuk landskap gunung yang ditafsirkan sebagai geomorfologi peringkat muda berdasarkan kehadiran beberapa air terjun dan jeram di kawasan saliran bercerun curam. Air terjun Jelawang terletak di Gunung Stong dan dianggap sebagai air terjun tertinggi di semenanjung Malaysia. Ia mengandungi ciri geologi dan bentuk muka bumi yang unik untuk menjalankan penyelidikan dan tinjauan. Kawasan kajian kebanyakannya terdiri daripada batuan penceroboh asid dan metasedimen. Model penilaian Geosites (M-GAM) yang diubah suai ialah model untuk menilai geokomposit yang berkembang daripada Model Penilaian Geosite (GAM) dan berkongsi struktur penunjuk dan sub-penunjuk yang sama yang terdiri daripada nilai utama dan tambahan. M-GAM disiasat dari perspektif dua kumpulan sasaran yang pandangan berbeza terhadap nilai sub-penunjuk boleh mempengaruhi kedudukan geosites dalam matriks M-GAM. Peta geologi Gunung Stong telah disemak, dan penilaian M-GAM bagi nilai tinggi menunjukkan kesesuaian geosite dengan penunjuk nilai tinggi bagi pemandangan indah dan estetik kerana ciri geomorfologinya yang unik.

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LIST OF ABBREVIATIONS

GIS	Geographical Information System
GPS	Global positioning System
M-GAM	A modified Geosite Assessment Model
KeTSA	Ministry of Energy and Natural Resources
AV	Additional value
MV	Main Value
Im	Importance
etc	Et cetera
USGS	United States Geological Survey
XPL	Cross polarised light
PPL	Plane polarised light

LIST OF SYMBOLS

%	Percentage
Km	Kilometre
Km^2	Kilometre square
m	Metre

INTRODUCTION

1.1 General Background

The geological map of the study area was published by The Department of Mineral and Geosciences Malaysia in 2003. According to the map, the study area consist Permian sedimentary rock under Gua Musang Formation, which is mostly composed of argillaceous rocks with some calcareous rocks and acid intrusive rock unit. The Gunung Stong is towering above hilly topography. It has unique geological feature and geological landform that can be as one of potential geomorphosite in Kelantan. Geologically, Gunung Stong is a granite intrusion. A few methods will be utilized to identify the geology of study area such as geological mapping and geoheritage mapping will be conducted to gain information about the geoheritage value as well.

Stong Geopark has been recognized as the eighth National Geopark under the Geopark Development Program by the Federal Government through the Ministry of Energy and Natural Resources (KeTSA). This recognition was made through the National Geopark Committee Meeting in the year 2022 held on 14 November 2022. Stong Geopark covers an area of 2,131.99 square kilometres covering Kuala Balah District, Batu Melintang District, and Jeli District in Jeli Colony, as well as Dabong District in Kuala Krai Colony with a population of approximately 110,000 people. The geopark is rich in geological diversity, with 25 geosites recognised. Of the 25 geosites, 4 have an international significance value, 11 have a national significance value and 10 have a local significance value.

Geosite is a rather recent invention term in nature conservation, came from the concept of nature conservation. It is therefore important that there is a need for contributions in various areas of theory but also direct protection (geo-conservation) and the promotion of geosites (geo-tourism). Geoheritage is a valuable natural resource for long-term development, hence its accurate assessment is critical. A few of geologist have offered several techniques and ways to such an evaluation. All of these and other advancements, predictably, tend to focus on the overall evaluation of geoheritage sites (geosites), with a particular focus on their heritage value, which is connected to uniqueness. The technical, which was known as an “additional” aspect which of geosites, on the other hand, requires advance study because it influence the exploitability of the manifestations of their distinctive characters. In Malaysia, the study of geoheritage has shown the exquisite geological landforms/landscapes, unusual geological occurrences, and rich Earth elements found in the Jeli region of Kelantan, are among the numerous geological attractions having geoheritage value. Especially in Kelantan, geosites' utility that was in Kelantan depended on the ability to visit, observe, investigate, characterize, and sample them. As for these alternatives are vital not just to (geo)tourists, but also to scientists, students, and geoheritage professionals who oversee inventory and monitoring.

1.2 Problem statement

The Jelawang waterfall has become one of Kelantan's geoheritage sites. Unfortunately, due to a lack of geosite assessment of Jelawang waterfall, the geological heritage values usually go unnoticed and unappreciated. If this area is neglected in terms of management, the aesthetic value of geoheritage will deteriorate, causing the area to be abandoned. As a result of the residents' lack of concern for the location, the privileges found there will lose their value. As a direct consequence, it is critical that this place be protected and preserved in order to ensure that the place's geoheritage is valued and that the site is preserved, including for plants and wildlife.

Furthermore, the geological information of Gunung Stong was outdated since 2003, so conducting this research in this geoheritage site will provide an updated map and detailed geological analysis on the Gunung Stong. Besides that, as surveys are conducted, Gunung Stong will be more exposed to the residents surrounding the area, allowing more exposure to this geoheritage site and thus creating awareness and knowledge among the community.

1.3 Objective

i. To update the geological map of Gunung Stong, Dabong in scale of 1 - 25000

ii. To identify the geosite potential of Jelawang waterfall at Gunung Stong, Dabong, Kelantan.

1.4 Scope of study

The evaluation for the geosite assessment of this study was mainly based on modified Geosite Assessment Model or M-GAM which will be used to develop the geosite value potential. To provide certain types of preservation and development of geo-heritage conservation, not only for analysis and education purposes but also to bring more visitors to support the development of tourism in the state of Kelantan. So, from this approach, we can use it to perceive the traveler and attain the objective. In updating the geological map, a geological mapping was conducted. Conducting research in the study area for geological mapping is essential for producing accurate and useful geological maps. It can use to identify important geological features to develop geological models and apply geological knowledge to practical applications.

1.5 Significant of study

Mapping have been strongly suggested in interpret the geological information to identify and record the information of geology from the outcrop of surface and rocks. From the method used, the results that gained can be used. As the results have been obtained, the future research will have the benefits in form of updated information, map and data of geological information for the next research. The results are often obtained from the ways that we tend to use. Thus, the effectiveness methodology can manufacture the most effective result. Finally, the advantage of this project is that the residents that visit Gunung Stong grasp the benefit and know the connected they with the earth science and study the geoheritage of the Gunung Stong.

An updated geological map is a valuable resource for future researchers in the field of geology. It can provide a baseline of information that can be used for future studies. Researchers can use this map to identify areas that have not been studied in detail, or to compare changes in geological features over time. This study also has a significant for the government agency. An updated geological map can help governments identify and protect environmentally sensitive areas such as wetlands, wildlife habitats, and groundwater recharge areas. They can also be used to monitor and manage natural hazards such as earthquakes, landslides, and volcanic eruptions.

In term of geosite assessment, the main method or tools which are public perception survey method. This method has been used to contribute the most to preserve and identify the potential geoheritage sites of Gunung Stong in Jeli district. Questionnaire analysis and M- GAM assessments will aid in determining their perceptions of the research region and how these places may be preserved.

1.6 Study area

The study area is located at the north-east part of Dabong area in the district of Kuala Krai, Kelantan with the coordinate of °21'16.49"N and 101°58'0.18"E. The study area covers around 25km2. Dabong is relatively a small town in the state of Kelatan. It was surrounded by hills making most of the residency loated at the valley. Dabong is located about 155 km from the state capital Kota Bharu. Based on the basemap, the main river in the study area is Sungai Batu. The main economic of the srudy area is mainly based on agricultural with the cultivation of rubber tree and palm oil. Beside that, there also several caves located at Dabong such as Gua Ikan, Gua Bual, Gua Pagar, Gua Gelap, Gua Keris and Gua Tembakau that serve as a tourist attraction. Gunung Stong is a mountain in Kelantan, Malaysia, located in the Dabong district of Kuala Krai.

Despite being in the Kuala Krai district, it is close to the city of Gua Musang. The peak rises to a height of 1,422 metres. Because it is so difficult, this peak may become a popular destination for mountain climbers. The Titiwangsa Range also includes Gunung Stong This mountain has a lot of vegetation that is beneficial to your health. The 1,433-meter-high Mount Stong is located about 300 kilometres from Kota Bharu and is designated as a popular eco-tourism destination in Asia. Flowing through the area is the 303-meter-high Jelawang water, which is regarded as the best in Southeast Asia.

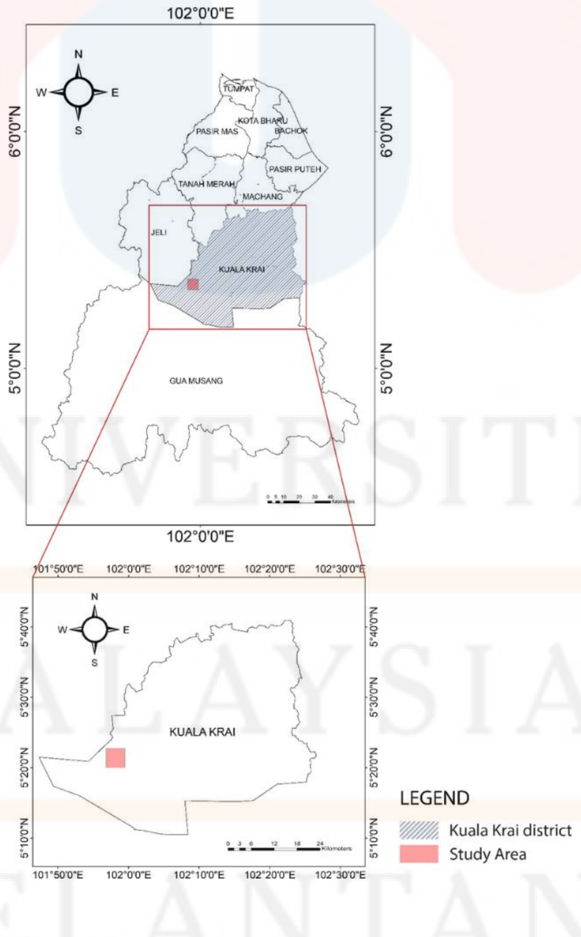

Figure 1.1: The location of the study area at Dabong, Kuala Krai, Kelantan

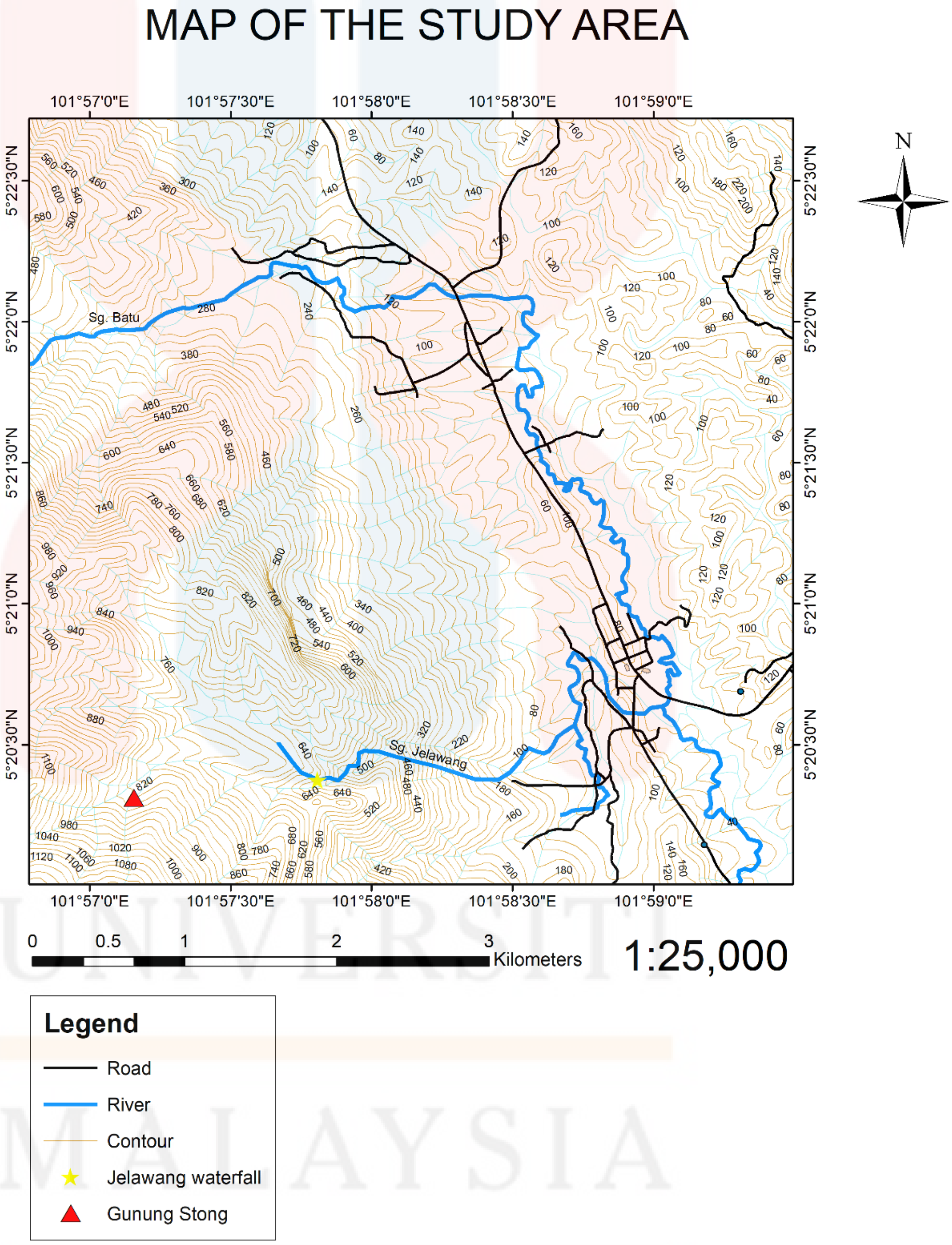

Figure 1.2: The map of the study area.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss the previous researcher's idea related to the scope of the study. The literature review source includes journals, books and reports related to Malaysia's general geology and structure analysis. Then, all the information is focused on the general geology in part of Dabong, Kuala Krai also structures analysis at the study area.

2.2 Regional geology and tectonic setting

The chapter provides a review on the literature study done to obtain an understanding of various structural geology studies. Kelantan is one of the states in Malaysia located in Peninsular Malaysia. While Peninsular Malaysia is part of Sibumasu and East Malaya blocks. It was divided into three tectonic belts which are western belt, central belt, and eastern belt.

Kelantan is located at central belt and eastern belt. As shown in Figure 2.1, the geology of Kelantan can be classified into four types of rocks which are unconsolidated sediments, volcanic rocks, sedimentary or metasedimentary rocks and granitic rocks (Dony Adriansyah Nazaruddin, 2015) as shown on Table 2.1. Within the central zone, there are windows of granitic intrusive, the more prominent of the Stong Migmatic complex and Kemahang pluton.

Rock type	Area (%)
Unconsolidated sediment	6
Extrusive rock	10
Sedimentary/Metasedimentary rocks	51
Granitic rocks	33

Table 2.1: The distribution of rock in Kelantan

Kelantan is located in the East of Malaysia, as shown in Figure 2.1. In East Malaysia, there are three major geological components which are the Carboniferous-Permian "Calcareous Series", the Triassic "Arenaceous Series", and Mesozoic Granite (MacDonald, 1967). The Southeast Asian region is a complex collage of terrains comprising fragments of continental affinity, island arc, accretionary complexes, marginal basin and oceanic crust. Peninsular Malaysia straddles at most minuscule two terrains: Sibumasu in the west and Indochina/East Malaya in the east, separated by the Uttaradit-Nan-Bentong-Raub suture zone (Metcalfe, 1984). As Hutchison (2009) stated, Sundaland is a part of South-East Asia, while Peninsular Malaysia is an integral part of the Eurasian Plate.

According to Goh Swee Heng's (2006) description, the overall geology of Kelantan is made up of a core zone of sedimentary and metasedimentary rocks that are surrounded on the west and east by granites of the Main Range and Boundary Range, respectively. Granitic intrusive windows may be found inside the core zone. The most notable of them are the Ulu Lalat (Senting) batholith, the Stong Igneous Complex, and the Kemahang pluton. These granite and country rock bands extending north-south represent, in essence, the continuation of the regional geology of north.

Pahang to the north.In the west and central Kelantan, the belts continue northward into southern Thailand. However, in the east, the Boundary Range granite is overlain by the coastal alluvial flat of Sungai Kelantan. The principal tectonic barrier separating Peninsular Malaysia's western and central belts, according to Almashoor (1996), is the Bentong Suture zone. At least seven different tectonic units make up several of the suture's rock types. Schist and phyllite are organised in a systematic succession from west to east (or from stratigraphically lower to higher levels), making up a whole tectonic unit.

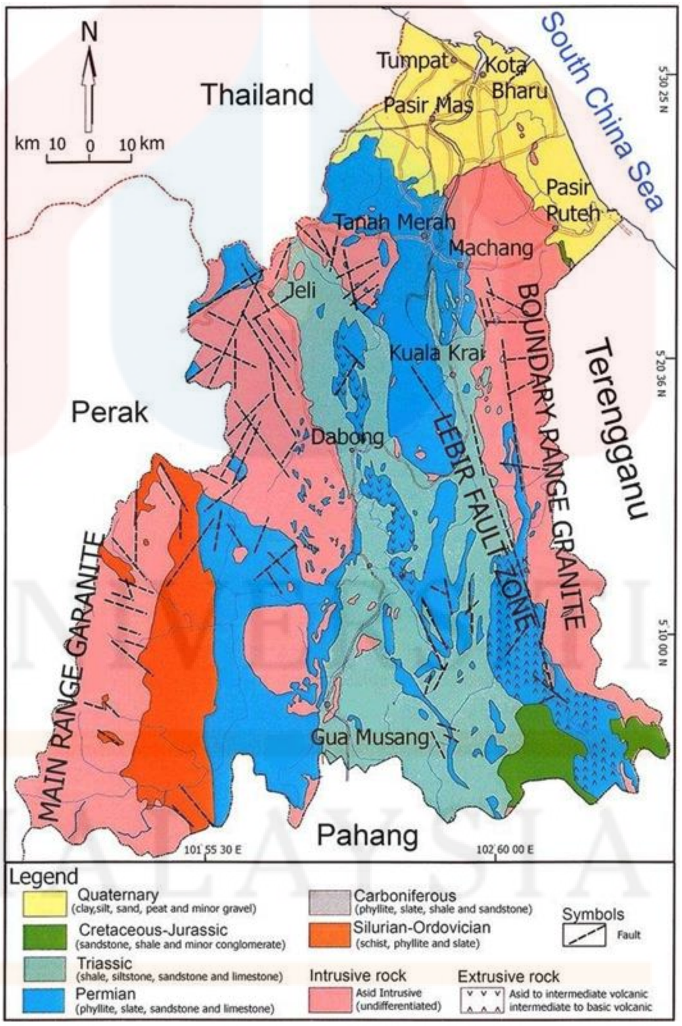

Figure 2.2: The geological map of Kelantan.

2.3 Geoheritage of Gunung Stong

Geologists are sometimes drawn to distinctive geologic features or geological landforms to conduct surveys and study. In the previous work of ,Nursufiah Sulaiman et al 2020, in order to determine the potential geoheritage value had define the paramter of evaluation in terms of educational values, scientific values(intrinsic), economic values, conservation values and added values(ecological), cultural and also aesthetic). It also shows the uncommon geological feature and landform is also found in Malaysia. An exploration in Dabong in the previous study of Nursufiah Sulaiman et al 2020, has also unearthed a hidden treasure mine of geological historical resources.

Although the locals consult with it as a "gunung" (Malay for "mount"), it's really a karstic hill that rises higher than the flat sediment plain. Gunung Stong State Forest Park (GSSFP) was also known as one of the top five ecotourism destinations. Despite its rich geodiversity, the GSSFP will also highlight some geological attractions, Gunung Stong Waterfall or known as Jelawang Waterfall was known as the highest waterfall in Southeast Asia, the igneous and metamorphic structures the better preserved and fossils such as the spider (Trapdoor). The region's terrain is distinguished by its distinctive hills, stunning caves, woods, valleys, plains, and plateaus, as well as its great geodiversity in terms of rocks, minerals, fossils, geological structures, geomorphological and landscape characteristics (Nazarruddin, 2015). Gunung Stong's geoheritage consists mostly of rocky coastlines, cliffs, peaks, and waterfalls, as well as caves. Some extremely significant areas have been designated as geoheritage sites, since they include one or more geodiversities with great heritage significance.

2.4 Geological landscape

A landscape is a part of the floor of the Earth that may be visible from one role at a time. It includes the geographic traits that become aware of a geographical area or are feature of it. From the previous study in Langkawi (Mohd Shafeea Leman1, 2008), it state that the wealth of geological exposures and landscapes is a remarkable blessing. In Gunung Stong, there are geological systems is maximum of it's far the natural panorama and some cultural landscapes. Firstly, a natural landscape consisting of mountains,and also plateaus which is made from a chain of landforms. Other traits of natural ecosystems encompass caves, herbal waterfall, and herbal vegetation. Second, an surrounding that people have converted is known as a cultural landscape. Cultural ecosystems are created through way of means of someone and the vegetation they raise, the fauna they may be safekeeping for, and the composition they make.

2.5 Stong Migmatite Complex

Geological features of the Stong Complex Migmatic is categorised as a young mountain region (Unjah, & Komoo, 2012). This terrain is distinguished by its geological singularity, such as the existence of a range of magmatic rocks, enclave structure, and vein diversity, as well as its distinctive scenery, such as the development of tors and rapids with high aesthetic, recreational, and scientific value. The formation of this terrain is attributed to magmatic and rare dynamo thermal phenomena, which resulted in the formation of a unique and picturesque landscape feature through exogenic processes. Several geosites of great aesthetic, recreational, and scientific historical value have been discovered.

The Stong Complex is the most northern plutonic complex in Peninsular Malaysia's Central Belt. The complex consists of Berangkat Tonalite, Kenerong Leucogranite, and Noring Granite, in the highest to the lowest order of age. The first two are somewhat distorted and heavily foliated. The Berangkat Tonalite is composed of grey, partially heavily foliated megacrystic tonalite and monzonite. The Berangkat Tonalite also contains modest facies of fine to medium-grained diorite. The alkali feldspar megacrysts vary in size from 10 to 55 mm; they are grey white in colour, often euhedral in shape, occupy around 20 to 30 percent of the rock, and are frequently cataclastically distorted.

Based on the stratigraphic naming of this previous researcher and compared with the Malaysian Stratigraphy Guide shows that if the stratigraphic naming is used as Stong Complex, then the Berangkat Tonalite, Leukogranite Kenerong and Noring Granite units will be classified as Supersuit. While the rock units in the Departed Tonalit Supersuit, Leukogranite Kenerong and Noring Granite can be further classified into Suit and Lithodeme units. However, each stratigraphic unit such as Complex, Supersuit, Suit and Lithodemic has certain characteristics and when the study was done it was found that the Stong Complex did not meet the criteria to place it as the standard of the Stong Complex, let alone to name the Berangkat Tonalite, Noring Granite and Kenerong Leucogranite as standard. Supersuit.

2.6 Geosite potential

Geosite potential may be assessed based on geomorphological and geological observations, such as rock and mineral properties, geological structure, groundwater conditions, and geological catastrophe potential (Irvani Irvani, 2019). The surrounding flora and wildlife are also observed, but they are not the primary focus of the investigation. Similarly, the beach and town area's ideas and supporting infrastructure are compiled as a geosite's potential for the development of geotourism, natural tourism, and natural education. In geomorphological study, landscape analysis or geomorphology employing Van Zuidam classification and river flow pattern from Howard, as well as rock weathering conditions, are of importance. Thematic geological characteristics of rock-minerals, geological structure, groundwater, and the likelihood of natural catastrophes are plotted and studied in a straightforward manner. On rocks, the identification and study of geological features such as folds, joints, and faults. Using eye inspection, the status of groundwater and surface water is determined. Various prospective natural catastrophes are investigated from a geological standpoint.

CHAPTER 3

MATERIALS AND METHODS

3.1 Materials

As with the materials and methods used in this research, some of the resources consist of maps, photographs, and literature that pertain primarily to the issue being examined and the study location. The bulk of the materials dedicated to this research is field equipment components, such as a Global Positioning System (GPS), a geological hammer, a Brunton compass, map, and other literary works associated with geoheritage and the study area. The materials will be utilized to map the study region Apart from that, the internet resources were the most crucial factor in the development of this project, as the software used to obtain the aerial image was Google Earth, which can provide a rough general image of the study area, including road connections, structural features, topography, and geomorphology. As a result, factors such as geological feature occurrence, rarity, integrity, and representatives should be thought of throughout the geoheritage site identification process.

Equipment	Function
Global Positioning System (GPS)	The GPS records and labels the coordinates when traversing
Geological hammer	These tools are used to gather rock samples
Brunton compass	Brunton Compass is used to measure the strike and dip.
Base map	Using a base map, it can show the data and information about the study region before visiting the field.
Hand lens	It can show the tiny features of rock samples, including fossils, minerals, and other materials.
Sample bags	A sample of rocks is collected, put in a sample bag, and tagged with the coordinates of the sampling location.
Measuring tape	To measure the outcrop.
Fieldwork book	To record all of the information gathered in the field.

Table 3.1: The equipment and their function

3.2 Methods

The study method follows the structure analysis investigations of potential geological sites which include geological mapping of the research area, field exploration of the study area, inventory, classification, characterization, assessment and evaluation.

3.2.1 Geological Mapping

Geological mapping was required to define the research area. To create the geological map and to analyse the facies. The lithology, geomorphology, structural geology and stratigraphy of the study area are observed. The study region was visitedas part of the data collection process, which is the most important element as it provides comprehensive information about the study area before analysis.

Good data collection is essential to get effective data analysis. Geographic information systems (GIS) play an important role as to analyses further about the data. A Geographical Information System (GIS) is a computer programme that captures, stores, analyses, and manages data and properties that are spatially referred to the Earth. From this perspective, the entire study region will be recorded in order to satisfy the primary goal of the issue statement, which is to create the lithology for geological value.

3.2.2 Field exploration data

One of the tactics that will be studied in this study is field exploration. Field exploration knowledge provides data on the situation and confirms the existence of geosites in the studied region. Baseline data were gathered via research based on Scopus, Google Scholar, MDPI, and ResearchGate databases, which were compiled by interdisciplinary reports made up of public institutions and scientific and tutorial analyses. The findings of this literature study (biological, ecological, and geological) were used to assess the further data to be collected in the field between September and December 2021. Direct interviews with certain body departments, native populations, visitors at random, and direct observations of the designated geosites will be used to obtain field data.

3.2.3 Data Analysis and Interpretation

The acquired and processed information will be examined and interpreted. The geological map that has been created is interpreted by recognising the geological features present on the map, such as fault, fold, and lineament. Based on the processed and created map, it is also possible to determine the kinds of rocks and their distribution within the research region. For geoheritage specification, secondary data-collected data is used to evaluate possible geoheritage through qualitative analysis, which is the classification based on Endere & Prado's (2014) six criteria. The criteria mentioned include palaeontological, geological, contextual, integrity, social and socioeconomically. Each criteria is selected according to its value, with zero being the lowest value and rising numbers representing increasing values. For a site to be evaluated as having the potential to become a geoheritage site, the sum of all the derived values must be more than or equal to 25. (Endere & Prado 2014).

3.2.4 Inventory

The inventory can be defined as an identification tool for determining potential geological heritage sites in the study area. The inventory was carried out according to the previous bibliographical overview in the article in the research journal of other fields of study and also in the field work in this area.

3.2.5 Classification

The next part is classification. Classification are specializing in the geodiversity’s field, yet because of the dimension of the location of the realm of the study of this paper. In classification, the geoheritage options had been classified supported many classes in geology that then replicate the subdisciplines of geology and may be thought about as the part of geoheritage inventory and assessment.

3.2.6 Characterization

On the opposite hand, the analysis of characterization by doing the observant and evaluating the location of the realm intimately are done. The characterization and inventory are synchronized along because the inventory is for characteristics and characterizations are additional to the representational process the sites that had been known supported the geological options that exist.

3.2.7 M-GAM assessment

The structure of the M-GAM model was used to evaluate the geodiversity values. The preceding criteria is the geomorphosite potential analysis parameter. (ura Miljkovi et al., 2018) It has a sub-parameter that will be assessed between 0 and 1, indicating that it is insignificant to critical. Due to the fact that the M-GAM model is developed from the geosites assessment model produced by Vujii et al., the same structure, consisting of two major indicators and sub-indicators, is utilised. According to table 3.2, the two primary indicators, core values and extra values, were further subdivided into 12 sub-indicators and 15 indicators, respectively.

Typically, central values are derived from geosites' natural characteristics. In contrast, extra values are mostly human-induced and may be modified to meet the demands of the visitor. The primary values consist of three indicators which are scientific/educational (VSE), Scenic/aesthetic (VSA), and Protection (VPr). In the meanwhile, the Additional Values (AV) are separated into two categories of indicators: functional (VFn) and touristic (VT) values (VT).

The survey was performed, and 50 respondents were asked to assess the importance (Im) of each of the 27 sub-indicators on a scale from 0.00 to 1.00; the mean values for each Im were then calculated.Table 3.1: The equipment and their function

Table 3.2: The structure of M-GAM sub-indicators and its descriptions

Sub-indicators	**Descriptions**
Scientific/Educational value	
Rarity	Number of closest identical sites
Representativeness	Didactic and exemplary characteristics of the site due to its own quality and general configuration
Knowledge on geoscientific issues	Number of written papers in acknowledged journals, thesis, presentations, and other publications
Level of interpretation	Level of interpretive possibilities on geological and geomorphologic processes phenomena and shapes and level of scientific knowledge
Scenic/Aesthetic	
Viewpoints	Number of viewpoints accessible by a pedestrian pathway. Each must present a particular angle of view and be situated less than 1 km from the site.
Surface	Whole surface of the site. Each site is considered in. quantitative relation to other sites
Surrounding landscape and nature	Panoramic view quality, presence of water and vegetation, absence of human induced deterioration, vicinity of urban area, etc.
Environmental fitting of sites	Level of contrast to the nature, contrast of colors, appearance of shapes, etc.
Protection	
Current condition	Current geosite state
Protection level	Protection by local or regional groups, the federal government, and international agencies, among others.
Vulnerability	Geosite susceptibility rating
Suitable number of visitors	Proposed number of concurrent visitors based on the site'ssurface area, susceptibility, and present condition.
Functional values	
Accessibility	Number of extra natural values within a 5-kilometer radius (Geosites also included)

Additional natural values	Number of extra anthropogenic values within a 5-kilometerradius
Additional anthropogenic values	Number of extra anthropogenic values within a 5-kilometerradius
Vicinity of emissive centres	proximity of emitting centres
Vicinity of important road network	Proximity of significant road networks within a 20-kilometerradius
Additional functional values	Parking garages, petrol stations, auto shops, etc.
	Touristic values
Promotion	Quantity and distribution of promotional assets
Organized visits	Number of arranged visitors to the geosite per year
Vicinity of visitor's centres	proximity of the visitor centre to the location
Interpretative panels	Interpretive properties of text and images, material quality, size, and environmental compatibility
Number of visitors	Number of annual tourists
Tourism infrastructure	Level of added tourism infrastructure (pedestrian pathways, resting places, garbage cans, toilets etc.)
Tour guide service	If available, competence level, foreign language(s) knowledge, interpretive abilities, etc.
Hostelry service	Hostel service near to the location
Restaurant service	Restaurant service close to geosite

5.0 RESEARCH FLOW CHART

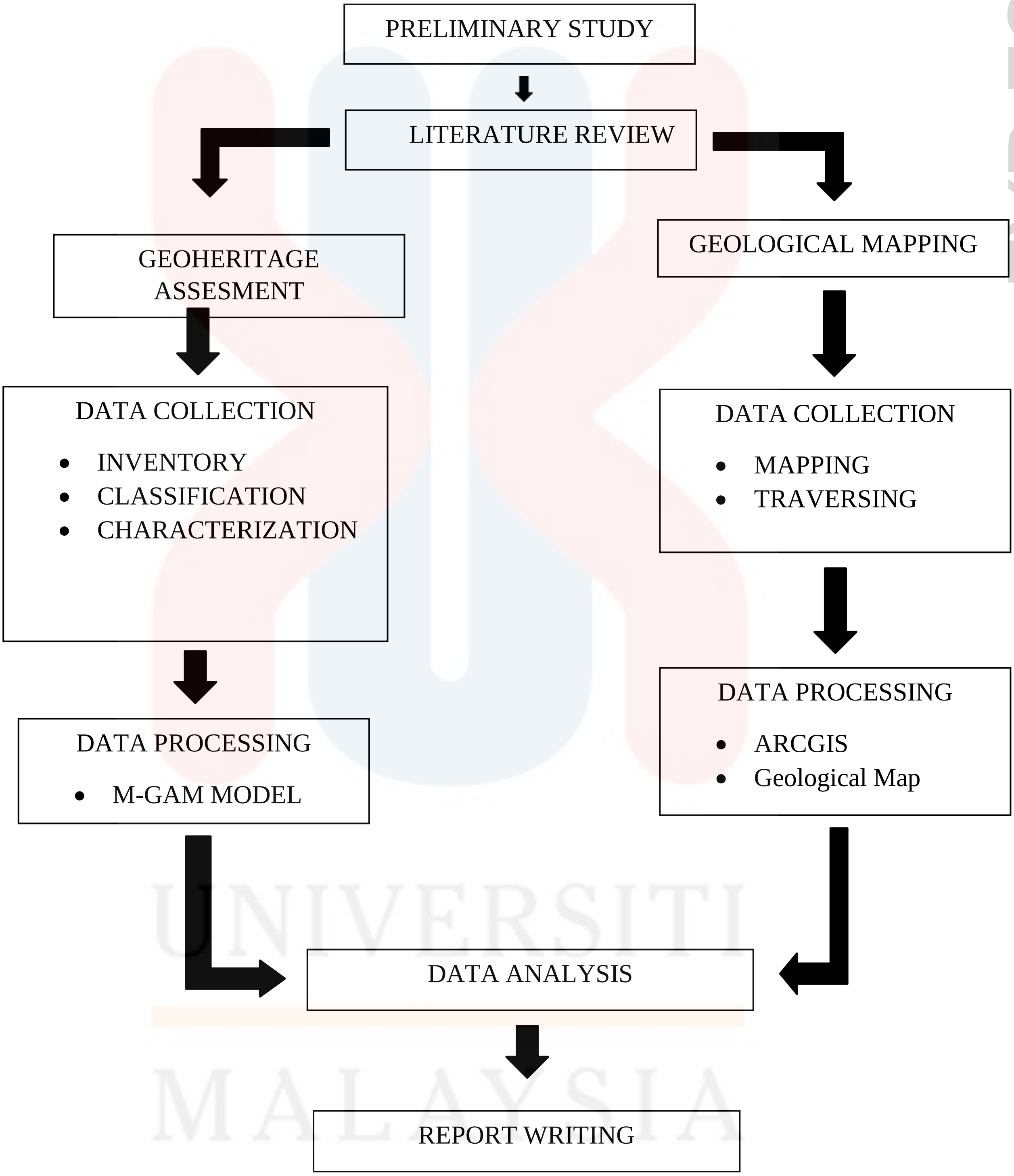

Figure 3.1: The flow chart for the research

CHAPTER 4
GENERAL GEOLOGY AND STRATIGRAPHY

4.1 Introduction

This research's general geology section discusses the location of the studied region as well as its geomorphology, lithostratigraphy, structural geology, and geologic history. The geological information and conclusions were derived via spatial data analysis and interpretation of the research region using DEM SRTM data collected from the USGS. The related maps displayed the processed and interpreted data. In the meanwhile, a geological map with a scale of 1:25,000 displays the general geology of the research region, including the distribution of rock units, rock borders, cross-section, and the age relationship of each rock unit.

4.2 Travers and field observation

The fieldwork was conducted several times. During this fieldwork, traversing within the study area cover along the main road and within the villages and the hiking trails of the Gunung Stong. The study area that has been selected covers an area of 25 square kilometers and is located in. Several aspects have been observed, which include accessibility, settlement, forestry, and land use.

4.2.1 Accessibility

The study area is located at west of Kuala Krai district in Dabong sub-district. The main access to the study area is from the northward direction of the study area through a road that is connected to Gua Musang. Meanwhile, the study area is also accessible from eastward direction through roads that are connected to Jelawang - Gua Musang road. The accessibility of the study area consists of several paved and unpaved roads utilized by lorries and trucks to transport crops within the plantation area.

4.2.2 Settlement

The settlement in the study area is a dispersed settlement in which there are several scattered houses along the main road with most common on the north. The settlement is moderately dense.

4.2.3 Forestry

Overall, the study area is covered by forestry as it is a highly vegetated on the east area with some area was covered with the plantation of oil palm and rubber trees. Most of the forestry was in the south site of the study area since most of the area are part of the reserved forest.

4.2.4 Traverse and Observation

Traverse is a method in the area of geological mapping that involves establishing waypoints or stations along a line or path in addition to measuring angles and distances between sites on the ground. Observation and mapping of the research area's terrain are used to collect all of its data. During traverses and observation, the Global Positioning System (GPS) plays a vital role by identifying geological features, and some hand samples are gathered for examination and interpretation.

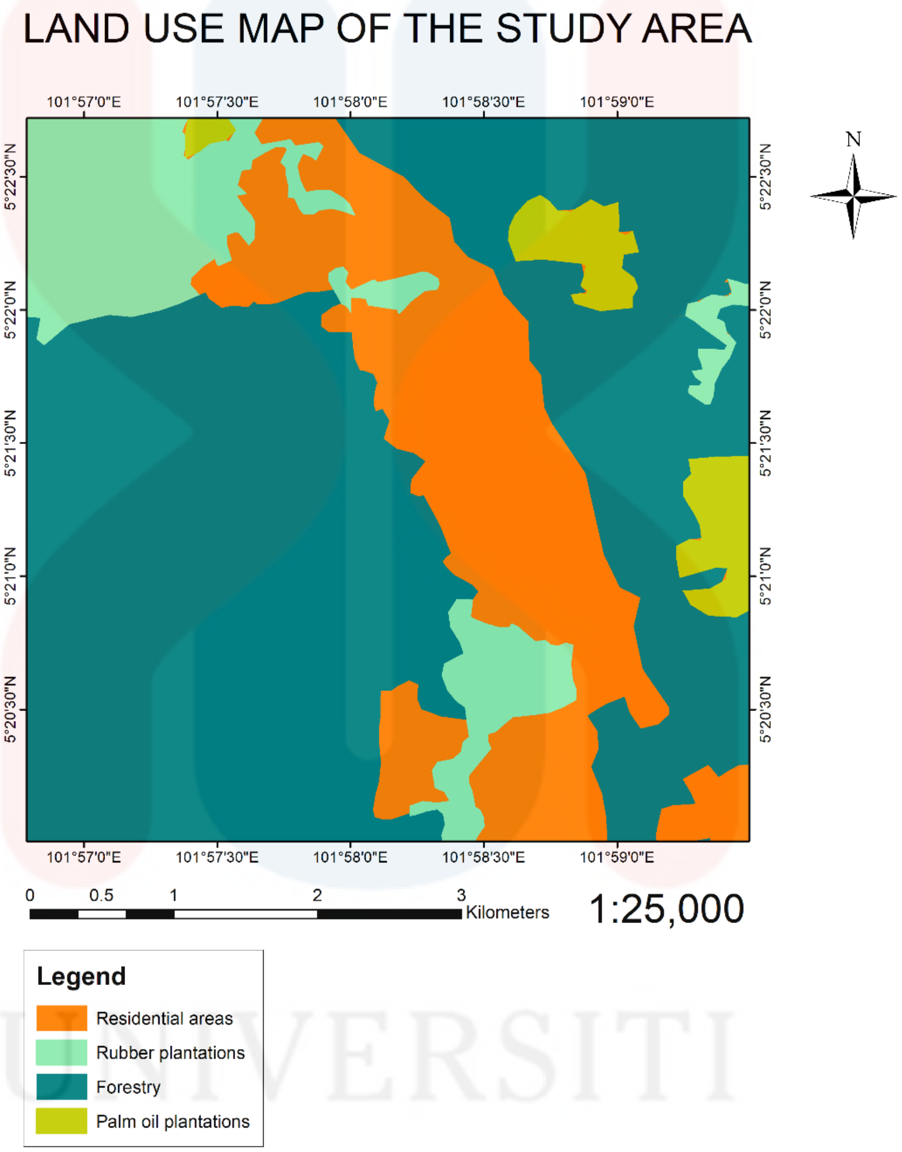

Figure 4.1: The land use map of the study area

4.3 Geomorphology

Geomorphology is defined as the study of landforms of the Earth, its physical features and processes that shaped them. Processes that shaped landforms consist of exogenic processes that are controlled by the climatic changes and endogenic processes that occurred due to tectonic settings. The most found landforms in Malaysia are mountain ranges, hills, river, fluvial and coastal. Landforms in the study area are dominant with hilly and fluvial geomorphology.

4.3.1 Fluvial environment

Running water dominates fluvial environments, which are widespread in the study area. Water runs over hillslopes as overland flow and rushes down gullies and river channels as streamflow. The study area composed mainly of fluvial environment which is most prominent at the west side at the map.

Elevation	Morphography
< 50 meter	Land
50 meter - 100 meter	Low land
100 meter - 200 meter	Low hill
200 - 500 meter	Hill
500 meter - 1500 meter	High hill
1500 meter - 3000 metER	Mountain
> 3000 meter	High mountain

Table 4.1: Classification of morphography based on elevation. (Source: Van Zuidam, 1985)

4.3.2 Geomorphologic Classification

Geomorphology in the study area is mainly classified based on the elevation of contour using Van Zuidam classification (1985) as shown in Table 4.1. The classification was made according to the relationship of elevation and morphography. The importance in classifying geomorphology based on contour elevation is to infer the landforms' morphogenetic which explains its origin and formation process. The contour elevation in the research area ranging from 96 m to 666 m. Thus, the elevation is classified into four classes which are low land (50 - 100 m), low hill (100 - 200 m), hill (200 - 500 m) and high hill (500 - 1000 m). The geomorphology in the study area consists of high hill, hill, low hill, low land and fluvial landforms as shown in Figure.

The study area is dominant with an elevation range of a low land, 50 - 100 m. Meanwhile, hilly geomorphology presents from south-west to south-west of the study area. The hilly landforms in the study area formed due to endogenic process which a part of the Kenerong pluton granitic body intrusion occurred during Paleozoic period. The physical of hilly landforms appears like a massive granitic dome if viewed from terrain map.

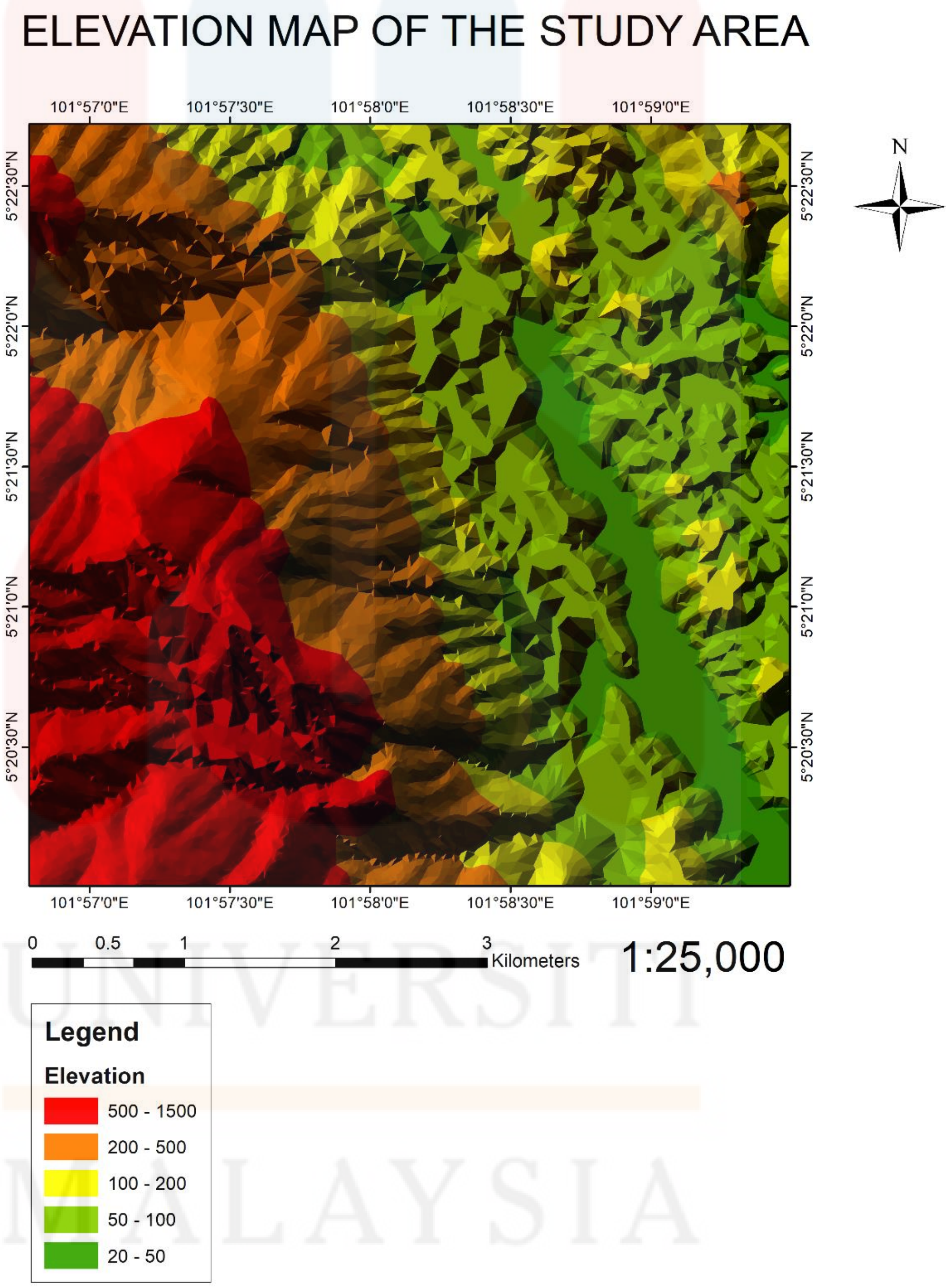

Figure 4.2: The elevation map of the study area

4.3.3 Drainage Pattern

Drainage pattern is a part of river system created by erosional process controlled by types of rock unit, soil, and structural form. The type of drainage pattern commonly found on Earth are dendritic, parallel, trellis, rectangular, annular, and radial. Drainage pattern in the study area comprises of major and modification drainage pattern which are parallel, rectangular, and dendritic as shown in Figure 4.4.

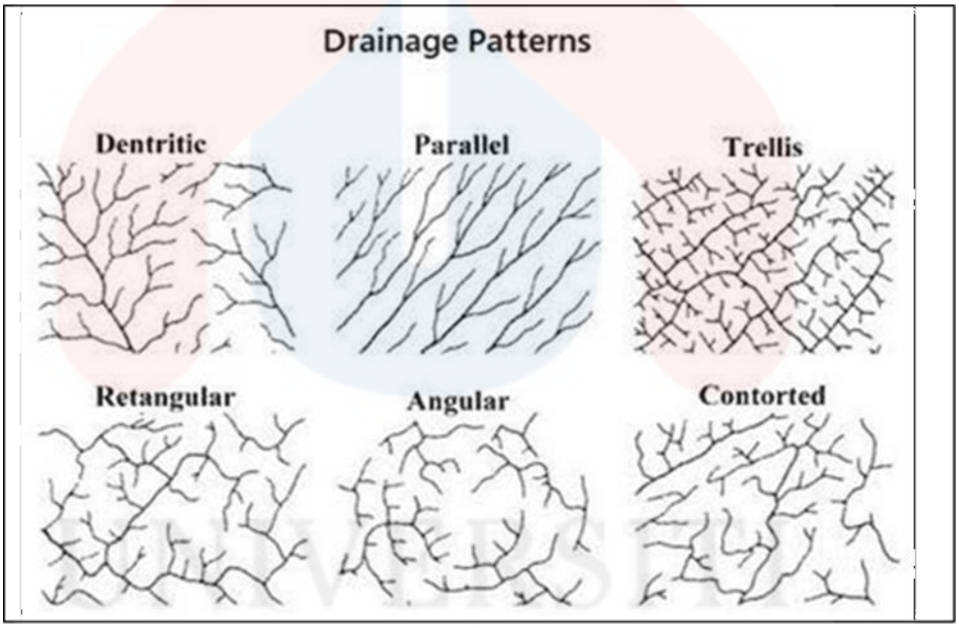

Figure 4.3: The types of drainage pattern (Howard, 2003)

In general, parallel pattern occurs in moderate to steep slopes with some relief which usually exist on elongate landforms along hill ranges. Tributaries run straight, flowing in the same direction, connected to mainstream parallel to each other. Parallel drainage pattern contrasting in terms of the irregularity of the parallel pattern which the streams direction upon connecting to mains streams and rivers are slightly parallel to each other. This pattern dominated the study area where it is distributed on granitic body which have a moderate to steep slope.

Dendritic drainage pattern forms irregular streams distribution and branching like tree branches on gently sloping areas. This pattern indicates relatively horizontal strata or non-uniform crystalline rocks with high resistance towards weathering. Dendritic drainage pattern exists in the north-west of the study area on granitic rock unit where the streams flow into Sungai Batu.

Steep slopes with some reliefs are responsible for the parallel drainage system in the region of study. Due to the steep slopes, the streams are rapid, straight, have few tributaries, and travel in the same direction. It was formed where there is a pronounced slope to the surface.

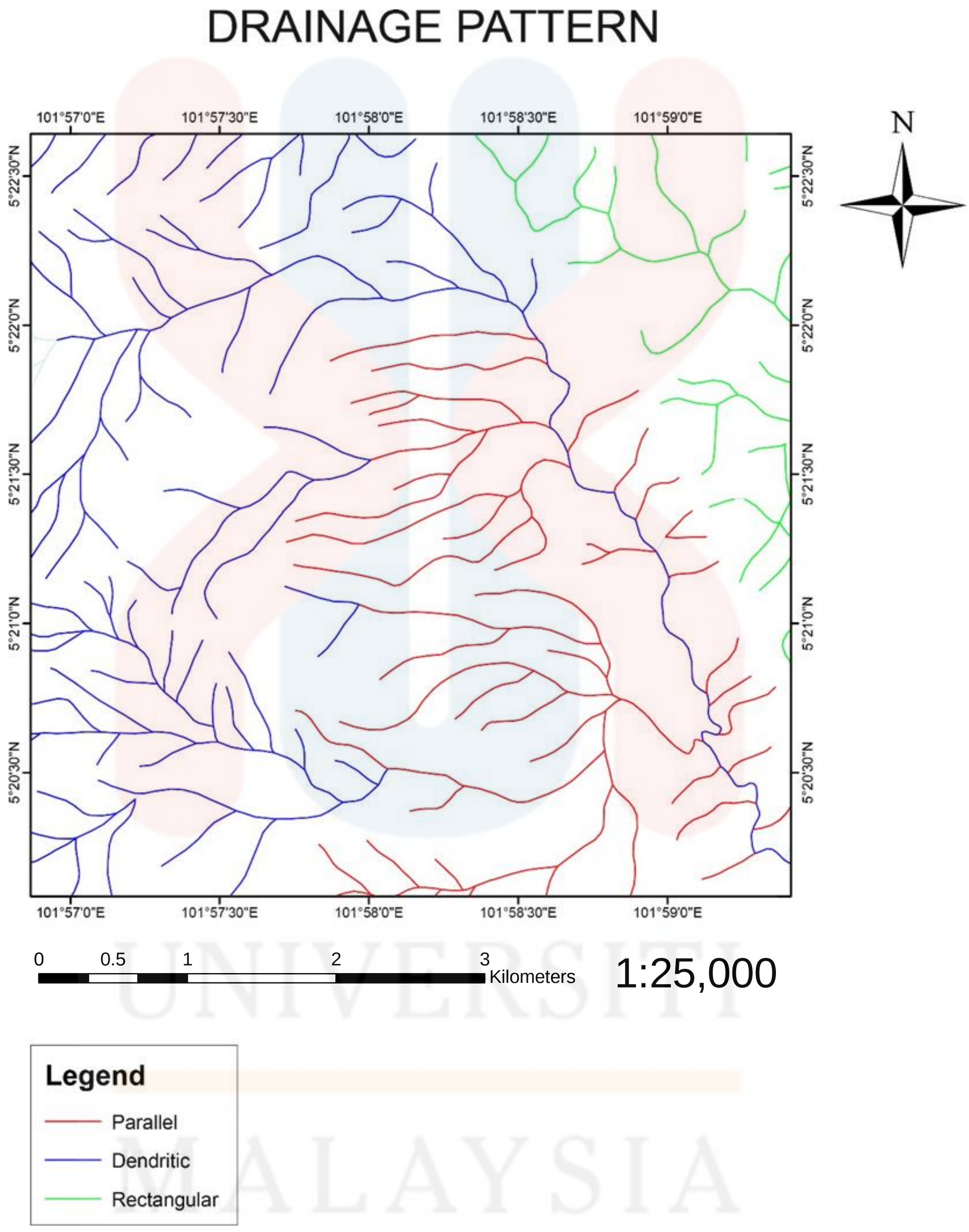

Figure 4.4: The drainage pattern in the study area

4.3.4 Lineament

Tectonic interpretation is done by using lineament analysis by referring to linear features, and the result is shown as in the Rose Diagram in Figure 4.5. Lineament is interpreted based on satellite imagery, terrain map and relief map, as displayed in Figure 4.6. The lineament is interpreted as associated system with fractures due to tectonic stresses. A rose diagram with dominant orientation of lineament is produced, the result is shown as in the first quadrant (0°- 90°), which shows the direction of force is coming from N-E. In Figure 4.4 shows a rectangular drainage pattern that can give information about the structural feature presents at the field. This type of drainage system is the result of structural joints and faults. This is because the compressed meandering stream is formed when sediments are eroded and deposited inside the bending stream.

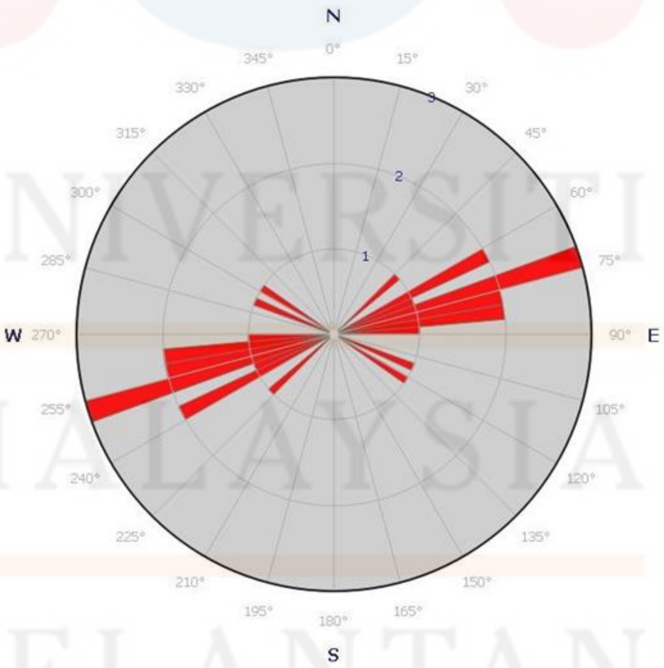

Figure 4.5: The analysis of the lineament in the study area

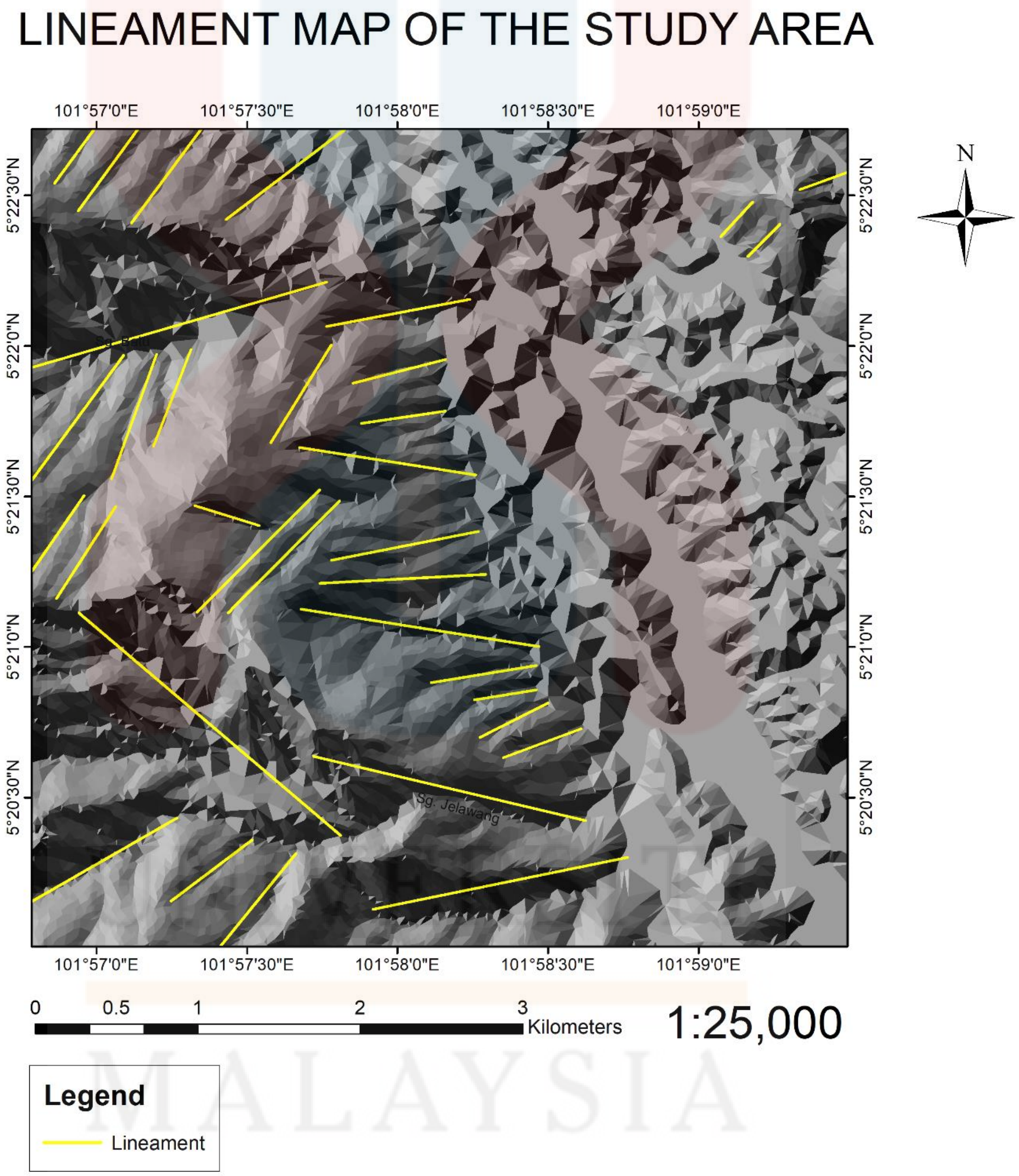

Figure 4.6: The lineament map of the study area

4.3.5 Weathering

Weathering is the process of disintegrating and decomposing rocks into a variety of states. There are three type pf weathering that can accur which is physical mechanical weathering, chemical weathering, and biological weathering. These three weathering processes exhibit distinct characteristics that might alter the state of the rock.

a. Physical weathering

Physical weathering is the scientific term for the geological cycle in which rocks disintegrate without changing their chemical content.

b. Chemical weathering

Chemical weathering is the breakdown of rocks by a subsequent chemical reaction. There include oxidation, hydrolysis, and carbonation in these processes. By forming or dissolving minerals, these processes alter the mineral content of rocks.

c. Biological weathering

Biological weathering refers only to weathering induced by living animals or species, such as people, plants, fungus, and bacteria. Burrowing creatures such as earthworms and moles, for example, can contribute to biological weathering.

In addition, the degree of weathering may be described using a variety of adjectives, including new, discoloured, disintegrated, and decomposed. Fresh indicates that there are no obvious signs of weathering on the rock material, whereas discoloured refers to a change in the original colour of the rock material. The phrase disintegrated indicates that the rock has been weathered to the condition of soil, but the mineral grains have not been decomposed. The term decomposed has the same meaning as disintegrated, but some mineral grains have been decomposed.

Observations made during field mapping indicate that two types of weathering have occurred in some areas of the study region.

Figure 4.7: Outcrop with physical weathering

Figure 4.7 displays the physical weathering of rock surfaces. When exposed to weathering factors such as wind and water, rocks can lose their cohesiveness and fragment. The degree of deterioration: abrasion.

Figure 4.8: Outcrop with chemical weathering

Figure 4.8 depicts chemical weathering, in which the original color of the rock is transformed because of a chemical interaction between weathering agents. The degree of deterioration: discoloration.

4.4 Stratigraphy

The purpose of stratigraphy is to identify the explanation, correlation, and interpretation of geological rocks and sediments. The stratigraphy column displays the age-ordered progression of rock units in the studied region. The oldest unit is found at the base of the stratigraphic column, whilst the most recent unit is positioned at the top. Based on earlier research, the stratigraphic column of the subject region is examined and modified.

4.4.1 Kenerong Leucogranite

The Kenerong Leucogranite is made up of sequence of veins of fine to medium-grained leucogranite and biotite granite, pegmatite, and aplite. The outcrop is near the Jelawang waterfall, which is dominant by leucogranite and biotite granite. Leucogranite is a type of granite that is composed mainly of feldspar minerals, with little or no mica minerals. It is usually light-coloured and has a similar appearance to granite, but with a more homogeneous colour and less variation in the size and shape of the crystals. Leucogranites are formed by high-level granitic intrusions.

4.4.2 Lithostratigraphy

Lithostratigraphic units are rock entities that are characterised and categorised according to their lithological properties and stratigraphic connections. The fundamental geological mapping units are lithostratigraphic units. During field mapping, the distribution of rock types in the research region was identified. The rocks are classified as Acid intrusive and Uni limestone. Figure depicts the geological map of the studied region.

The geological map illustrates the rock lithology, structural geology, cross section, and stratigraphic column that are essential for comprehending the geology of the region under investigation. Previous scholars have analysed the Gua Musang Formation, which is referenced in the stratigraphic column of the study region. Technically, rock description is essential for lithology classification. The description of the rock is such an interpretation, or a picture of the rock as viewed with detailed information seen with the naked eye or by doing a petrographic examination. The tool, such as the optical microscope and the hand lens, is used to evaluate the rock's individual grains.

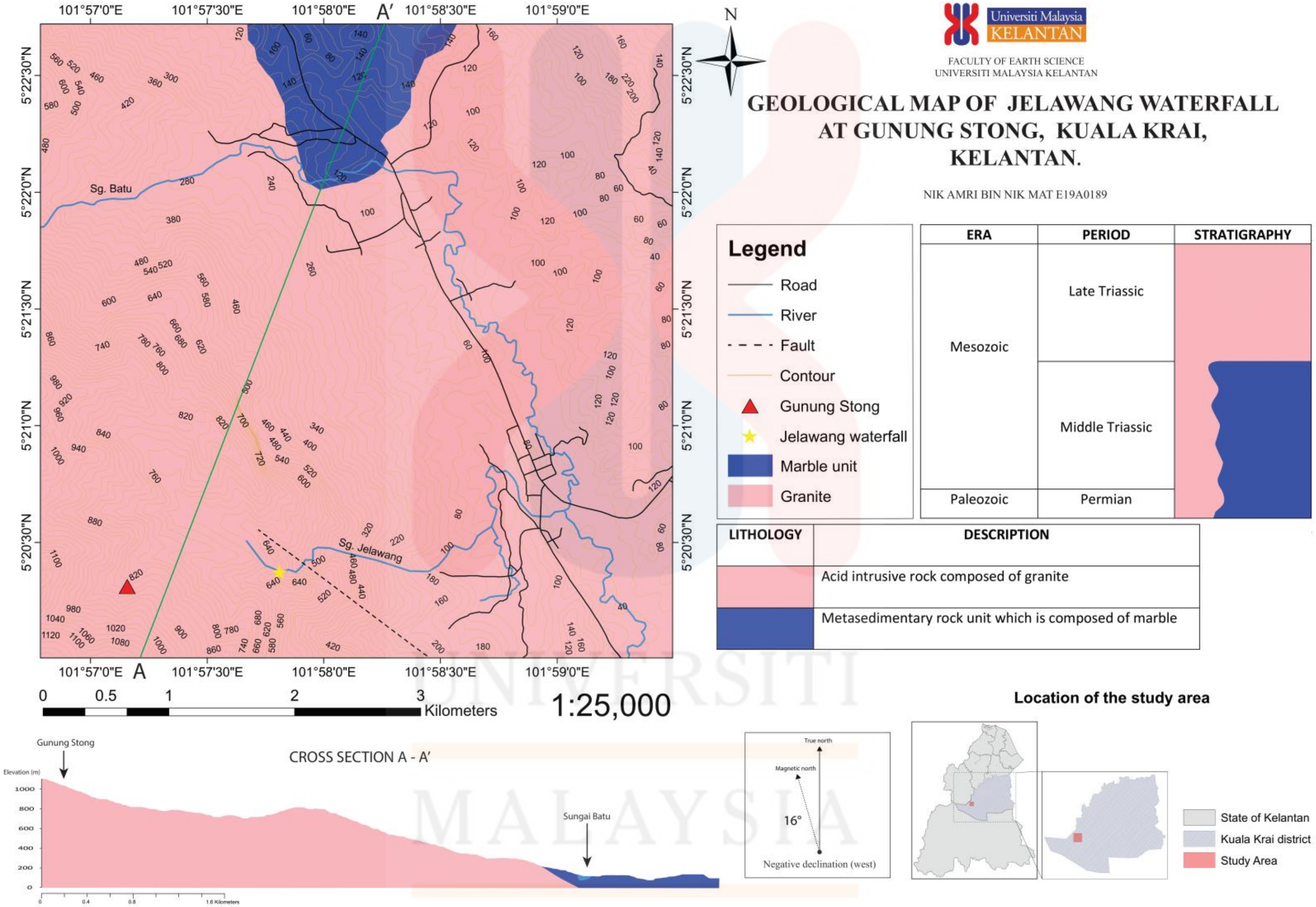

Figure 4.9: The geological map of the study area

Acid intrusive

An acid intrusive unit is a type of rock that forms when magma or molten rock cools and solidifies underground, forming a body or intrusion of rock. Acid intrusive units are so named because they are typically made up of rocks that are rich in silica, such as granite, which are classified as acidic in terms of their chemical composition. Intrusive rocks form when magma or molten rock cools and solidifies slowly beneath the Earth's surface, allowing the minerals in the magma to crystallize and form a rock. In contrast, extrusive rocks form when magma or lava cools and solidifies rapidly at the Earth's surface, such as during a volcanic eruption.

Acidic intrusive units in the study area are composed of minerals such as quartz, feldspar, and mica, and they are hard and resistant to weathering. They are found in areas where there has been a history of tectonic activity and associated with the formation of mountain ranges. Based on the point counting, the rock can be identified as granite.

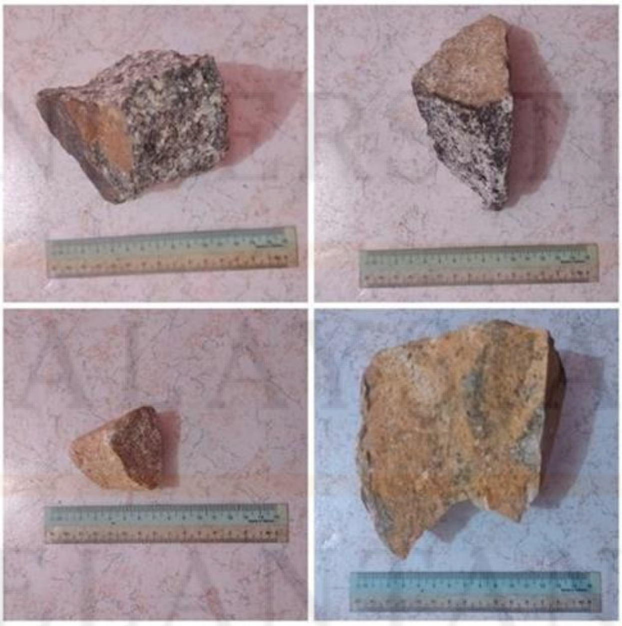

Figure 4.10: Acid intrusive rock sample that was discovered in the study.

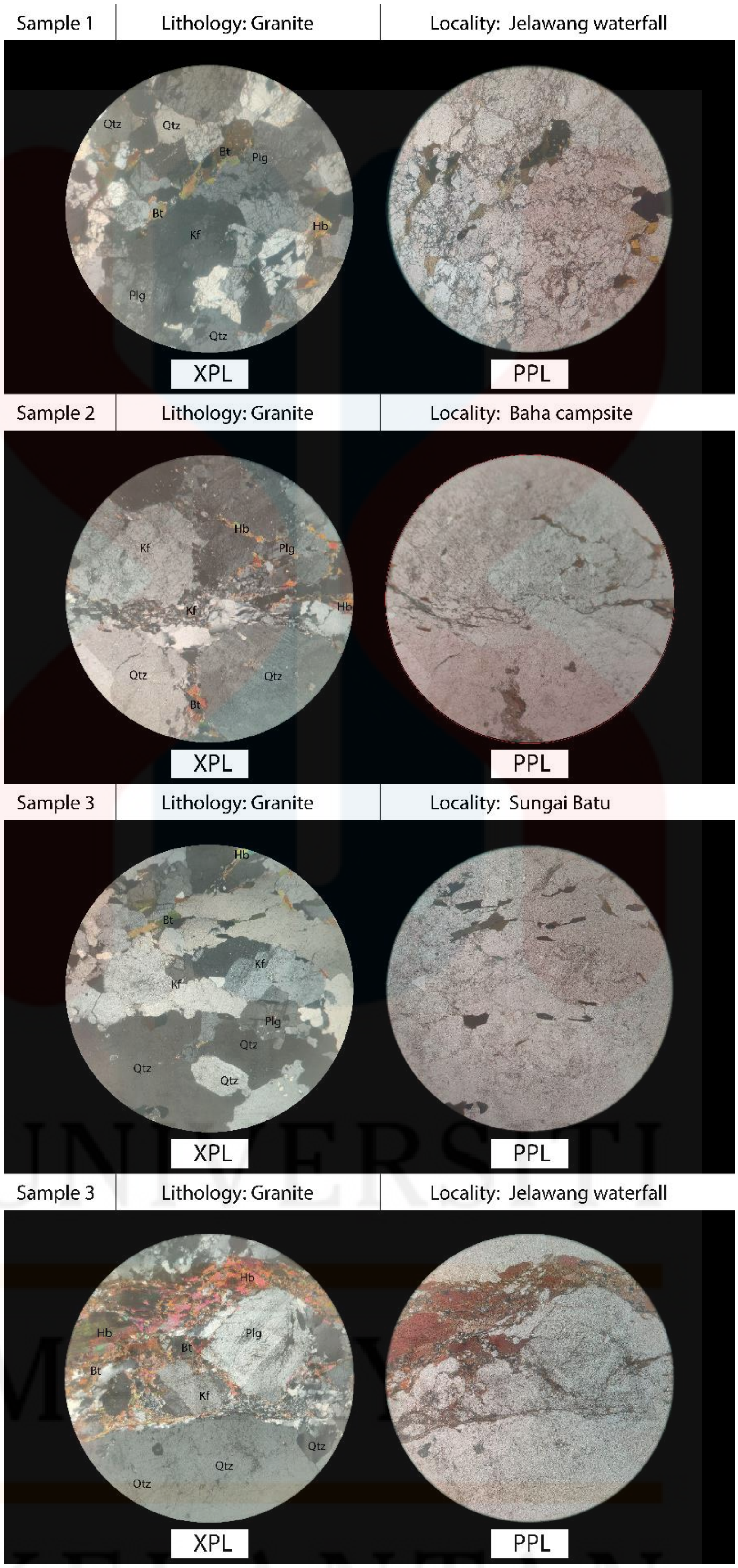

Figure 4.11: Granite sample under cross polarised light (XPL) and plane polarised light (PPL)

Minerals

Plagioclase

In PPL, the absorption color is colorless, low relief, no pleochroism, euhedral – anhedral crystal form, 1-way cleavage. In XPL the interference color is gray – white order 1, dark angles are parallel, albit – kalsbad-albit twinning,

Quartz

At PPL the absorption color is colorless, low relief, no pleochroism, anhedral crystal form, no cleavage. In XPL the interference color is order 1 gray – white, the dark corners are wavy, there is no twinning.

Biotite

At PPL absorption color is brown – greenish, moderate relief, strong pleochroism, subhedral – euhedral crystal form, 1 way cleavage. In XPL, the interference color is green – orange order 3, there are no twinning parallel dark angles.

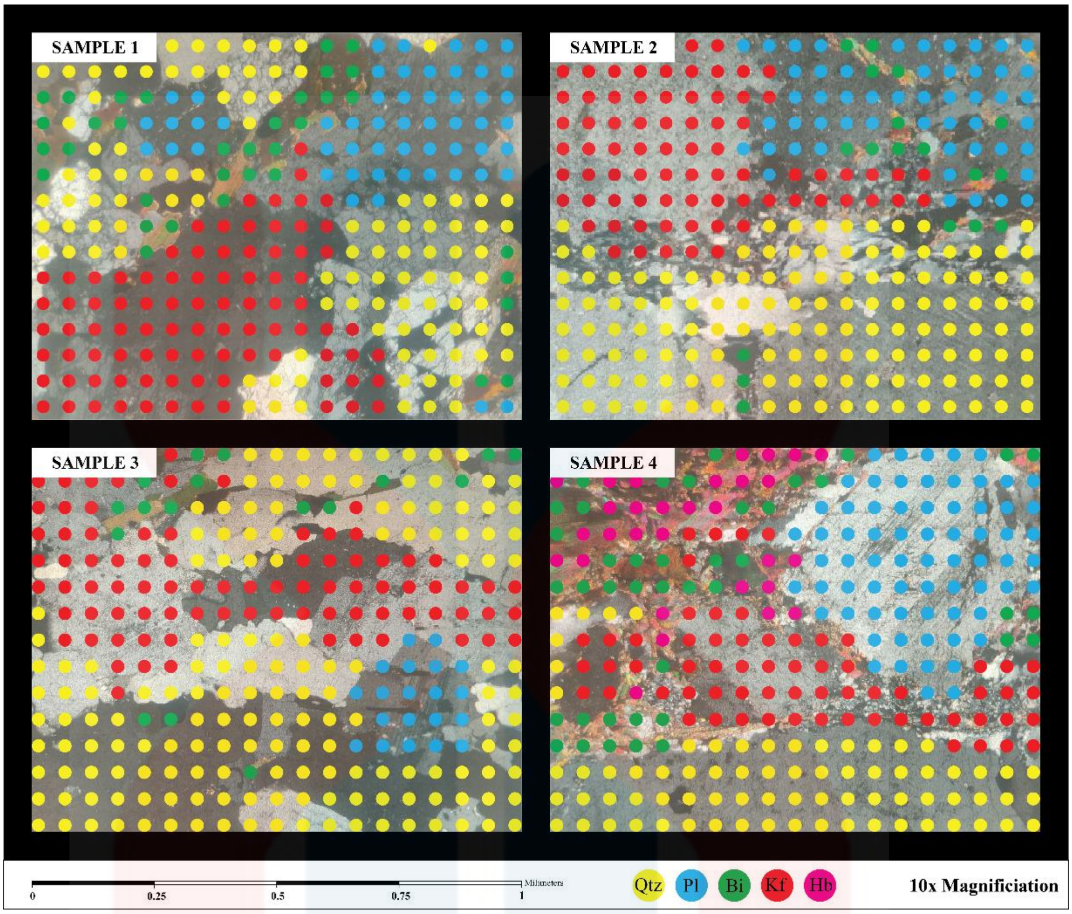

Figure 4.12: the photomicrograph of sample 1, 2, 3 and 4 with point counting.

Minerals percentage (%)	Sample 1	Sample 2	Sample 3	Sample 4
Quartz	41	56	58	34.8
Alkali feldspar	33.7	25	31.5	42
Plagioclase	25.3	19	10.5	23.2

Table 4.2: Classification of mineral percentages from the point counting.

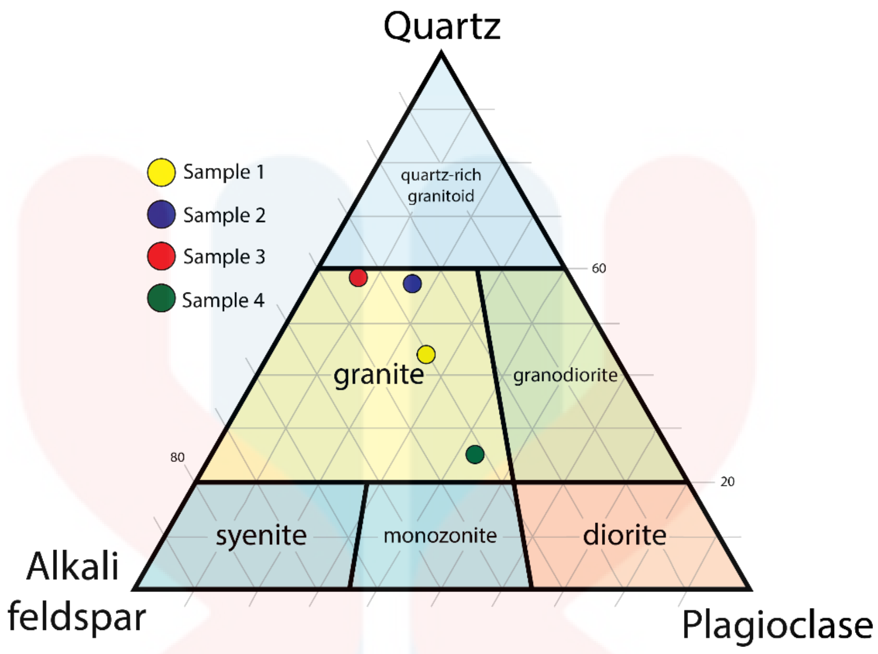

Figure 4.13: the point counting from the IUGS system for plutonic igneous rocks.

Metasedimentary rock

A marble rock is a rock of sedimentary origin that has been subjected to metamorphism. The protolith for this lithology is limestone, and the metamorphism produces marble and then paragneiss as temperature and pressure increase. However, the sample is considered a low-grade metamorphism. As grain size increases, the rock first acquires a foliation. The metamorphism of pure limestone produces marble.

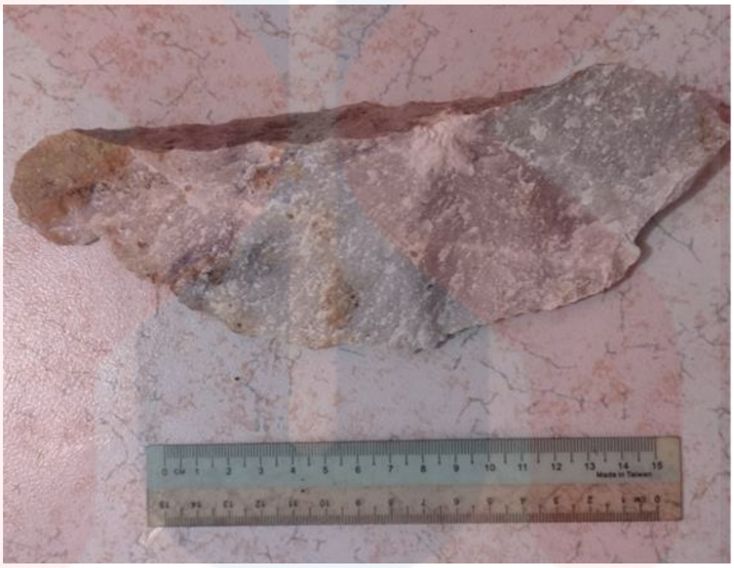

Figure 4.12: Marble rock sample that was discovered in the study area.

Figure 4.13: The outcrop for the marble rock

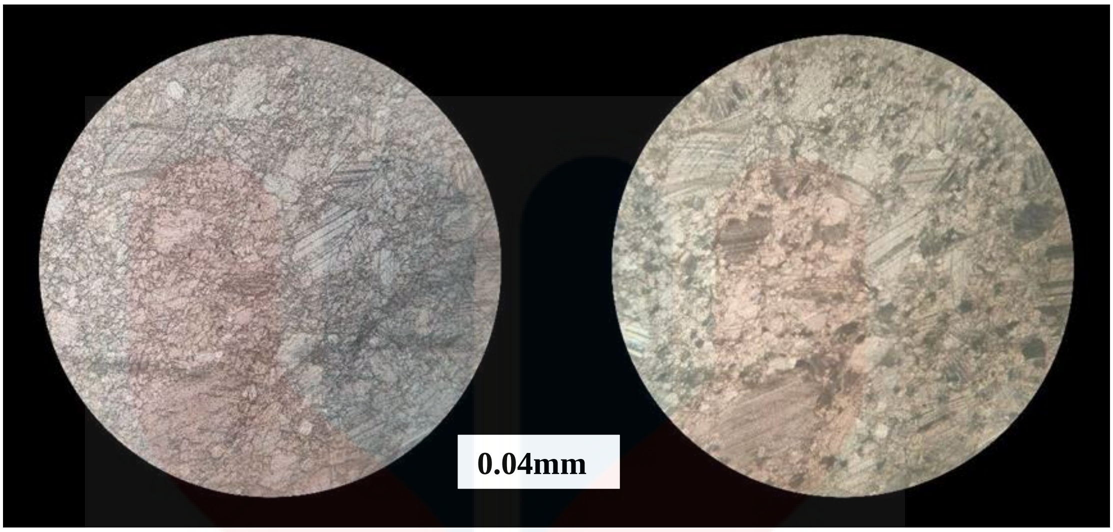

Figure 4.14: Marble under cross polarised light (XPL) and plane polarised light (PPL)

Minerals

Calcite

At PPL the absorption colour is colourless, low relief - moderate, no pleochroism, anhedral crystal form, 2-way cleavage does not exist.

1. Grain Size: Coarse grained.
2. Texture: Granular
    - Foliation: Granular.
    - Lineation: Granular.
    - Structure: Granulose.

The rock is considered as low-grade metamorphism since it still has a significant amount of hydrous minerals such as calcite.

4.5 Structural Geology

The study of the processes that result in the production of geological structures and their consequences on rocks is known as structural geology. The strong tectonic forces that shape the planet frequently result in geological formations. These forces cause rock to fold and fracture, deep faults to form, and mountains to rise. Current measurements of rock geometry are frequently employed in geological structure to understand the stress field that produced the observed strain and geometries and to learn more about the past history of rock deformation.

Two types of structural geology were recognised based on the research area: joints and faults. Taking field trend and frequency values and visualising them using Georose software, a joint analysis was conducted. This programme will display the force's direction on rocks. In the meanwhile, a lineament analysis was applied to the fault investigation.

4.8.1 Joint

There are two types of joints: systematic and non-systematic. Systematic joint and cross have been discovered in the field of research. The joint is categorised as a systematic joint due to its frequent break. Joints are the consequence of brittle fracture of a rock mass caused by tensile and compressive pressures. The rock cracks along a plane parallel to the highest principal stress and perpendicular to the least principal stress when this occurs.

Figure 4.15: Igneous rock with joints

4.8.2 Fault

A fault is a crack between two rock blocks when displacement has occurred. The types of faults include normal fault, reversing fault, and thrust fault. This fault is identified by the nature and orientation of the stress acting on the earth's crust. The location of the fault can be found at the 5°20'26.21''N latitude and 101°58'12.28''E longitude.

Figure 4.16: Outcrop with fault

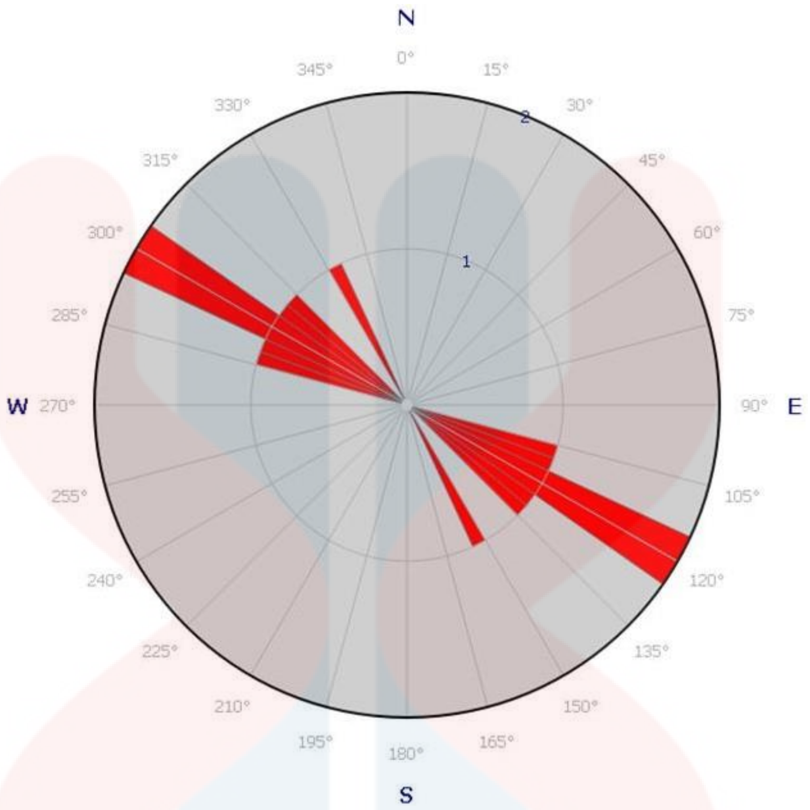

Figure 4.17: Rose diagram of the fault

The fault in the study area is a dip-slip fault, which means that the hanging wall has moved up in relation to the footwall. A compressive stress produces a reverse fault.

4.6 Mechanism of structure

The study area's structural mechanism is thought to have developed because of igneous intrusion. When lava cools and solidifies under the Earth's surface, intrusive igneous rocks are created. Because they form underground, they cool more slowly than extrusive igneous rocks, which are formed when magma reaches the Earth's surface and cools rapidly. As a result, intrusive igneous rocks have a coarser texture and larger mineral crystals than extrusive igneous rocks.

When magma rises through the Earth's crust and solidifies within, it created a body of rock that is surrounded the area. When the magma intrudes into pre-existing fractures in the crust, it also created a long, thin bodies of rock known as dikes.

Figure 4.18: the present of dike in the study area.

CHAPTER 5

GEOSITES POTENTIAL OF JELAWANG WATERFALL

5.1 Introduction

In general, this chapter will be discussed about the geosites potential of the study area, which is the Jelawang waterfall located in Kuala Krai, Kelantan. A modified Geosite Assessment Model or M-GAM is used to determine the potential geosite in the area. According to Wimbledon, a geosite is a site location region or territory where a geological or geomorphological importance for conservation may be identified.

In general, geosite value is linked to geodiversity features. Geosites analyses are utilized by M-GAM to determine the heritage value of the study area. The evaluation of Jelawang waterfall was used based on the assessment to assess the potential geosite.

5.2 Geosite Analysis for Jelawang waterfall based on M-GAM.

To justify the Jelawang waterfall as a potential geosite location, a survey was conducted. The total of 50 respondents ranging from both experts and Visitors was surveyed. The first part of the survey included the socio-demographic of the respondents. The second part is the M-GAM assessment that include Main Value (MV) and Additional Value (AV)

5.3 Socio-demographic of the respondents

In figure 5.1, The gender of the respondents mostly dominated by males with 31 respondents followed by female respondents at 19 respondents. This data can help in understanding how gender influences the choices of an individual. In figure 5.2, The age group of the respondents are mostly dominated by the age group of young adults (17 – 30 years old) at a total of 31 respondents. The age group of middle-aged adults (31 – 45 years old) consists a total of 16 respondents while the age group of old-aged adults (46 years old and above) consist of 3 respondents. In figure 5.3, The education levels of the respondents are mostly with a bachelor's degree (36 respondents). A total of 7 respondents with the education levels of diploma and a total of 6 respondents with the education levels of school certificates. Master's degree makes up the least numbers of respondents with only 1 respondent. In figure 5.4, A total of 35 respondents have expertise in a field related to geology while a total of 15 respondents doesn't have expertise in a field related to geology.

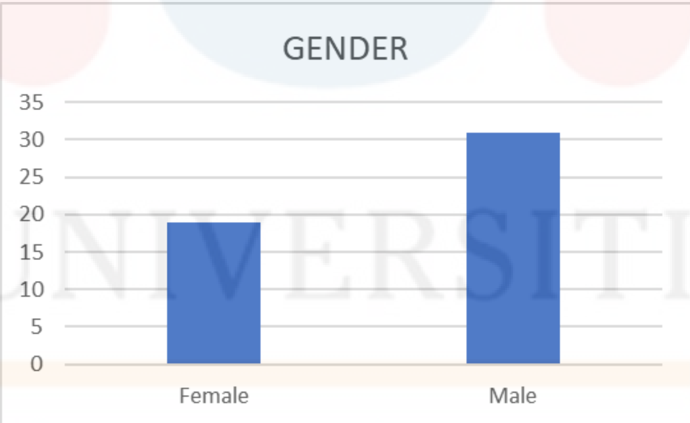

Figure 5.1 shows the gender of the respondents.

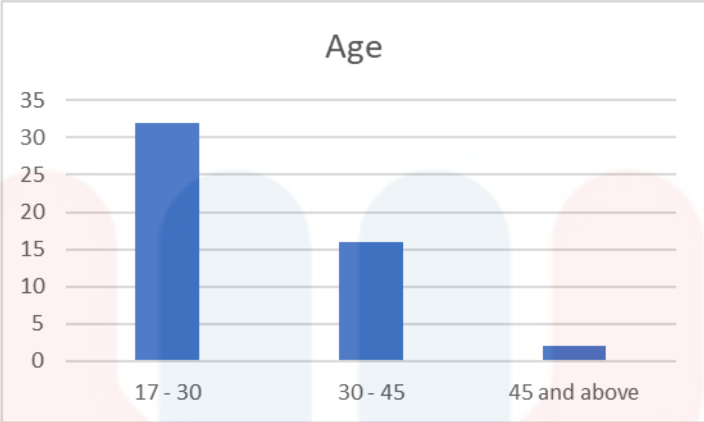

Figure 5.2 shows the age group of the respondents.

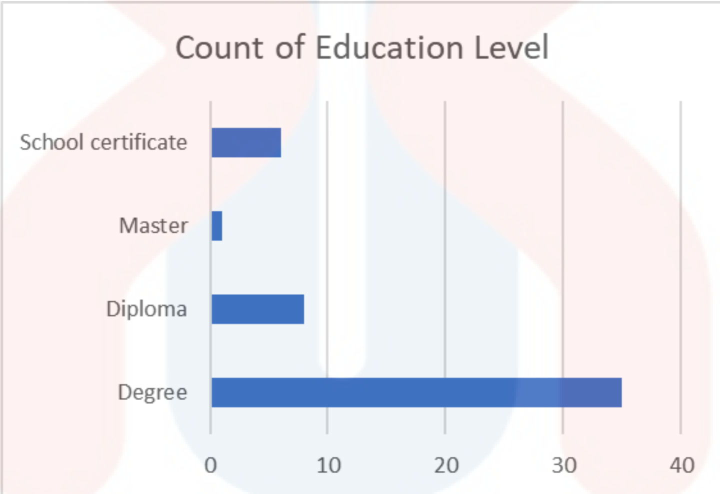

Figure 5.3 shows the education level of the respondents.

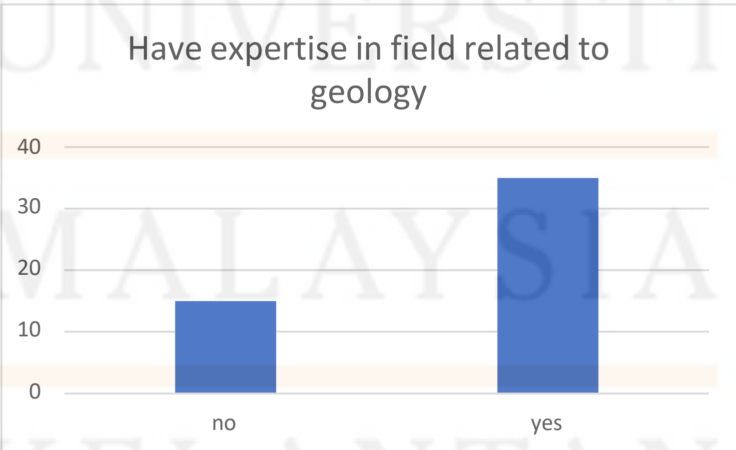

Figure 5.4 shows the number of expertise vs the number of visitors among the respondents.

5.3 Main Value (MV)

For the rarity count ($SIMV_1$) in figure 5.5, most of the experts (15 respondents) agree that the site has a regional level of rarity with the total of MGAM counts of 3.75 while most of the visitors agree that it has both regional (6 respondents) and national (6 respondents) level of rarity with the total of MGAM counts of 1.5 and 3 respectively. None of the respondents agree that the site have the only occurrence of rarity.

For the representatives count (SIMV2) in figure 5.6, most of the experts (18 respondents) and visitors (6 respondents) agree that the geosite have a moderate level of representative with a total of MGAM counts of 9 and 3 respectively. None of the respondents agree that the geosite have an outmost level of representatives**.**

For the knowledge of geoscientific issue ($SIMV_3$) in figure 5.7, most of the experts (17 respondents) agree that the geosite have a national publications level with the total of MGAM counts of 12.75 while most of the visitors (7 respondents) agree that the geosite have a local publications level with the total of MGAM counts of 1.75. None of the respondents agree that the geosite doesn't have a publication on geoscientific issues.

For the level of interpretation ($SIMV_4$) in figure 5.8, most of the experts agree that the geosite have a good example of processes but hard to explain (13 respondents) and moderate level of processes but easy to explain (13 respondents) with the MGAM counts of 6.5 and 9.75 respectively. Meanwhile, most of the visitors (7 respondents) agree that the geosites have a good example of processes but hard to explain with the MGAM count of 3. None of the respondents agree that the geosite doesn't have any level of interpretation.

For the viewpoints ($SIMV_5$) in figure 5.9, most of the experts (22 respondents) and visitors (13 respondents) agree that there are 2 to 3 counts of viewpoint at the geosite with the MGAM counts of 11 and 6.5 respectively. None of the respondents agree that the geosite doesn't have any viewpoints.

For the surface ($SIMV_6$) in figure 5.10, most of the experts (28 respondents) and visitors (14 respondents) agree that the geosite have a level of surface area of 2 which is medium with the MGAM counts of 14 and 7 respectively. None of the respondents agree that the geosite have a small surface area.

For the surrounding landscape and nature ($SIMV_7$) in figure 5.11, Most of the experts agree that the geosite have a medium (15 respondents) and high (15 respondents) level of surrounding landscape and nature with the MGAM count of 7.5 and 11.25 respectively. Meanwhile, most of the visitors (9 respondents) agree that the geosite have high level of surrounding landscape and nature with the MGAM counts of 6.75. None of the respondents agree that the geosite doesn't have surrounding landscape and nature.

For the environmental fitting of sites ($SIMV_8$) in figure 5.12, most of the experts (27 respondents) and visitors (11 respondents) agree that the environmental fitting of site is neutral with the MGAM count of 13.5 and 5.5 respectively.

For the current condition ($SIMV_9$) in figure 5.13, most of the experts (21 respondents) and visitors (8 respondents) agree that the current condition of the geosite is medium damaged with the MGAM count of 5.25 and 2 respectively. None of the respondents agree that the current conditions of the geosite are totally damaged.

For the protection level ($SIMV_{10}$) in figure 5.14, most of the experts agree that the geosite have a regional (14 respondents) and national (14 respondents) protection level with the MGAM count of 7 and 10.5 respectively. Meanwhile, most of the visitors

(8 respondents) agree that the geosite have a regional protection level with the MGAM counts of 4. None of the respondents agree that the geosite doesn't have a protection.

For the vulnerability (SIMV11) in figure 5.15, most of the experts (24 respondents) and visitors (7 respondents) agree that the vulnerability of the geosite is medium with the MGAM counts of 12 and 3.5 respectively. None of the respondents agree that the geosite have an irreversible level of vulnerability.

For the suitable number of visitors (SIMV12) in figure 5.16, most of the experts (17 respondents) agree that the proposed number of visitors on the site at the same time is at 10 to 20 persons with the MGAM counts of 8.5. Meanwhile, most of the visitors agree that the proposed number of visitors on the site at the same time is at 10 to 20 (5 respondents) and 20 to 50 (5 respondents) persons with the MGAM counts of 2.5 and 3.75.

RARITY ($SIMV_1$)

Figure 5.5 shows the graph bar of the rarity count.

REPRESENTATIVENESS ($SIMV_2$)

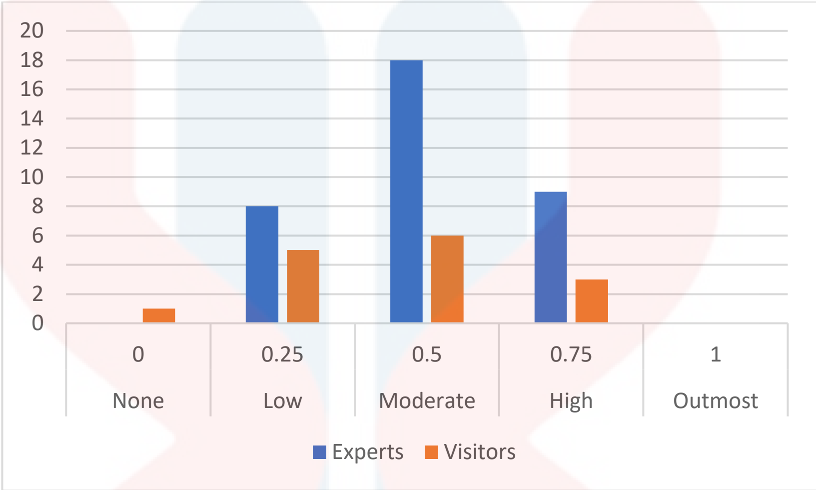

Figure 5.6 shows the graph bar of the representativeness count

KNOWLEDGE ON GEOSCIENTIFIC ISSUES ($SIMV_3$)

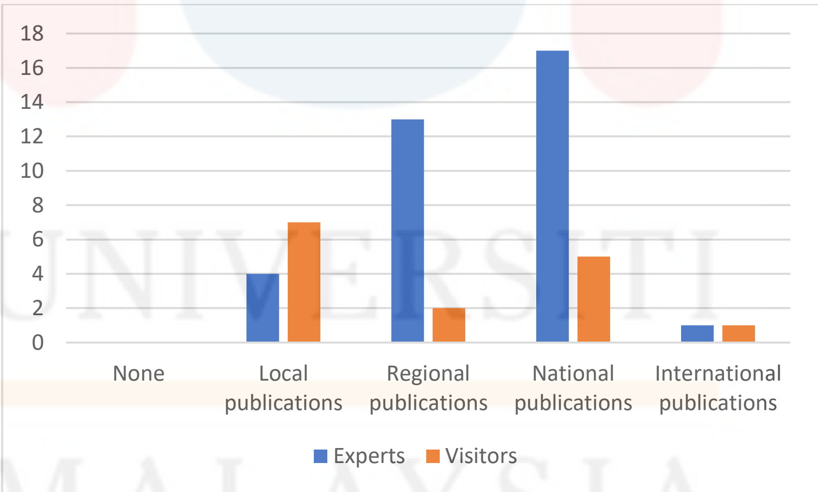

Figure 5.7 shows the graph bar of knowledge on geoscientific issues count

LEVEL OF INTERPRETATION ($SIMV_4$)

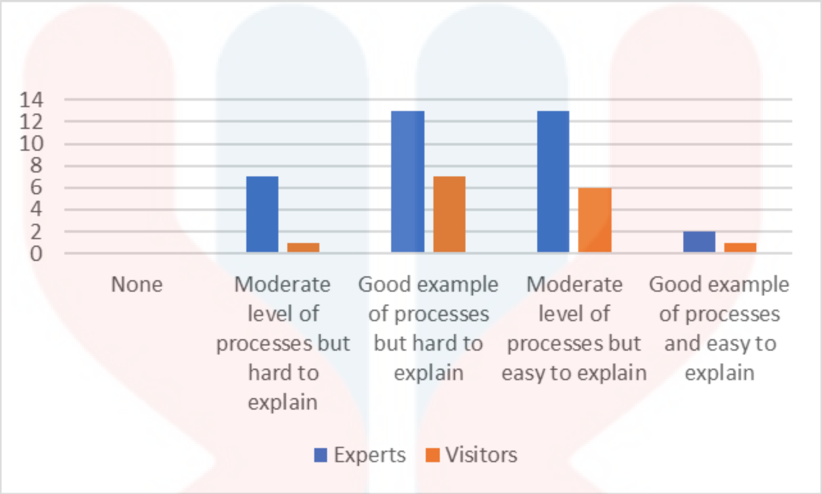

Figure 5.8 shows the graph bar of level of interpretation count.

VIEWPOINTS ($SIMV_5$)

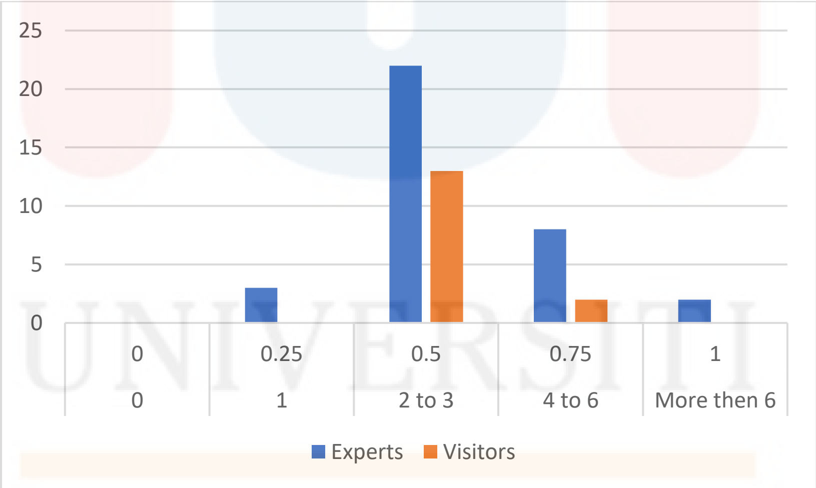

Figure 5.9 shows the graph bar of viewpoints count.

SURFACE ($SIMV_6$)

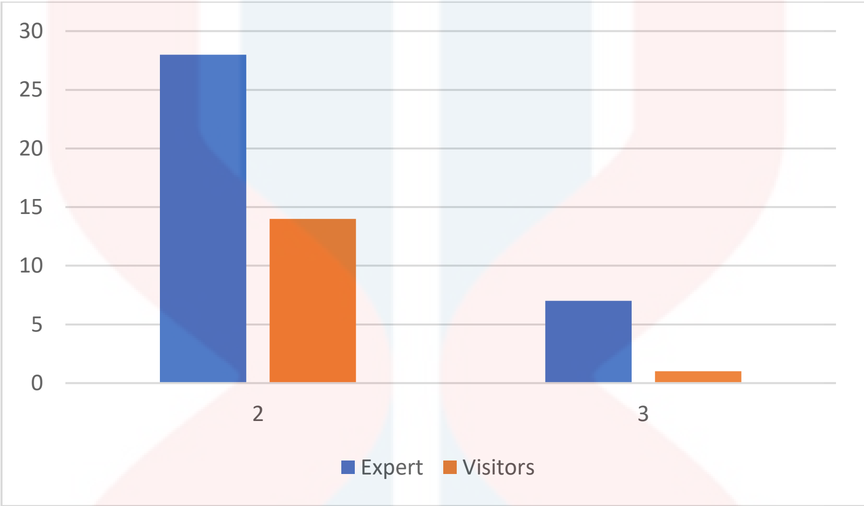

Figure 5.10 shows the graph bar of surface count.

SURROUNDING LANDSCAPE AND NATURE ($SIMV_7$)

Figure 5.11 shows the graph bar of surrounding landscape and nature count.

ENVIRONMENTAL FITTING OF SITES ($SIMV_8$)

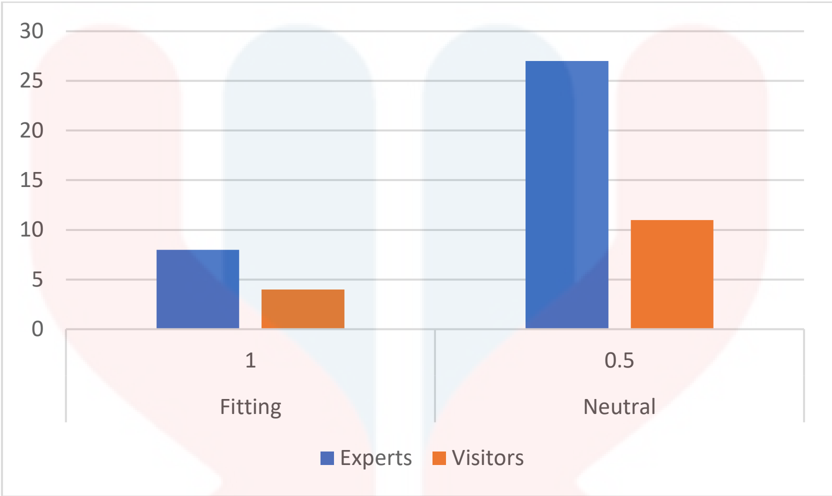

Figure 5.12 shows the graph bar of environmental fitting of sites count.

CURRENT CONDITION ($SIMV_9$)

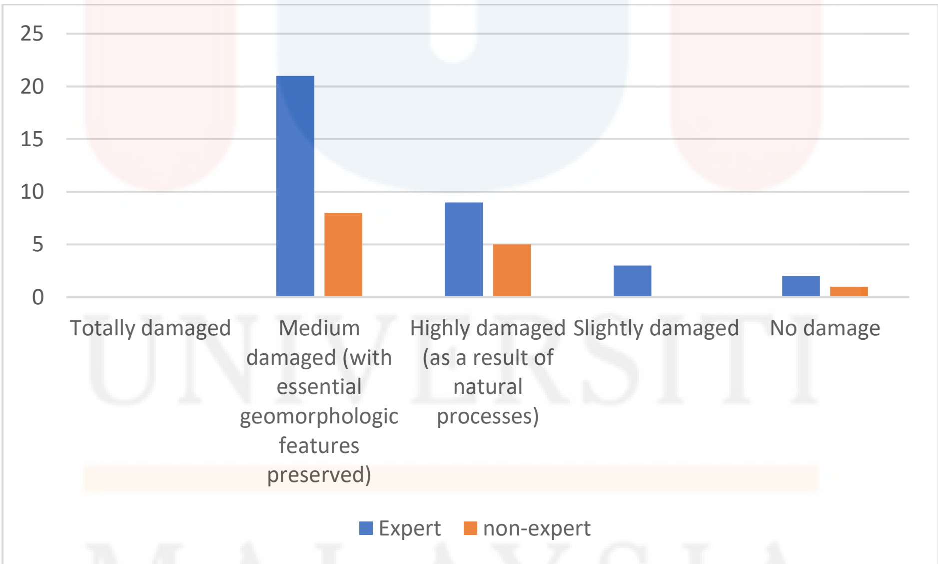

Figure 5.13 shows the graph bar of current condition of the sites count**.**

PROTECTION LEVEL (SIMV10)

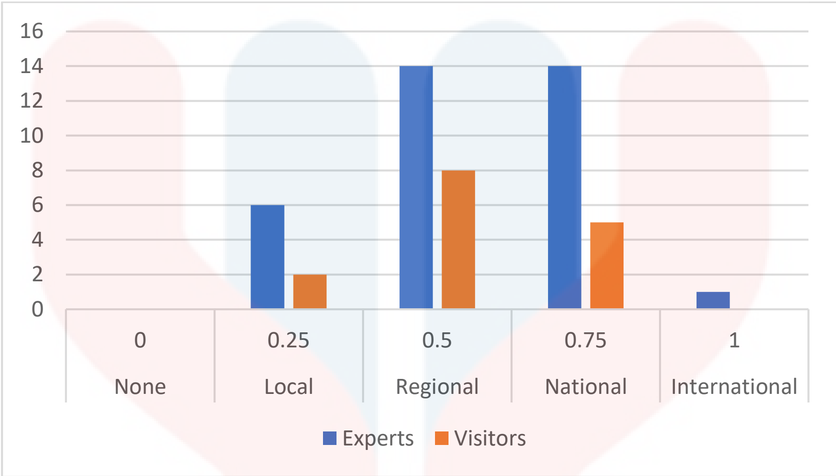

Figure 5.14 shows the graph bar of protection level count.

VULNERABILITY (SIMV$_{11}$)

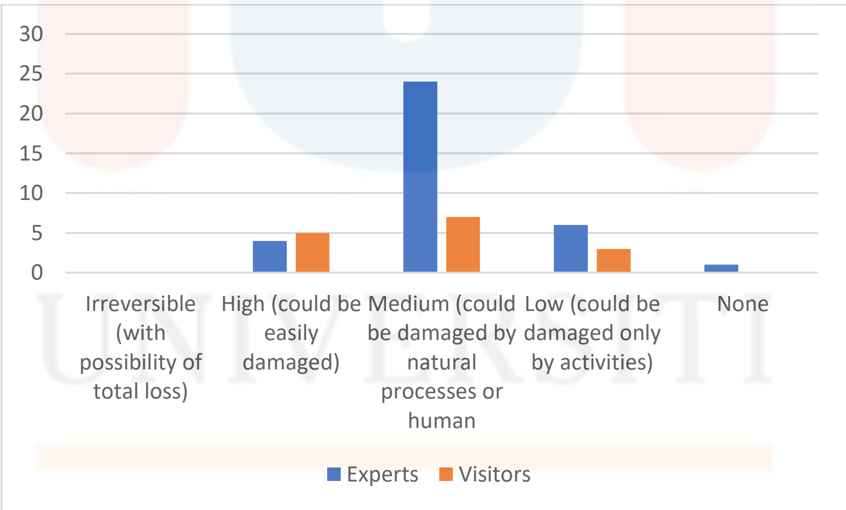

Figure 5.15 shows the graph bar of vulnerability count.

SUITABLE NUMBER OF VISITORS ($SIMV_{12}$)

Figure 5.16 shows the graph bar of suitable number of visitors count.

5.5 Additional Value (AV)

For the accessibility counts ($SIAV_1$) in figure 5.17, most of the experts (20 respondents) and visitors (9 respondents) agreed that the accessibility of the geosite are low which required special equipment and expert guide tours. The MGAM counts of 5 and 2.25 respectively.

For the Additional natural values ($SIAV_2$) in figure 5.18, most of the experts (20 respondents) and visitors (8 respondents) agreed that the number of additional natural values in the in radius of 5 km is at 2 to 1 with the MGAM counts of 10 and 4 respectively.

For the additional anthropogenic values ($SIAV_3$) in figure 5.19, most of the experts agreed that the number of additional anthropogenic values in the in radius of 5 km are at 2 to 3 sites (15 respondents) and 4 to 6 sites (15 respondents) with the MGAM counts of 7.5 and 11.25 respectively. Meanwhile, most of the visitors agreed that the number of additional anthropogenic values in the in radius of 5 km are at 2 to 3 sites (9 respondents) with the MGAM counts of 4.5.

For the vicinity of emissive centers ($SIAV_4$) in figure 5.20, most of the experts (19 respondents) and visitors (7 respondents) agreed that the closeness of emissive centers is at 50 to 25 km with the MGAM value of 9.5 and 3.5 respectively. None of the experts agreed that the closeness of emissive centers is more than 100 km.

For the vicinity of important road network ($SIAV_5$) in figure 5.21, most of the experts (19 respondents) and visitors (7 respondents) agreed that closeness of important road networks in the in radius of 20 km is on a regional scale with the MGAM counts of 9.5 and 3.5 respectively. None of the visitors agreed that closeness of important road networks in the in radius of 20 km is at an international scale.

For the functional additional values ($SIAV_6$) in figure 5.22, most of the experts (16 respondents) and visitors (7 respondents) agreed that the geosite have a medium functional additional values with MGAM count of 8 and 3.5 respectively.

For the promotion ($SIAV_7$) in figure 5.23, Most of the experts (17 respondents) agreed to the promotion at a regional scale with the MGAM counts of 8.5. Meanwhile, most of the visitors (8 respondents) agreed that the promotion at a national scale with MGAM counts of 6.

For the organized visits ($SIAV_8$) in figure 5.24, most of the experts (15 respondents) and visitors (9 respondents) agreed that the annual number of organized visits to the geosite is at 12 to 24 visits per year with MGAM counts of 7.5 and 4.5 respectively. None of the visitors agreed that the annual number of organized visits to the geosite is more than 48 visits per year.

For the vicinity of visitor centers ($SIAV_9$) in figure 5.25, most of the experts (12 respondents) agreed that the closeness of visitor center to the geosite is at 50 to 20 km with MGAM counts of 3. Meanwhile, the visitors agreed that the closeness of visitor center to the geosite is at 5 to 1km, 5 to 20 km and 20 to 50 km with the MGAM counts of 3.75, 2.5 and 1,25 respectively. None of the visitors agreed that the closeness of visitor center to the geosite is more than 50 km.

For the Interpretative panels ($SIAV_{10}$) in figure 5.26, most of the experts (19 respondents) and visitors (11 respondents) agreed that the interpretative characteristics is at medium quality with MGAM counts of 9.5 and 5.5 respectively. None of the visitors agreed that the interpretative characteristics is at utmost quality.

For the number of visitors ($SIAV_{11}$) in figure 5.27, most of the experts (24 respondents) and visitors (6 respondents) agreed to the annual number of visitors of medium (5,001 to 10,000 person) with MGAM counts of 12 and 3 respectively.

For the tourism infrastructure ($SIAV_{12}$) in figure 2.28, most of the experts (15 respondents) and visitors (7 respondents) agreed that the level of additional infrastructure for tourism is at a medium level with MGAM counts of 8.5 and 3.5 respectively. None of the visitors agreed that the level of additional infrastructure for tourism is at a outmost level.

For the tour guide service ($SIAV_{13}$) in figure 2.29, most of the experts (18 respondents) and visitors (6 respondents) agreed that the tour guide service is at a medium level with MGAM counts of 9 and 3 respectively. None of the experts agreed that the tour guide service didn't exist.

For the hostelry service ($SIAV_{14}$) in figure 2.30, most of the experts (17 respondents) agreed the hostelry service close to geosite is around 5 to 10 km with MGAM counts of 12.75. Meanwhile, most of the visitors (7 respondents) agreed that the hostelry service close to geosite is around 10 to 25 km with MGAM value of 3.5. None of the visitors agreed that the hostelry service close to geosite is less than 5 km.

Lastly, for the restaurant service ($SIAV_{15}$) in figure 2.31, most of the experts (16 respondents) and visitors (8 respondents) agreed that the restaurant service close to geosite is around 5 to 10 km with MGAM counts of 8 and 4 respectively. None of the visitors agreed that the restaurant service close to geosite is less than 1 km.

ACCESSIBILITY ($SIAV_1$)

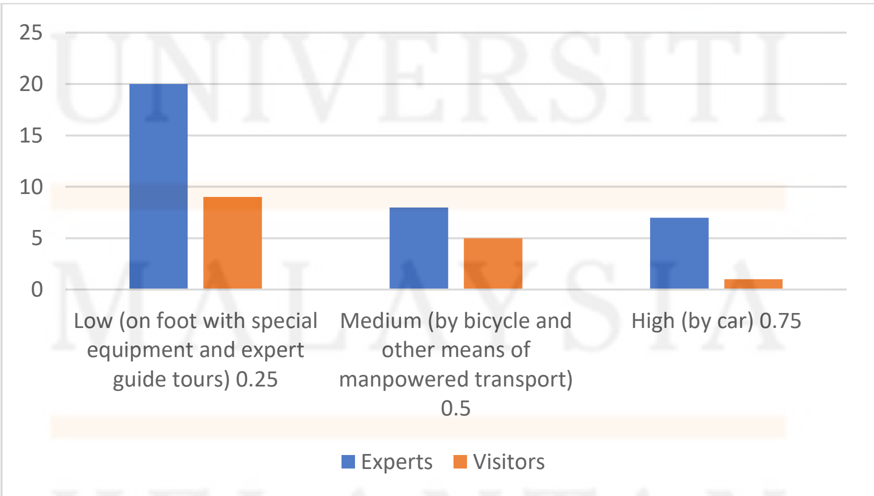

Figure 5.17 shows the accessibility count.

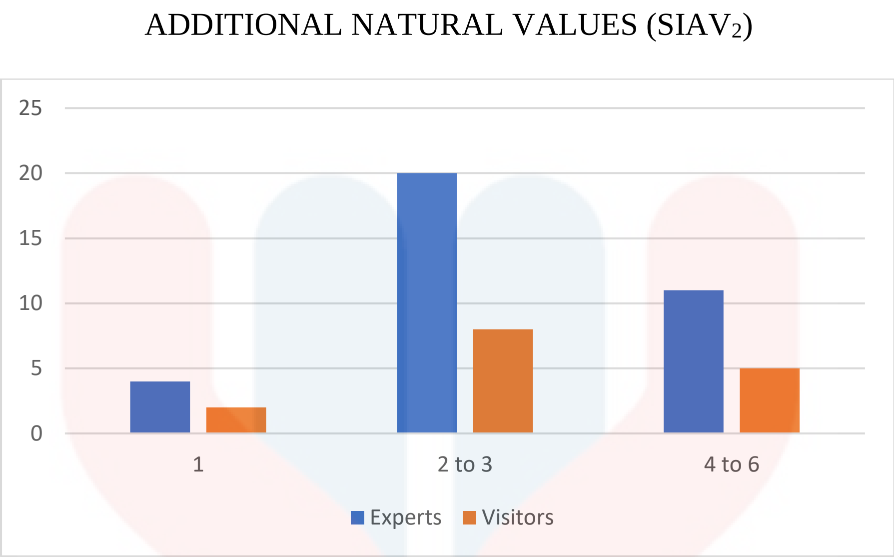

Figure 5.18 shows the additional natural values count.

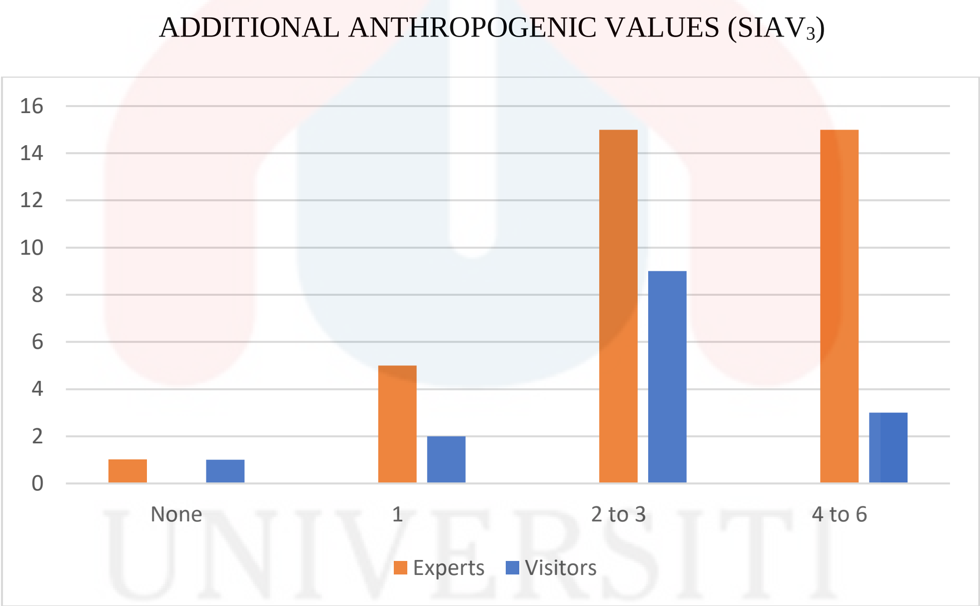

Figure 5.19 shows the additional anthropogenic values count.

VICINITY OF EMISSIVE CENTRES ($SIAV_4$)

Figure 5.20 shows the vicinity of emissive centers count.

VICINITY OF IMPORTANT ROAD NETWORK ($SIAV_5$)

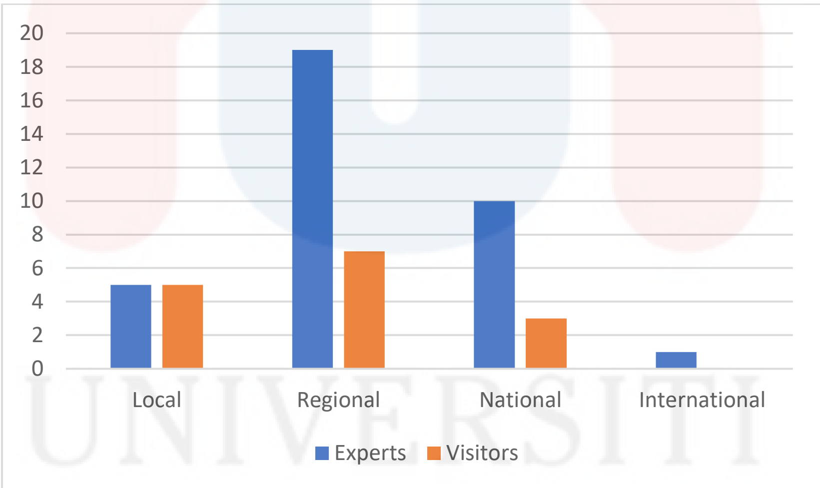

Figure 5.21 shows the vicinity of important road network count.

ADDITIONAL FUNCTIONAL VALUES ($SIAV_6$)

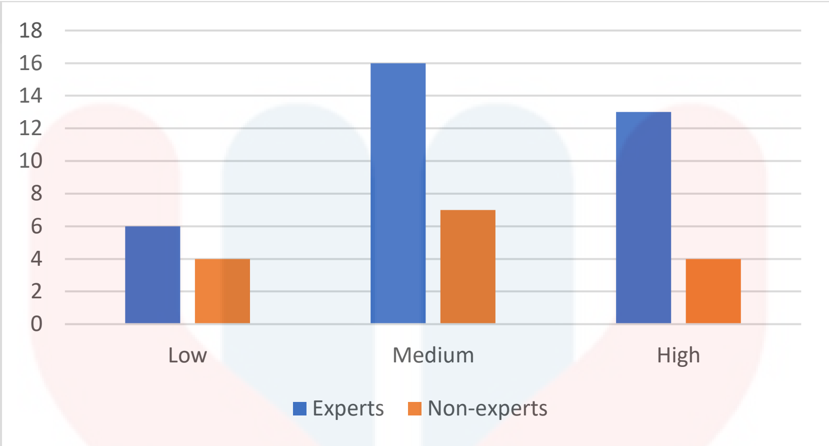

Figure 5.22 shows the additional functional values count.

PROMOTION ($SIAV_7$)

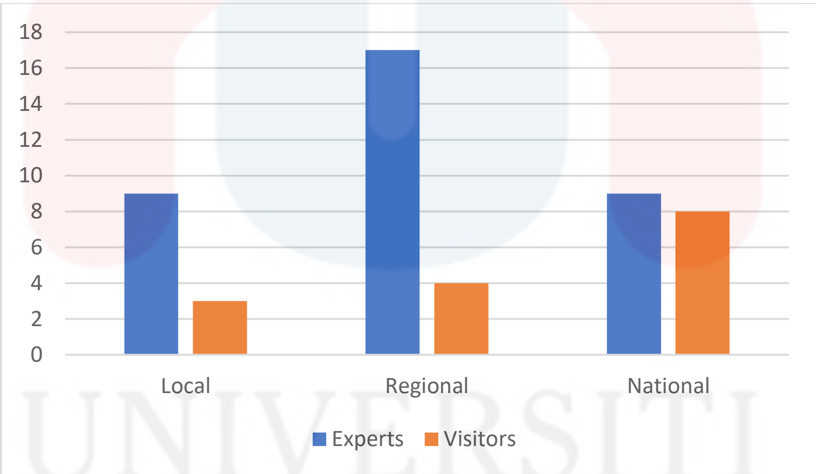

Figure 5.23 shows the promotion count.

ORGANIZED VISITS ($SIAV_8$)

Figure 5.24 shows the organized visits count.

VICINITY OF VISITOR'S CENTERS ($SIAV_9$)

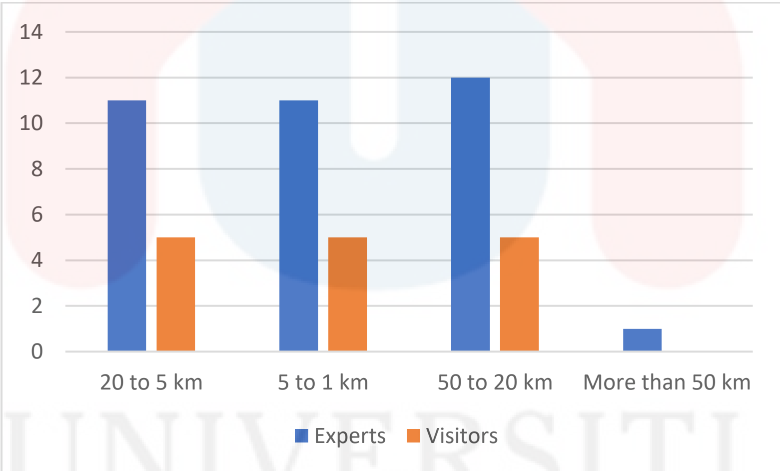

Figure 5.25 shows the vicinity of visitor's centers count.

INTERPRETATIVE PANELS ($SIAV_{10}$)

Figure 5.26 shows the interpretative panels count.

NUMBER OF VISITORS ($SIAV_{11}$)

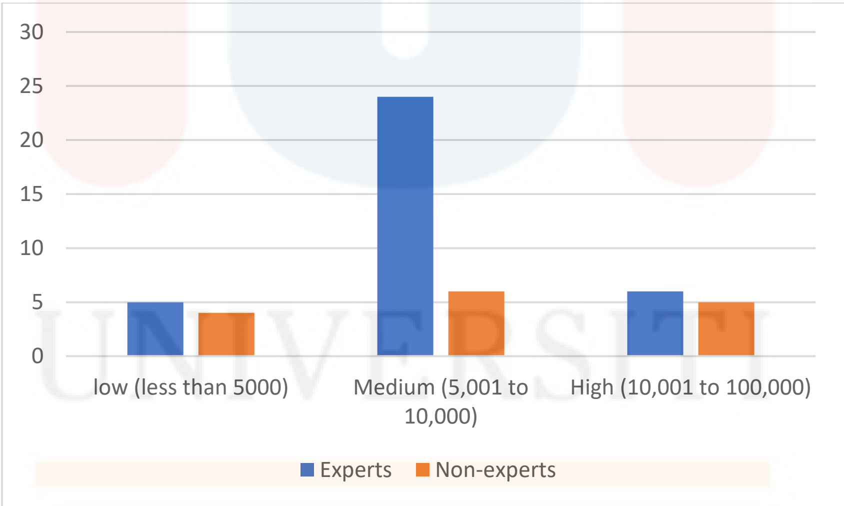

Figure 5.27 shows the number of visitors count.

TOURISM INFRASTRUCTURE ($SIAV_{12}$)

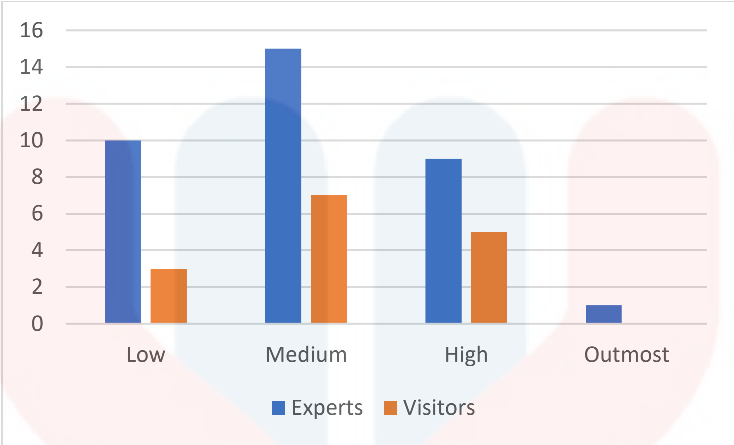

Figure 5.28 shows the tourism infrastructure count.

TOUR GUIDE SERVICE ($SIAV_{13}$)

Figure 5.29 shows the tour guide service count.

HOSTELRY SERVICE ($SIAV_{14}$)

Figure 5.30 shows the hostelry service count.

RESTAURANT SERVICE ($SIAV_{15}$)

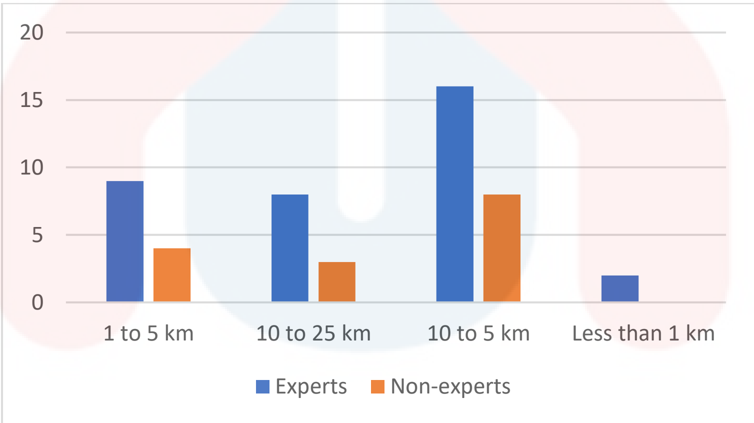

Figure 5.31 shows the restaurant service count.

Table 5.2 shows the values assigned to each sub indicator in the GAM model by experts and visitors.

Main value (MV)			
Main indicators	**Sub-indicators**	**Value given by experts**	**Value given by Visitors**
Scientific/Educational values (VSE)	$SIMV_1$	0.41	0.3
	$SIMV_2$	0.5	0.43
	$SIMV_3$	0.6	0.5
	$SIMV_4$	0.69	0.61
Total percentage		**55%**	**46%**
Scenic/Aesthetic values (VSA)	$SIMV_5$	0.56	0.53
	$SIMV_6$	0.6	0.53
	$SIMV_7$	0.64	0.68
	$SIMV_8$	0.61	0.63
Total percentage		**60%**	**59%**
Protection (VPr)	$SIMV_9$	0.4	0.36
	$SIMV_{10}$	0.57	0.55
	$SIMV_{11}$	0.53	0.47
	$SIMV_{12}$	0.55	0.58
Total percentage		**51%**	**49%**
Additional value (AV)			
Functional values (VFn)	$SIAV_1$	0.4	0.38
	$SIAV_2$	0.57	0.55
	$SIAV_3$	0.55	0.48
	$SIAV_4$	0.54	0.45
	$SIAV_5$	0.55	0.46
	$SIAV_6$	0.55	0.50

Total percentage		53%	47%
Touristic values (VTr)	$SIAV_7$	0.50	0.58
	$SIAV_8$	0.55	0.56
	$SIAV_9$	0.47	0.5
	$SIAV_{10}$	0.54	0.46
	$SIAV_{11}$	0.50	0.52
	$SIAV_{12}$	0.50	0.53
	$SIAV_{13}$	0.50	0.46
	$SIAV_{14}$	0.6	0.56
	$SIAV_{15}$	0.54	0.52
Total percentage		**52%**	**52%**

Table 5.2 shows the values assigned by the experts.

Main values (MV)				
Geosites	Scientific/educational value (VSE)	Scenic/aesthetic (VSA)	Protection (VPR)	Total Main Value
Jelawang waterfall	55%	60%	51%	**55%**
Additional Values (AV)				
Jelawang waterfall	Functional values (VFns)		Touristic values (VTr)	Total Additional Value
	53%		52%	53%

Table 5.3 shows the values assigned by the visitors.

Main values (MV)				
Geosites	Scientific/educational value (VSE)	Scenic/aesthetic (VSA)	Protection (VPR)	Total Main Value
Jelawang waterfall	46%	59%	49%	51%
Additional Values (AV)				
Jelawang waterfall	Functional values (VFns)		Touristic values (VTr)	Total Additional Value
	47%		52%	49%

5.6 Discussion

Based on M-gam, the statistical analysis been conducted through the evaluation of scientific, aesthetic, protection, functional and touristic characteristics which have value that can be conserves to determine the Geosite potential of Jelawang waterfall. The methodology that was implemented in this analysis is based on M-GAM model (Modified Geo Assessment Model) developed by (Tomić & Božić,2015

Primarily, the primary values (MV) indicators are categorised into three groups: scientific/educational (VSE), scenic/aesthetic (VSA), and protection values (VPr). At the same time, Additional Values (AV) are categorised into two categories of indicators, namely functional (VFn) and touristic (Trvl) indicators (VTr).

Based on M-GAM model, the result is influenced by the experts and potential tourists. M-GAM is analysed two target groups' differing perspectives on the importance of sub indicators can affect the suitability of geomorphosites. The result shows Jelawang waterfall has high percentage of Scenic/aesthetic as well as ccientific/educational value, that indicate the suitability for geomorphosites.

Regarding scientific/educational value, the highest value for experts and Visitors is the level of interpretation. It proved that both groups agreed that Jelawang waterfall has geological and geomorphologic processes, phenomena and shapes and has a high level of scientific knowledge. It can be justified because, due to its height, Jelawang waterfall has a unique feature where some of the water turns into mist since and creates beautiful scenery.

Among all the indicators for experts and visitors, the percentage of scenic/aesthetic is the highest. Both agreed that Jelawang waterfall has beautiful geological landforms/landscapes. Based on the perspective of experts, the highest value is the surrounding landscape and nature, and it proved that Jelawang waterfall has an attractive position, imposing appearance and present ecological resource with the preserved area. Visitors also agreed that scenic and aesthetics is the main attraction for Jelawang waterfall, with the highest value of environmental fitting of sites. Due to this fact, it can be considered that the Jelawang waterfall location is suitable for the landscape and with the presence of high vegetation, absence of human-induced deterioration, and the lack of vicinity of the urban area.

In terms of protection, experts and visitors agreed that Jelawang waterfall has a higher level of protection. It is because the study area is of reserved forest and geopark area that was protected. Due to that factor, the protection by local or regional groups and national government is strict. Based on my field observation, Jelawang waterfall is still in good condition without any significant damage.

For the functional value, experts and visitors also agreed that this geosite has additional natural values. The Jelawang waterfall is a massive geosite with an interesting geological feature at the bottom and the top of the waterfall. At the top of the waterfall where Kem Bahar is located, the constant water flow can create a depression or hole in the granite, known as a pothole as seen on figure 5.33. The locals called the potholes "Telaga Tujuh," or seven wells. At the bottom of the Jelawang waterfall is a segmented waterfall where the water flows over a series of drops or cliffs as seen on figure 5.34. As it falls, the water is separated into distinct channels or segments. This can create a series of smaller drops or pools rather than a continuous flow of water.

Next, in terms of Touristic values value, The expert believes that the hostelry service is the highest value. This is because, at the foot of Jelawang waterfall, a resort provides hostelry service less than 100m from the geosite. For the visitors, promotion gained the highest value. This is because the Jelawang waterfall is located at Gunung Stong state park, and World Wide Funds Malaysia (WWF Malaysia) and the state government of Kelantan have promoted it for at the national level as we seen in figure 5.35.

Figure 5.32: Potholes at Jelawang waterfallw

Figure 5.33: Segmented waterfall at the foot of the Jelawang waterfall.

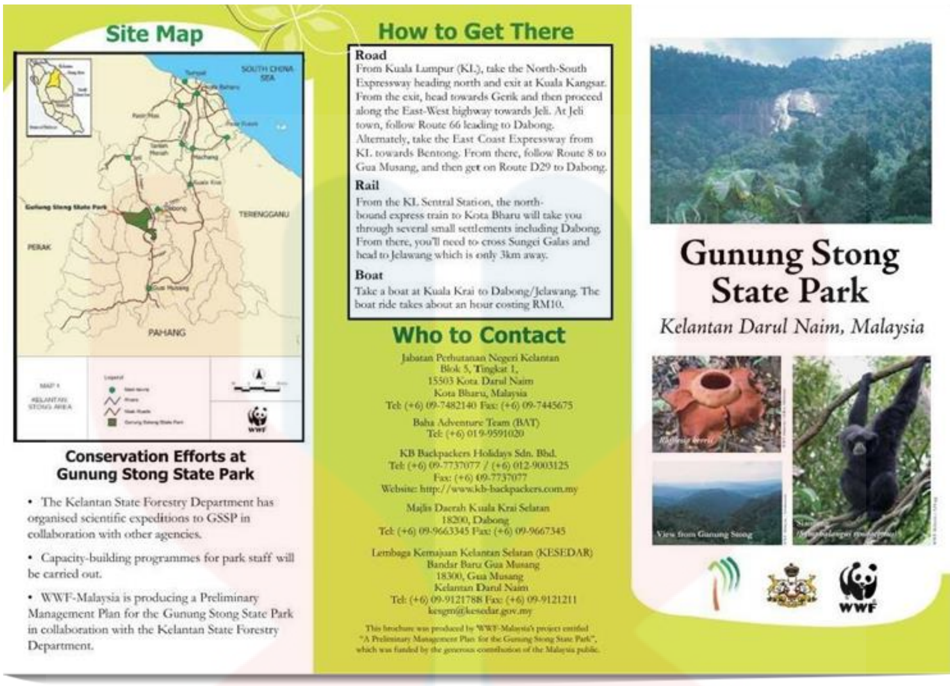

Figure 5.34: A brochure that promotes Gunung Stong state park.

Figure 5.35: Hostelry service near Jelawang waterfall

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Introduction

In this chapter, the conclusion and recommendation will be discussed. It concludes the result of geological mapping and geosites assessment.

6.2 Conclusion

In conclusion, the geological map of Gunung Stong can be produced with a scale of 1:25,000. An updated geological map is vital and beneficial for geologists as a reference for undertaking research and geological field or survey. Furthermore, an updated geological map is also precious to the future researcher to collect data and geological facts about that location. The metasedimentary rock unit that was not found by previous study has been found in the area in this study.

Jelawang waterfall is very suitable for geomorphosite due to geomorphology and landscape having high scientific, cultural, aesthetic, and social economic value due to human exploitation. The survey has been conducted among the experts and visitors to evaluate Jelawang waterfall as geomorphosite by using the M- GAM model assessment. Based on the value that both groups have evaluated, the highest score is the Scenic/aesthetic indicators. It can be concluded this Jelawang waterfall has a beautiful landscape that results from special geomorphological landform. This site study area made of an intrusion of granite creates a breath-taking waterfall formation.

However, the score the expert and tourist gave for accessibility got the lowest among the indicators because these values are not so developed in this area. The extreme hike to the geosite, permit requirements and a narrow road to the geosite makes it harder for tourist to access the geosites.

6.3 Recommendation

Based on this study, certain things require improvement and revisions. A more thorough study on the structural geology is highly recommended since it will give more information on the formation of Gunung Stong. Furthermore, petrographic analysis can be done for better understanding the nature of rocks and the origin of the rock in this study area.

Due to the low value for accessibility given by both experts and visitors, a better road is recommended to be constructed. The extreme hiking trail makes climbing to the geosites harder for ordinary tourists. The hiking trail is recommended to be made more accessible and will not interfere with the aesthetics of Gunung Stong. A better target respondent is also recommended due to the target respondent is only consist of 2 target groups.

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APPENDIX A

<u>QUESTIONAIRE</u>

A modified Geosite Assessment Model (M-GAM) OF Jelawang Waterfall, Dabong, Kelantan.

Questionnaire survey for a final year project conducted by Geoscience Programme, Faculty of Earth Sciences, Universiti Malaysia Kelantan.

All information gained from this survey is confidential and will be only usedfor the research purpose.

Objective: To evaluate the important of main values and additional values of Jelawang waterfall for the suitability of geosites.

* Required

1. **Gender** *

   Mark only one oval.

   - ◯ Male
   - ◯ Female

2. **Age** *

   Mark only one oval.

   - ◯ 17 - 30
   - ◯ 30 - 45
   - ◯ 45 and above

3. **Education Level** *

Mark only one oval.

- ⬭ School certificate
- ⬭ Diploma
- ⬭ Degree
- ⬭ Master
- ⬭ PhD

4. **Do you have expertise in field related to geology?** *

Mark only one oval.

- ⬭ yes
- ⬭ no

Main values (MV)

5. **Rarity (SIMV1)** *

Number of closest identical sites.

Mark only one oval.

- ⬭ Common
- ⬭ Regional
- ⬭ National
- ⬭ International
- ⬭ The only occurrence

6. **Representativeness (SIMV2)** *

Didactic and exemplary characteristics of the site due to its own quality andgeneral configuration.

Mark only one oval.

- None
- Low
- Moderate
- High
- Utmost

7. **Knowledge on geoscientific issues (SIMV3)** *

Number of written papers in acknowledged journals, thesis, presentations andother publications

Mark only one oval.

- None
- Local publications
- Regional publications
- National publications
- International publications

8. **Level of interpretation (SIMV4)** *

Level of interpretive possibilities on geological and geomorphologic processes,phenomena and shapes and level of scientific knowledge

Mark only one oval.

- None
- Moderate level of processes but hard to explain to non experts Good
- example of processes but hard to explain to non experts Moderate level
- of processes but easy to explain to common visitorGood example of
- processes and easy to explain to common visitor

Scenic/Aesthetic (VSA)

9. **Viewpoints (SIMV5)** *
Number of viewpoints accessible by a pedestrian pathway

Mark only one oval.

- None1
- 2 to 3
- 4 to 6
- More then 6

10. **Surface (SIMV6)** *
Whole surface of the site. Each site is considered in quantitative relation toother sites

Mark only one oval.

Small

- 1
- 2
- 3

Large

11. **Surrounding landscape and nature (SIMV7)** *

Panoramic view quality, presence of water and vegetation, absence of humaninduced deterioration, vicinity of urban area, etc.

Mark only one oval.

- Low
- Medium
- High
- Outmost

12. **Environmental fitting of sites (SIMV8)** *

Level of contrast to the nature, contrast of colors, appearance of shapes, etc.

Mark only one oval.

- Unfitting
- Neutral
- Fitting

Protection (VPr)

13. **Current condition (SIMV9)** *

Current state of geosite

Mark only one oval.

- Totally damaged (as a result of human activities)
- Highly damaged (as a result of natural processes)
- Medium damaged (with essential geomorphologic features preserved)
- Slightly damaged
- No damage

14. *Protection level (SIMV10)*

Protection by local or regional groups, national government, internationalorganizations, etc.

Mark only one oval.

- None
- Local
- Regional
- National
- International

15. **Vulnerability (SIMV11)** *

Vulnerability level of geosite

Mark only one oval.

- Irreversible (with possibility of total loss)
- High (could be easily damaged)
- Medium (could be damaged by natural processes or human
- Low (could be damaged only by activities)
- None

16. **Suitable number of visitors (SIMV12)** **Pro*

Mark only one oval.

- 0
- 0 to 10
- 10 to 20
- 20 to 50
- More than 50

Additional values (AV)

17. Accessibility (SIAV1

Possibilities of approaching to the site

Mark only one oval.

- Inaccessible
- Low (on foot with special equipment and expert guide tours)
- Medium (by bicycle and other means of manpowered transport)
- High (by car)
- Utmost (by bus)

18. **Additional natural values (SIAV2)** *

Number of additional natural values in the in radius of 5 km (geosites alsoincluded)

Mark only one oval.

- None1
- 2 to 3
- 4 to 6
- more than 6

19. **Additional anthropogenic values (SIAV3)** *

Number of additional anthropogenic values in the in radius of 5 km

Mark only one oval.

- None1
- 2 to 3
- 4 to 6
- More than 6

20. **Vicinity of emissive centers (SIAV4) ***
Closeness of emissive centers

Mark only one oval.

- More than 100 km
- 100 to 50 km
- 50 to 25 km
- 25 to 5 km
- Less than 5 km

21. **Vicinity of important road network (SIAV5)** *
Closeness of important road networks in the in radius of 20 km

Mark only one oval.

- none
- Local
- Regional
- National
- International

22. **Additional functional values (SIAV6)** *
Parking lots, gas stations, mechanics, etc.

Mark only one oval.

- None
- Low
- Medium
- High
- Utmost

23. ***Promotion (SIAV7)***

Level and number of promotional resources

Mark only one oval.

- None
- Local
- Regional
- National
- International

24. **Organized visits (SIAV8)** *

Annual number of organized visits to the geosite

Mark only one oval.

- None
- Less than 12 per year
- 12 to 24 per year
- 24 to 48 per year
- more than 48 per year

25. **Vicinity of visitors centers (SIAV9)** *

Closeness of visitor center to the geosite.

Mark only one oval.

- More than 50 km
- 50 to 20 km
- 20 to 5 km
- 5 to 1 km
- Less than 1 km

26. **Interpretative panels (SIAV10)** *
Interpretative characteristics of text and graphics, material quality, size, fittingto surroundings, etc.

Mark only one oval.

- None
- Low quality
- Medium quality
- High Quality
- Utmost quality

27. **Number of visitors (SIAV11)** *
Annual number of visitors

Mark only one oval.

- none
- low (less than 5000)
- Medium (5,001 to 10,000)
- High (10,001 to 100,000)
- Outmost (more than 100,00)

28. **Tourism infrastructure (SIAV12)** *

Level of additional infrastructure for tourist (pedestrian pathways, restingplaces, garbage cans, toilets etc.)

Mark only one oval.

- None
- Low
- Medium
- High
- Outmost

29. **Tour guide service (SIAV13)** *

If exists, expertise level, knowledge of foreign language(s), interpretative skills,etc.

Mark only one oval.

- None
- Low
- Medium
- High
- Outmost

30. **Hostelry service (SIAV14)** *

Hostelry service close to geosite.

Mark only one oval.

- More than 50 km
- 25 to 50 km
- 10 to 25 km
- 5 to 10 km
- less than 5 km

31. **Restaurant service (SIAV15)** *

Restaurant service close to geosite

Mark only one oval.

- More than 25 km
- 10 to 25 km
- 10 to 5 km
- 1 to 5 km
- Less than 1 km

RESPONDENTS DATA

Gender	Age	Education Level	Do you have expertis	Rarity (SIMV1) *Numbe*	Representativeness (	Knowledge on geosc	Level of interpretatio	Viewpoints (SIMV5) *N*	Surface (SIMV6) *Whol*	Surrounding landsca	Environmental fitting	Current condition (SI	Protection level (SIM	Vulnerability (SIMV11
Male	17 - 30	Degree		National	Moderate	International publicatio	Moderate level of proce	2 to 3	2	Outmost	Fitting	Medium damaged (with	National	Medium (could be dam
Male	17 - 30	Degree		National	Moderate	National publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Medium damaged (with	National	Medium (could be dam
Female	17 - 30	Degree		National	Moderate	National publications	Good example of proce	4 to 6	3	High	Neutral	Medium damaged (with	National	Medium (could be dam
Female	17 - 30	Degree		Common	Moderate	Regional publications	Good example of proce	2 to 3	2	High	Fitting	Medium damaged (with	National	Medium (could be dam
Female	17 - 30	Degree		International	High	National publications	Good example of proce	More then 6	3	High	Fitting	Slightly damaged	National	Low (could be damage
Female	17 - 30	Degree		National	High	Regional publications	Good example of proce	2 to 3	2	High	Neutral	Medium damaged (with	Regional	Medium (could be dam
Male	17 - 30	Degree		Regional	Moderate	Regional publications	Moderate level of proce	2 to 3	2	Medium	Neutral	No damage	Local	Medium (could be dam
Male	17 - 30	Degree		Regional	Moderate	Local publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Highly damaged (as a	Local	Medium (could be dam
Male	17 - 30	Degree		Regional	Moderate	National publications	Good example of proce	2 to 3	2	High	Neutral	Highly damaged (as a	Regional	High (could be easily c
Female	17 - 30	Degree		Regional	Moderate	National publications	Moderate level of proce	2 to 3	2	High	Neutral	Medium damaged (with	Local	Medium (could be dam
Male	17 - 30	Diploma		National	Low	Regional publications	Moderate level of proce	4 to 6	2	High	Neutral	Highly damaged (as a	Regional	Low (could be damage
Male	17 - 30	Degree		National	Low	National publications	Moderate level of proce	2 to 3	2	Low	Neutral	Medium damaged (with	Regional	Low (could be damage
Male	17 - 30	Diploma		Regional	Low	Regional publications	Moderate level of proce	4 to 6	2	Medium	Neutral	Medium damaged (with	Regional	Medium (could be dam
Male	17 - 30	Degree		International	Moderate	National publications	Moderate level of proce	2 to 3	3	High	Neutral	Medium damaged (with	International	Medium (could be dam
Male	17 - 30	Degree		National	Moderate	Regional publications	Good example of proce	2 to 3	2	High	Fitting	Medium damaged (with	Regional	Medium (could be dam
Male	17 - 30	Degree		Common	Low	Local publications	Moderate level of proce	4 to 6	2	High	Neutral	Slightly damaged	National	None
Female	17 - 30	Degree		Regional	High	National publications	Moderate level of proce	4 to 6	2	High	Fitting	No damage	Regional	Medium (could be dam
Male	17 - 30	Degree		Regional	Moderate	International publicatio	Good example of proce	More then 6	3	Outmost	Fitting	Medium damaged (with	Regional	Medium (could be dam
Female	17 - 30	Degree		Regional	Low	Local publications	Good example of proce	1	3	Outmost	Fitting	Highly damaged (as a	National	Low (could be damage
Male	30 - 45	Degree		Common	Low	Local publications	Good example of proce	2 to 3	2	Low	Neutral	No damage	Regional	Low (could be damage
Male	17 - 30	Degree		National	High	Regional publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Medium damaged (with	National	Medium (could be dam
Male	17 - 30	Degree		National	Moderate	National publications	Moderate level of proce	2 to 3	2	High	Fitting	Medium damaged (with	National	Low (could be damage
Female	30 - 45	Degree		National	Moderate	National publications	Moderate level of proce	2 to 3	3	Outmost	Neutral	Medium damaged (with	National	High (could be easily c
Male	17 - 30	Degree		Regional	Moderate	National publications	Moderate level of proce	2 to 3	3	High	Neutral	Medium damaged (with	Regional	Low (could be damage
Male	30 - 45	Degree		National	Moderate	Regional publications	Good example of proce	2 to 3	3	Medium	Neutral	Medium damaged (with	Regional	Medium (could be dam
Male	17 - 30	Degree		Regional	High	Regional publications	Moderate level of proce	2 to 3	2	High	Neutral	Medium damaged (with	Regional	Medium (could be dam
Female	17 - 30	Degree		National	Low	National publications	Good example of proce	2 to 3	2	High	Fitting	Slightly damaged	National	Medium (could be dam
Male	30 - 45	Diploma		National	High	National publications	Good example of proce	4 to 6	2	Medium	Neutral	Medium damaged (with	Regional	Medium (could be dam
Male	17 - 30	School certificate		Regional	High	National publications	Good example of proce	2 to 3	2	Medium	Neutral	Highly damaged (as a	Local	Medium (could be dam
Female	17 - 30	School certificate		Regional	None	Local publications	Moderate level of proce	4 to 6	2	Medium	Neutral	Highly damaged (as a	Local	Medium (could be dam
Female	30 - 45	School certificate		Common	Low	Local publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Highly damaged (as a	Regional	Medium (could be dam
Female	17 - 30	School certificate		Regional	Moderate	Local publications	Moderate level of proce	2 to 3	2	High	Neutral	Medium damaged (with	Regional	Medium (could be dam
Male	17 - 30	Diploma		National	High	Local publications	Moderate level of proce	4 to 6	2	Medium	Fitting	Highly damaged (as a	Regional	High (could be easily c
Male	17 - 30	Degree		Regional	Moderate	Regional publications	Moderate level of proce	2 to 3	2	High	Fitting	Medium damaged (with	Regional	Medium (could be dam
Male	45 and above	Diploma		National	Low	National publications	Good example of proce	1	2	High	Fitting	Highly damaged (as a	National	Medium (could be dam
Female	17 - 30	School certificate		National	Low	Local publications	Good example of proce	2 to 3	2	Medium	Neutral	Highly damaged (as a	National	High (could be easily c
Female	17 - 30	Master		Regional	Moderate	Regional publications	Good example of proce	2 to 3	2	High	Neutral	Medium damaged (with	Local	Medium (could be dam
Female	17 - 30	Degree		International	Low	National publications	Good example of proce	4 to 6	2	Medium	Neutral	Highly damaged (as a	Regional	High (could be easily c
Female	30 - 45	Degree		International	High	Regional publications	Good example of proce	2 to 3	2	High	Neutral	Medium damaged (with	National	Low (could be damage
Male	30 - 45	Degree		International	Low	Regional publications	Moderate level of proce	2 to 3	2	High	Neutral	Medium damaged (with	Regional	Medium (could be dam
Female	30 - 45	Diploma		Regional	Moderate	Local publications	Good example of proce	2 to 3	2	Medium	Neutral	Highly damaged (as a	Regional	High (could be easily c
Female	45 and above	Diploma		Regional	Moderate	National publications	Good example of proce	2 to 3	2	High	Neutral	Medium damaged (with	Regional	High (could be easily c
Male	30 - 45	Diploma		Regional	High	Local publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Highly damaged (as a	Local	Medium (could be dam
Male	30 - 45	Degree		National	Low	National publications	Good example of proce	2 to 3	2	Medium	Neutral	Medium damaged (with	Local	High (could be easily c
Male	30 - 45	Degree		Regional	High	National publications	Moderate level of proce	1	2	Medium	Neutral	Medium damaged (with	National	Medium (could be dam
Male	30 - 45	School certificate		National	Moderate	National publications	Good example of proce	2 to 3	2	High	Neutral	Totally damaged (as a	Regional	Medium (could be dam
Male	30 - 45	Degree		Regional	Moderate	Regional publications	Good example of proce	2 to 3	2	High	Neutral	Highly damaged (as a	National	Medium (could be dam
Male	30 - 45	Degree		National	High	National publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Medium damaged (with	National	High (could be easily c
Male	30 - 45	Degree		National	Moderate	Regional publications	Moderate level of proce	4 to 6	2	Medium	Neutral	Medium damaged (with	National	Medium (could be dam
Female	30 - 45	Degree		Regional	Moderate	National publications	Moderate level of proce	2 to 3	2	Medium	Neutral	Medium damaged (with	National	Low (could be damage

Suitable number of vi	Accessibility (SIAV1)	Additional natural val	Additional anthropog	Vicinity of emissive c	Vicinity of important	Additional functional	Promotion (SIAV7) Le	Organized visits (SIA	Vicinity of visitors ce	Interpretative panels	Number of visitors (S	Tourism infrastructu	Tour guide service (S	Hostelry service (SIA	Restaurant service (S
10 to 20	Low (on foot with speci	1	None	25 to 5 km	National	Medium	National	12 to 24 per year	20 to 5 km	Medium quality	low (less than 5000)	Medium	High	10 to 25 km	10 to 5 km
20 to 50	High (by car)	4 to 6	4 to 6	100 to 50 km	National	Medium	Regional	more than 48 per year	More than 50 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	5 to 10 km	1 to 5 km
20 to 50	Medium (by bicycle an	4 to 6	4 to 6	25 to 5 km	Regional	Medium	National	12 to 24 per year	5 to 1 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	5 to 10 km	10 to 5 km
20 to 50	Medium (by bicycle an	4 to 6	4 to 6	50 to 25 km	Regional	Medium	Regional	12 to 24 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	10 to 25 km	10 to 5 km
More than 50	Medium (by bicycle an	4 to 6	4 to 6	25 to 5 km	National	High	National	24 to 48 per year	50 to 20 km	High Quality	High (10,001 to 100,0	High	High	10 to 25 km	1 to 5 km
More than 50	Medium (by bicycle an	2 to 3	2 to 3	100 to 50 km	Regional	Medium	Regional	12 to 24 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	10 to 25 km	10 to 5 km
10 to 20	Low (on foot with spec	2 to 3	2 to 3	Less than 5 km	Local	Medium	National	12 to 24 per year	5 to 1 km	Medium quality	low (less than 5000)	Medium	High	less than 5 km	Less than 1 km
10 to 20	Low (on foot with spec	2 to 3	2 to 3	100 to 50 km	Regional	Low	Local	12 to 24 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	Low	Low	10 to 25 km	10 to 25 km
10 to 20	Medium (by bicycle an	2 to 3	2 to 3	50 to 25 km	Local	Medium	Regional	Less than 12 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	High	Medium	25 to 50 km	10 to 5 km
10 to 20	High (by car)	2 to 3	2 to 3	50 to 25 km	Local	High	Regional	Less than 12 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	Low	Medium	10 to 25 km	10 to 25 km
10 to 20	High (by car)	2 to 3	4 to 6	100 to 50 km	Regional	Low	Regional	Less than 12 per year	50 to 20 km	Low quality	low (less than 5000)	Low	Low	25 to 50 km	10 to 25 km
10 to 20	High (by car)	4 to 6	2 to 3	50 to 25 km	Regional	Low	Regional	Less than 12 per year	50 to 20 km	Low quality	Medium (5,001 to 10,0	Low	Low	25 to 50 km	10 to 25 km
20 to 50	High (by car)	2 to 3	4 to 6	50 to 25 km	Regional	Medium	Local	Less than 12 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	Low	Medium	25 to 50 km	10 to 5 km
10 to 20	Low (on foot with spec	2 to 3	4 to 6	50 to 25 km	Local	High	Regional	12 to 24 per year	5 to 1 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	5 to 10 km	10 to 25 km
20 to 50	Low (on foot with spec	2 to 3	2 to 3	50 to 25 km	Regional	Medium	Regional	Less than 12 per year	20 to 5 km	High Quality	High (10,001 to 100,0	Medium	Low	10 to 25 km	1 to 5 km
20 to 50	Low (on foot with spec	2 to 3	1	50 to 25 km	National	High	Regional	12 to 24 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	High	High	5 to 10 km	10 to 5 km
More than 50	High (by car)	4 to 6	4 to 6	More than 100 km	Regional	High	National	24 to 48 per year	20 to 5 km	High Quality	High (10,001 to 100,0	High	High	5 to 10 km	10 to 5 km
10 to 20	Medium (by bicycle an	2 to 3	2 to 3	50 to 25 km	Regional	Medium	Regional	12 to 24 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	10 to 25 km	10 to 5 km
10 to 20	Low (on foot with spec	1	4 to 6	50 to 25 km	National	Low	Local	24 to 48 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	Medium	Low	5 to 10 km	1 to 5 km
0 to 10	High (by car)	2 to 3	1	25 to 5 km	Regional	High	Regional	Less than 12 per year	20 to 5 km	High Quality	low (less than 5000)	Low	Low	less than 5 km	Less than 1 km
20 to 50	Medium (by bicycle an	4 to 6	4 to 6	50 to 25 km	Regional	High	Regional	12 to 24 per year	5 to 1 km	Low quality	low (less than 5000)	Medium	Medium	5 to 10 km	1 to 5 km
10 to 20	Low (on foot with spec	4 to 6	2 to 3	50 to 25 km	Regional	Medium	National	12 to 24 per year	5 to 1 km	Medium quality	Medium (5,001 to 10,0	Low	Low	10 to 25 km	10 to 5 km
20 to 50	High (by car)	4 to 6	4 to 6	50 to 25 km	International	Medium	Regional	24 to 48 per year	5 to 1 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	10 to 25 km	10 to 5 km
20 to 50	Medium (by bicycle an	2 to 3	2 to 3	50 to 25 km	Regional	High	National	24 to 48 per year	5 to 1 km	Medium quality	Medium (5,001 to 10,0	Medium	Medium	5 to 10 km	1 to 5 km
10 to 20	Medium (by bicycle an	4 to 6	2 to 3	25 to 5 km	National	High	National	24 to 48 per year	5 to 1 km	Medium quality	low (less than 5000)	High	Medium	10 to 25 km	1 to 5 km
More than 50	Low (on foot with spec	2 to 3	4 to 6	25 to 5 km	Regional	High	National	24 to 48 per year	20 to 5 km	Utmost quality	High (10,001 to 100,0	Medium	Medium	5 to 10 km	1 to 5 km
20 to 50	Low (on foot with spec	2 to 3	4 to 6	50 to 25 km	National	Medium	Regional	24 to 48 per year	5 to 1 km	Utmost quality	Medium (5,001 to 10,0	Medium	High	25 to 50 km	10 to 5 km
10 to 20	Low (on foot with spec	2 to 3	4 to 6	50 to 25 km	National	Medium	Local	12 to 24 per year	20 to 5 km	High Quality	Medium (5,001 to 10,0	Low	Medium	5 to 10 km	10 to 5 km
20 to 50	Low (on foot with spec	2 to 3	2 to 3	50 to 25 km	Regional	Low	Regional	12 to 24 per year	50 to 20 km	Low quality	Medium (5,001 to 10,0	High	Medium	5 to 10 km	10 to 5 km
10 to 20	Medium (by bicycle an	2 to 3	1	25 to 5 km	National	Low	Local	12 to 24 per year	50 to 20 km	Medium quality	High (10,001 to 100,0	Low	Medium	5 to 10 km	10 to 5 km
0 to 10	Medium (by bicycle an	2 to 3	4 to 6	50 to 25 km	Regional	Medium	Regional	24 to 48 per year	50 to 20 km	Low quality	High (10,001 to 100,0	Low	Low	5 to 10 km	10 to 5 km
0	Low (on foot with spec	1	2 to 3	50 to 25 km	Regional	High	Local	24 to 48 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	Low	Medium	5 to 10 km	10 to 25 km
0	Low (on foot with spec	2 to 3	1	50 to 25 km	Local	Low	Local	24 to 48 per year	50 to 20 km	Low quality	low (less than 5000)	Low	None	5 to 10 km	10 to 25 km
20 to 50	Low (on foot with spec	2 to 3	2 to 3	Less than 5 km	Regional	High	Regional	24 to 48 per year	5 to 1 km	Medium quality	High (10,001 to 100,0	Outmost	Medium	5 to 10 km	1 to 5 km
0 to 10	Low (on foot with spec	4 to 6	2 to 3	50 to 25 km	Regional	Low	National	12 to 24 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	High	Medium	25 to 50 km	10 to 5 km
0 to 10	Low (on foot with spec	2 to 3	1	25 to 5 km	Local	High	Local	12 to 24 per year	50 to 20 km	High Quality	Medium (5,001 to 10,0	High	Low	5 to 10 km	10 to 25 km
10 to 20	Medium (by bicycle an	1	2 to 3	50 to 25 km	Regional	High	Regional	12 to 24 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	High	Low	5 to 10 km	1 to 5 km
10 to 20	Low (on foot with spec	4 to 6	2 to 3	100 to 50 km	Regional	Medium	Regional	Less than 12 per year	5 to 1 km	Low quality	Medium (5,001 to 10,0	Medium	Medium	10 to 25 km	1 to 5 km
20 to 50	Low (on foot with spec	2 to 3	2 to 3	25 to 5 km	Local	Medium	National	24 to 48 per year	50 to 20 km	Medium quality	low (less than 5000)	High	Medium	10 to 25 km	1 to 5 km
10 to 20	Low (on foot with spec	4 to 6	2 to 3	100 to 50 km	Regional	Medium	National	12 to 24 per year	5 to 1 km	Low quality	Medium (5,001 to 10,0	Medium	High	25 to 50 km	10 to 5 km
10 to 20	Low (on foot with spec	4 to 6	2 to 3	50 to 25 km	National	Medium	National	12 to 24 per year	5 to 1 km	Medium quality	High (10,001 to 100,0	Medium	High	10 to 25 km	10 to 25 km
0 to 10	Low (on foot with spec	2 to 3	1	100 to 50 km	National	Low	Local	24 to 48 per year	20 to 5 km	Medium quality	High (10,001 to 100,0	Medium	Low	5 to 10 km	10 to 5 km
10 to 20	Low (on foot with spec	1	4 to 6	50 to 25 km	Regional	Medium	Local	12 to 24 per year	20 to 5 km	High Quality	low (less than 5000)	Low	Medium	10 to 25 km	10 to 25 km
20 to 50	Medium (by bicycle an	1	2 to 3	100 to 50 km	Local	Medium	National	12 to 24 per year	50 to 20 km	Medium quality	Medium (5,001 to 10,0	High	Medium	25 to 50 km	10 to 5 km
0 to 10	Low (on foot with spec	2 to 3	4 to 6	100 to 50 km	Regional	High	Local	24 to 48 per year	5 to 1 km	Medium quality	Medium (5,001 to 10,0	Medium	High	10 to 25 km	10 to 5 km
0 to 10	Low (on foot with spec	2 to 3	4 to 6	50 to 25 km	Regional	Low	National	12 to 24 per year	50 to 20 km	Medium quality	High (10,001 to 100,0	High	Low	5 to 10 km	10 to 5 km
20 to 50	Low (on foot with spec	4 to 6	2 to 3	25 to 5 km	Local	High	Regional	12 to 24 per year	5 to 1 km	Low quality	High (10,001 to 100,0	Medium	High	10 to 25 km	1 to 5 km
10 to 20	Low (on foot with spec	2 to 3	2 to 3	100 to 50 km	National	Medium	Local	12 to 24 per year	5 to 1 km	High Quality	Medium (5,001 to 10,0	High	Low	5 to 10 km	10 to 5 km
10 to 20	Low (on foot with spec	4 to 6	2 to 3	25 to 5 km	Local	Medium	National	24 to 48 per year	20 to 5 km	High Quality	Medium (5,001 to 10,0	Medium	High	5 to 10 km	10 to 5 km
10 to 20	Low (on foot with spec	2 to 3	1	50 to 25 km	National	High	National	24 to 48 per year	20 to 5 km	Medium quality	Medium (5,001 to 10,0	High	High	5 to 10 km	10 to 25 km