SATELLITE-BASED RISK ANALYSIS MAPPING FOR URBAN DEVELOPMENT IN KUANTAN DISTRICT, PAHANG

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Bachelor of Engineering Technology (Energy and Environment)

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ABSTRAK

Bandar pertumbuhan dan pembangunan bandar adalah antara pemacu utama pertumbuhan bahaya alam, terutamanya bencana banjir. Bandar membangun bukan sahaja mengalami risiko tinggi kejadian banjir, tetapi mencetuskan banyak konflik manusia-hidupan liar. Kuantan mempunyai banyak ruang tanah tetapi ruang koridor hijau mampan terhad. Kekurangan ruang hijau menunjukkan kapasiti rendah ekosistem semula jadi untuk memerangi anomali fenomena semula jadi seperti kerpasan berlebihan yang membawa kepada skala bahaya semula jadi tempatan seperti banjir dan air bertakung. Objektif penyelidikan ini adalah untuk menjana penunjuk risiko tinggi ke rendah bagi meminimumkan potensi konflik manusia-hidupan liar mengikut taburan GI sedia ada menggunakan pendekatan penderiaan jauh dan membangunkan analisis peta risiko banjir Kuantan, Pahang menggunakan pendekatan berasaskan satelit dan alatan GIS. Seterusnya, untuk mengagihkan GI secara spatial mengikut penunjuk risiko tinggi ke rendah untuk meminimumkan potensi konflik manusia-hidupan liar. Kajian ini adalah untuk memfokuskan kawasan di Kuantan, Pahang sebagai tapak perintis dengan variasi ciri topologi, permukaan beralun, dan bahaya semula jadi semasa. Bermula pada fasa 1 ia terdiri daripada pengumpulan data dan pemprosesan data untuk mencapai objektif pertama dalam Bab 1. Fasa 2 terdiri daripada pembentangan data. Kemudian, selepas proses pengesahan, penjanaan peta untuk menghasilkan hasil akhir. Peta risiko banjir dipengaruhi oleh parameter kerpasan hasil daripada berat tinggi yang diberikan semasa kaedah AHP. Selain itu, ia telah dikategorikan dalam 5 peringkat kelas risiko iaitu zon banjir sangat rendah, rendah, sederhana, tinggi dan sangat tinggi. Hasil kajian menunjukkan kawasan banjir yang sangat tinggi diliputi ialah Tanjung Lumpur, Berserah dan Balok. Sementara itu, peta ini diregres dengan nilai NDVI yang dihasilkan daripada jalur inframerah merah dan dekat Landsat. Titik panas tertinggi dicatatkan di sebelah timur daerah Kuantan iaitu kawasan Teluk Cempedak di mana semakin rendah nilai NDVI, semakin tinggi konflik hidupan liar manusia berlaku. Dengan membangunkan peta ini, ia telah dijana di mana sejumlah 25% kawasan Kuantan telah ditunjukkan sebagai zon paling terdedah kepada bahaya banjir, 40% risiko sederhana dan 35% dikenal pasti sebagai zon berisiko rendah. Peta risiko banjir ini menyediakan penambahbaikan penting dalam strategi kawalan banjir dan menyediakan pelan pemindahan untuk pihak berkuasa. Secara tidak langsung, gabungan NDVI dan HWC adalah penting kerana indeks tumbuhan tertinggi, konflik hidupan liar manusia yang paling rendah berlaku. Oleh itu, lokasi yang mempunyai indeks tumbuhan tertinggi dipilih sebagai koridor hijau.

ABSTRACT

Urban growth and development cities are among the major drivers of natural hazard growth, especially flood disasters. Developing cities not only experienced high risk of flood occurrences, but triggers plenty human-wildlife conflicts. Kuantan has a lot of land space but limited spaces of sustainable green corridor. Lack of green spaces indicates the low capacity of the natural ecosystem to combat the anomalies of the natural phenomenon such as excessive precipitation which led to local scale of natural hazards like flood and stagnant water. The objectives of this research which are to generate high-to-low risk indicator to minimize potential of human-wildlife conflict according to existing GI distribution using remote sensing approach and to develop flood risk map analysis of Kuantan, Pahang using satellite-based approach and GIS tools. Next, to spatially distribute GI according to high-to-low risk indicator to minimize potential of human-wildlife conflict. This study is to focus on area in Kuantan, Pahang as the pilot site with a variation of topological features, undulating surface, and current natural hazards. Begin at phase 1 it consists of data collection and data processing to achieve the first objectives in Chapter 1. Phase 2 consists of data presentation. Then, after the verifications process, the map generation to produce final outcomes. The flood risk map is influenced by precipitation parameters as a result of the high weight assigned during the AHP method. Besides, it has been categorized in 5 levels of risk classes which are very low, low, moderate, high, and very high zones of flood. The results show that the very high flood areas covered were Tanjung Lumpur, Berserah and Balok. Meanwhile, this map is regressed with NDVI value that produced from red and near infrared band of Landsat. The highest hotspot was recorded at east side of Kuantan district, which is Teluk Cempedak area whereby, the lower NDVI value, the higher human wildlife conflict occurred. By developing this map, it has been generated where a total of 25% of Kuantan area was indicated as the most vulnerable zone for flood hazard, 40% moderate risk and 35% identified as low risk zone. This flood risk map provides a crucial improvement of flood control strategies and preparing an evacuation plan for authorities. Indirectly, the combination of NDVI and HWC is important because the highest vegetation index, the lowest human wildlife conflict occur. Thus, the location with the highest vegetation index was selected as green corridor.

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HWC	Human wildlife conflict
GI	Green infrastructure
DEM	Digital elevation model
NDVI	Normalized difference vegetation model
SDP	Sustainable development goals
GIS	Geographic information system
GPS	Global positioning system
OLI	Operational land imager
AHP	Analytical hierarchy process
SRTM	Shuttle radar topography mission
TRMM	Tropical rainfall measuring mission

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Rapid urbanization and technological advancements have had a huge impact on how the urban environment has evolved. The growing popularity of distributed city models in the twentieth century not only contrasted starkly with earlier, more compact cities of the nineteenth century, but also had a detrimental effect on infrastructure and services. As a result, environmentally friendly growth strategies were pursued (Kenzie, 2018). Obtaining such progress in the era of sustainable development will continue to take committed effort and, most importantly, personal involvement. Most cities have planning instrument in place to influence the nature of their green spaces (Kenedy, 2017).

Urban growth and development cities are among the major drivers of natural hazard growth, especially flood disasters. Floods are a widespread universal natural occurrence that occurs in the majority of the world, and they are perhaps the most damaging of all natural disasters. However, flood risk is a product of flood vulnerability multiplied by the total amount of flood risk properties. The overall likelihood of flood hazards, as well as the properties at risk of those hazards, determines flood risk. The flood risk occurred due to increasing rapid urbanisation. According to Malaysia's Department of Irrigation and Drainage, especially during the northeast monsoon season (October to March), the numerous rivers that flow through the country put approximately 9% of the country's total land area at risk of flooding, affecting an estimated 2.7 million people. Rapid urbanization would exacerbate the issue by increasing population concentrations and putting vulnerable facilities at risk, as well as by increasing land use and channelling of water courses (Saffioti, 2019).

Nowadays, an increasing in deforestation has occurred in Malaysia due to rapid urban development. Developing cities not only experienced high risk of flood occurrences, but triggers plenty human-wildlife conflicts. This activity has resulted human wildlife conflict (HWC). Human wildlife conflict (HWC) refers to adverse encounters between humans and wild animals, which have ramifications for both humans and their resources, as well as wildlife and their ecosystems. According to (Raupp et al. 2016), HWC is rapidly becoming a serious threat to the survival of many endangered species around the world, particularly large and threatened 15 mammals such as tigers, lions, orangutans, and elephants, because of to the incapability of the remaining forest to sustain their populations. Furthermore, human-wildlife conflict in Malaysia is exacerbated by the high density of human and wildlife populations competing for the same natural resources, such as water and land.

Therefore, this study is important to analyse and minimize severe impact of flood risk and human wildlife conflict that occurred in a local place, town such as Kuantan city. Green Infrastructure is one of the effective solutions in mitigating issues of flood risk and HWC. GI refers to a strategically designed and implemented network of the highest quality green spaces and other environmental features. It should be developed and operated as a multifunctional resource capable of providing the ecological services and quality-of-life advantages that the communities it serves require and that are required to assure sustainability. Moreover, green infrastructure increases exposure to the natural environment, reduces exposure to harmful substances and conditions, provides opportunity for recreation and physical activity, improves safety, promotes community identity and a sense of well-being, and provides economic benefits at both the community and household level. Thus, this study focused on the GI construction planning at the most suitable places in Kuantan city.

1.2 Problem Statement

High populated city such as Kuantan is vulnerable flood events and trend of HWC increasing. Kuantan has a lot of land space but limited spaces of sustainable green corridor. Lack of green spaces indicates the low capacity of the natural ecosystem to combat the anomalies of the natural phenomenon such as excessive precipitation which led to local scale of natural hazards like flood and stagnant water. Multi-factors of both natural elements and man-made infrastructure need to be analysed to understand repetition of the hazards and the repercussion of less green infrastructure in the city and no constructive planning on distributing GI to handle HWC issue.

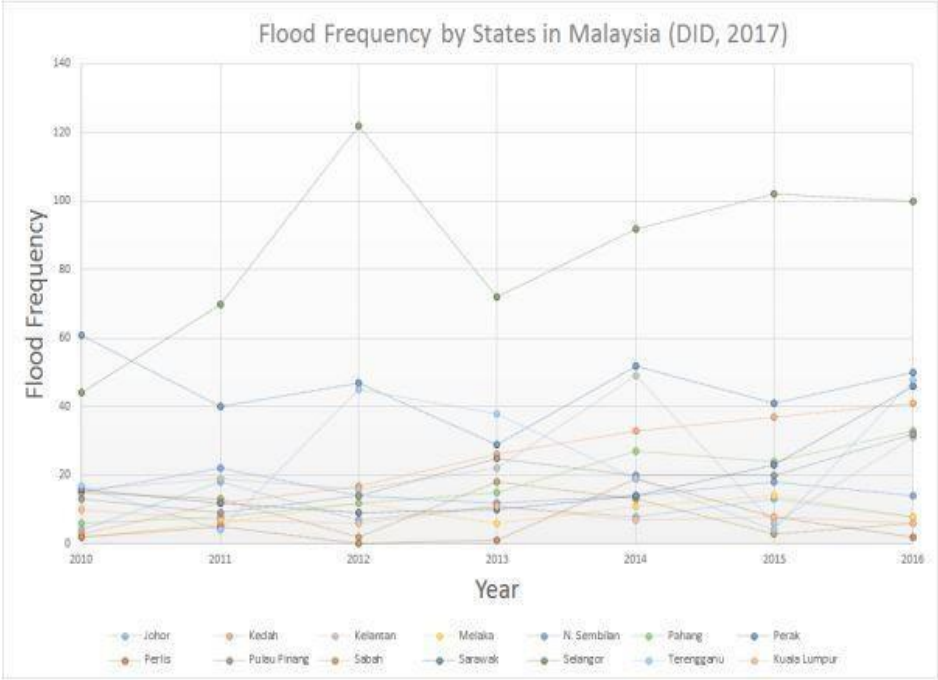


Figure 1.1 Flood frequency in Malaysia (2010-2016)

Source: Universiti Teknologi Malaysia

The graph in Figure 1 shown the flood increased yearly since 2010 until 2016 for most states in Malaysia. According to recent records, the worst flood catastrophes happened in December 2014 in Kelantan, Pahang, Terengganu, and Sabah, claiming numerous lives and wreaking havoc on property. Additionally, vital states and urban areas such as Selangor and Penang, as well as Kuala Lumpur, Malaysia's capital, are hit by floods each year, and the government must spend significant time and resources to aid inhabitants in recovering and rebuilding infrastructure following disasters.

Therefore, residents of local area tend to highly exposed to the wildlife where high human-wildlife interaction much likely triggers conflicts in a regular basis.

Geospatial analysis is required to minimize those sorts of risks which jeopardize the livelihood and safety. Green corridor mapping can isolate the dense, fair, and less potential wildlife habitat in Kuantan and map the conflicts risk with the peoples.

1.3 Objectives

The objectives of this research which are the following: -

i. To generate high-to-low risk indicator to minimize potential of human-wildlife conflict according to existing GI distribution using remote sensing approach

ii. To develop flood risk map analysis of Kuantan, Pahang using satellite-based approach and GIS tools

1.4 Scope of Study

This study is to focus on Kuantan District area with a variation of topological features, undulating surface, and current natural hazards. As stated by the Kuantan Municipal, the number of flood victims in Kuantan is increasing every year. This is because the annual flooding event caused by the seasonal monsoon which accounts for significant losses (Alagesh, 2021). Kuantan also have an issue with increasing wildlife death in on its highways. According to (Alagesh, 2017), land clearing activities has ruined their habitat and has forced the animals to travel further to find for food.

Furthermore, the application that was used in this study was multispectral satellites images with moderate spatial resolution (30 m) of Landsat series and Sentinel-2 with 10m spatial resolution. Fine-resolution satellite image (<2m) and high resolution of Digital Elevation Model (DEM) were used in conducting this research. By analyzing these spectral images for remote sensing, various combinations of bands and spectral indexes derived on the basis enable the discovery of previously unseen information about objects or features. In the range of 30-10m, it categorized as medium to high resolutions thus, allows to clearly see the buildings, small boats, and narrow streets.

Sentinel-2 and Landsat 8 performed similarly in terms of accuracy, with area-adjusted overall accuracies of 96.7 percent and 95.7 percent, respectively. All of these digital images have distinct characteristics in terms of spatial resolution, spectral resolution, radiometric resolution, and temporal resolution, which will generate a research comparison result. This topic is covered in better detail in Chapter 3.

1.5 Significance of Study

This study is crucial to propose a solution to mitigate flood occurrences based on the satellite-based risk map analysis. Therefore, the findings can provide the communities in this area with the required details. The research also included an understanding of the type of floods normally occurring in study areas. Additionally, the proposed method of risk mapping identifies locations that are particularly prone to flooding. Spatial and temporal information is required, including the location, frequency of occurrence, length, and severity of the event. The first step toward flood risk assessment is the creation of risk maps. Their objective is to improve understanding and communication about the amount and features of flooding, such as water depths and velocity.

Furthermore, it offers a fundamental basis of suggestion to distribute GI at ideal location in Kuantan under a green urban sustainable development. GI can be improved by focusing on tracking, preserving, upgrading, and linking existing areas and features, as well as developing new uses and features, through strategic and organized initiatives. Moreover, determine low risk area for intact area of interaction between human and wildlife. Green infrastructure also benefits habitat in tiny streams and washes by minimizing erosion and sedimentation. Green infrastructure on a large scale, such as parks and urban forests, aids in wildlife mobility and connectivity between habitats.

However, to work toward solutions, instead of focusing on improving positive relationships between humans and animals, the focus should be on reducing negative experiences. Good encounters, coexistence, and attitudes of tolerance toward wildlife must all be included. Besides that, green infrastructure may help organizations save money on infrastructure, spur economic growth, and create construction and maintenance jobs. Increased green space and parks promote outdoor physical exercise, hence lowering obesity and decreasing chronic diseases related with it, such as heart disease, high blood pressure, and stroke.

1.6 Summary

This chapter lays the flood risk and human wildlife conflict to introduce the highlight of research problem and objectives of the study. In the section on study significance, the study problem was justified, and the research contributions were explained. This chapter discussed the study's scope briefly and provided some justifications. Meanwhile, the thesis format has been described in detail to provide an excellent overview of the study's opening section.

CHAPTER 2

LITERATURE REVIEW

2.1 Flood Risk Analysis and Human Wildlife Conflict using GIS/Remote Sensing technology

Floods are the most common type of disaster and occur when water overflows, usually dry land. Floods frequently occur in coastal locations as a result of excessive rainfall, quick snowmelt, or a storm surge from a tropical cyclone or tsunami. Floods may wreak havoc on communities, killing lives and severely affecting on personal property and crucial public health infrastructure. Between 1998 and 2017, floods harmed over 2 billion people worldwide (WHO, 2021). Floods are particularly deadly for residents who live in floodplains or in non-flood-resistant structures, or who lack flood warning systems or are unaware of the threat (WHO, 2017). There are 3 common types of floods which are flash floods. It is caused by heavy and rapid rainfall, which rapidly raises water levels, and rivers, streams, channels, and roads may be overwhelmed (USGS, 2021). Following that, river floods occur when consistent rain or snow melt causes a river to overflow its capacity. Furthermore, coastal flooding is a result of storm surges caused by tropical cyclones and tsunamis.

According to (Varnika & Mitashi, 2019), this disaster was happening in India country which is both governments and people have taken surprise from the recent floods in Bihar and Eastern Uttar Pradesh. The city has stopped severe water logging in Patna, with hospitals and residential areas full of deep waist. Transportation services have been affected, and numerous trains have been cancelled (Masih, 2019). Although unseasonably severe rainfall might be linked to climate variance, the massive urban floods are mostly a result of uncontrolled urbanisation (Gupta, 2019). Flooding in urban areas is not solely a result of overflowing rivers; it is also a result of the cities' ill-informed approach to urbanisation. Excessive drainage, rash and unregulated construction, and buildings designed without regard for natural topography and hydrogeomorphology all contribute to the harm (Varnika & Mitashi, 2019). This easily makes urban floods a man-made disaster. Meanwhile, lack of green corridor areas has led to flooding and caused conflict to wildlife habitat.

Other than that, Human-Wildlife Conflict (HWC) refers to interactions between wild animals and humans, as well as the negative consequences for people, their resources, or wild animals and their habitat (Mekonen, 2020). This issue exists if the same resources are shared between wild animals and humans. The expansion of the human population into or around wildlife-dwelling areas and the alteration of the natural environment for farming activities increase conflict between human and wildlife (Dickman, 2010). In developed countries, the issue of human-wildlife conflicts is mostly stated in terms of crop raiding, animal depredation, predation of controlled wildlife species or the killing of people (Meles & Dessalegn, 2018). Mostly all the wildlife in developing countries that affect community livelihoods.

According to (WWF, 2021), the trees, swamps, deserts, lakes and other ecosystems on the earth are vanishing as they are harvested for human consumption and cleared for farming, residences, motorways, pipelines, and other industrial development markers. Without a coherent strategy for land and marine protected areas, significant natural ecosystems would continue to be lost. These incidents occurred on the Indonesian island of Sumatra, where unlawful forest fires resulted in severe levels of air pollution in neighbouring nations such as Singapore and Malaysia (Yeung, 2019). The haze generated by these illegal and uncontrolled fires was caused by land clearing for crops that predominantly rely on oil palm trees (Vidal, 2013). Agriculture expansion, as the primary cause, has a significant impact on Malaysia's natural forests and animals.

2.2 Current Scenario of Floods and HWC

2.2.1 Floods Risk due to Natural or Combination Disaster

Flood is a natural phenomenon that is expected to become increasing in recent years, especially in urban areas. This is a natural phenomenon or occurrence when water overflows or floods a dry field (Qomariyatus et al.2020). The rate of precipitation events is also expected to increase due to climate change, ineffective drainage system and lacks sustainable green corridor. The flood level increased due to human activity (Miceli, 2017). Floods often have devastated economic effects and the environment often involves loss of life. Moreover, floods have the greatest potential for damage to all-natural disasters in the world and are affecting most people. Floods wash away everything every year, destroying crops, livestock, houses, and other property, as well as dislocating the region's inhabitants (Saru, 2012).

Table 2.1 Floods Disaster Incidents in Malaysia

Date/Year	Incident	Natural, Human-made or Combination	Property, Material, Crop or Other Losses (USD)	Number of Deaths
1926	Flood known as “The storm forest flood”	Natural	Thousands of hectares of forests destroyed	NA
December 1996	Floods brought by Tropical Storm Greg in Keningau (Sabah State)	Combination	300 million	241
2000	Floods caused by heavy rains in Kelantan and Terengganu	Combination	Million	15
December 2004	Asian Tsunami	Natural	Million	68

December 2006 & January 2007	Floods in Johor State	Combination	489 million	18
2008	Floods in Johor State	Combination	21.19 Million	28
2010	Floods in Kedah and Perlis	Combination	8.48 Million (Aid alone)	4
2011 & 2012	La Nina in 2011 and 2012 (which brought floods)	Natural	NA	NA

Source: (Chan, 2012)

There are two types of floods in Malaysia which are Monsoon floods and Flash Floods. Therefore, Monsoon floods takes place when wind systems alternate in the northeast and the southwest throughout the summer in the southern hemisphere during winter (Zal, 2018). Floods caused by the northeast monsoon are common along Peninsular Malaysia's east coast. The rain has been particularly heavy this season, and several days have been spent in the rain. The monsoon season was also regarded as the period when the sea was rough and threatening (Chan, 2012). The east coast states of Kelantan, Terengganu, and Pahang are usually the first to be hit by northeast monsoon floods in Malaysia. It usually happens between November and March. (Chan, 2012).

Flash floods occur rapidly for short period of time but with high rain fall depth. In Malaysia, major cities such as Kuala Lumpur, Georgetown, Selangor, Ipoh and others have suffered severe flooding. Flash floods occur because of population density and densely constructed and paved roads (Musa, 2014). For the occurrence of flash flooding, the rain for two hours is adequate. When the water has no dry space, flash floods occur because rivers are deposited and replaced by drains or smaller drains (Saru, 2012). In addition, flash floods also occur in Malaysia because of land-use changes in land use arise as the population of the compact area (Che Ros et al.2019). Because of this high flood risk, Malaysia's government has an obligation to spend a significant amount of its annual budget to minimize flood risk and visibility (Chan, 2012).

According to the Malaysian Government's Drainage and Irrigation Department. Excess water (floods) and a lack of water are two of these issues (droughts) (Hussaini, 2007). Both issues have harmed the country's quality of life and economic development, and can result in significant property damage and destruction, as well as the loss of human lives, as the floods in Johor in December 2006 and January 2007 demonstrated (Hussaini, 2007).

2.2.2 Human Wildlife Conflict due to insufficient green corridor

As the urban population approaches 50% of the global population and continues to grow, the quantity and quality of green space in urban areas has become critical for maintaining people's life and biological diversity (José et al.2018). Human-wildlife conflict is caused by a lack of green space, human settlement, agricultural development, illegal grass collection, livestock overgrazing, and deforestation in national parks (Mekonen, 2020). As a result, local communities disliked wildlife inhabiting in and around their surroundings. As a result, native peoples loathed wildlife that lived in and around their communities. This has a significant negative influence on wildlife conservation. Additionally, this struggle has resulted in the extinction of numerous species, altered the structure and function of the ecosystem, and massive losses of human life, crops, livestock, and property (Nyhus, 2016). When the needs and behaviour of animal’s conflict with human goals, or when human goals conflict with the needs of wildlife, a conflict occurs (Mekonen, 2020).

According to the World Wide Fund for nature (WWF, 2018), conflict between humans and elephants is caused by deforestation and destruction of habitats. when elephants and humans meet, there is dispute over resources and harm to humans and habitat, and when elephants die, it is not necessarily due to environmental problems. Also, the Malaysian state of Sabah, which is in Borneo, has confirmed nearly two dozen pygmy elephants being killed by poaching, poaching, poisoning, and snaring as the animals since the start of the year so far. These accidents do cause by the elephants entering agricultural land, where they eat crops and trample the soil (Louis, 2020).

Besides, HWC includes various levels of impacts, such as loss of livestock and crops, as well as well as animal attacks. Approximately 63% of all recorded wildlife incidents include snakes, wild boars, water monitor lizard and macaques. There are numerous wildlife roadkill incidents in the states of Perak, Johor, and Kelantan as well (Saaban, 2017). However, HWCs do occur because of vehicles traveling at excessive speeds on declivitous roads on both sides of the steep road, most commonly when some significant wildlife crosses the road at night or during the wet season (Misbari et al.2018). The billowy surface or non-flattened road surface has an impact on the vehicle speed, as the road user naturally drives faster on the billowy surface than on the flat surface. The growing amount of traffic on roads and highways was one of the factors that contributed to HWCs occurring more frequently (Misbari et al.2018).

Table 2.2: The Highest Number of Animal-Vehicle Collision from 2012 to 2017

No	NDX	English Name	Scientific Name	Quantity
1	Mammals	Wild Boar	Sus scrofa	265
2	Mammals	Leopard Cat	Prionailurus bengalensis	88
3	Mammals	Malayan Tapir	Tapirus indicus	68
4	Mammals	Long-tailed Macaque	Macaca fascicularis	439
5	Mammals	Common Palm Civet	Paradoxurus hermaphroditus	418
6	Reptile	Water Monitor Lizard	Varanus salvator	742

Source: PERHILITAN Malaysia

Table 2.3 Malayan Tapirs Roadkill Range of Distances by State

No	State	Roadkill	Range of Approximate Distance (km)	No. of ecoviaduct	Value of Loss (RM100,000 per unit) (Act 716, 2010)
1	Terengganu	30	38.71 – 135.14	3	3,000,000
2	Pahang	13	139.62 - 208.07	3	1,300,000
3	N. Sembilan	6	15.29 – 45.04	2	600,000
4	Johor	13	N/A	No ecoviaduct	1,300,000
5	Kelantan	4	N/A	No ecoviaduct	400,000
6	Selangor	2	N/A	No ecoviaduct	200,000
	Total	**68**			**RM6,800,000**

Source: PERHILITAN Malaysia

2 tapirs die after being run over by car

By TN Alagesh - August 26, 2017 @ 2:17pm

It is learned that the driver escaped unhurt but the vehicle was severely damaged. Pic by STR/ MOHD RAFI MAMAT

KUANTAN: Three days after an elephant died when it was hit by a tour bus in

Figure 2.1 Malayan tapir death on Kuantan Road

Source: NST

Figure 2.2 A sun bear were killed in road accidents in north-east Malaysia on Christmas Eve

Source: NST

2.3 Flood Mitigation and Wildlife Habitat

2.3.1 Factors involved contributing to flood risk

Urbanization is a major factor that contributes to an increase in the frequency and severity of urban flooding. Rapid urbanization decreases green spaces and raises impervious surfaces, all of which can intensify flooding (Hyomin et al.2016). Open areas and green infrastructure will make a valuable contribution to surface water management. Moreover, open spaces and green infrastructure can be included in vital flood risk management processes by providing flood management space and protecting constructed areas (Ciria, 2021).

Other than that, the underlying source of flood risk is the poorly maintained drainage system. It has the potential to result in human death, property damage, crop and other plant destruction, and livestock loss. Furthermore, the lack of adequate drainage systems will result in erosion issues. However, implementing Sustainable Drainage Systems is a method of addressing water quantity (flooding), water quality (pollution), and environmental amenity problems. Sustainable drainage is a philosophy that considers long-term environmental and social considerations when making drainage decisions. (Smith, 2016).

2.3.2 Factors of Human Wildlife Conflict

Deforestation led to a reduction in global forest areas lost in other uses such as agricultural croplands, urbanization, or mining (Dean, 2020). Deforestation can result in the massive loss of wildlife habitat and the sharp reduction of habitat. Eliminating trees and other forms of vegetation reduces available food, shelter, and breeding habitat. Wildlife habitats become fragmented, with indigenous species forced to live on solitary forest islands surrounded by disturbed land used for agriculture and other purposes (Greentumble, 2018).

Human activity is by far the most significant contributor to habitat reduction. Agricultural expansion is the most common individual cause of habitat loss. Every year, an estimated 177,000 square kilometres of forests and woodlands are cleared to make way for agriculture or to harvest timber for fuel and wood products (WWF, 2017). Land clearing has a negative impact not only on native animal species, but also on the environment. Plants and trees are removed, leaving the ground exposed, which can lead to soil erosion. Soil erosion refers to the depletion of natural nutrients in the soil that aid plant growth. Dry land salinity can also be exacerbated by leaving land exposed to the elements (Leach, 2017).

2.3.3 Important of Geographical Information System (GIS)

A geographic information system (GIS) is a type of computer software that enables the user to analyze geography and make informed decisions. However, GIS is critical in urban planning because it enables a city's existing needs to be better understood and then designed to meet those needs. As urban populations continue to rise and expand, the value of GIS is in its ability to compile the massive quantities of data required to manage conflicting goals and solve complex problems (USC, 2020). Therefore, urban planning has great importance in mapping and managing the natural risk of flash floods for future planning. In recent years, geographic information system (GIS) data and visual features have been used to forecast flood prone areas and flood maps (Ozkan & Tarhan, 2015). Besides, the GIS has been shown to be an effective tool for analysing hydrological aspects, especially in the area of flood risk mitigation. The GIS can store attribute data using maps and could organize large databases.

Apart from that, GIS technology is a highly effective tool for managing, assessing, and displaying wildlife data in order to identify regions in need of conservation efforts. Geospatial study of habitats is critical for determining the health of a species in the wild. GIS helps to monitor and visualize: -

i. Population and distribution,
ii. Habitat use and preferences
iii. Progress of conservation activities
iv. Historical and present regional biodiversity

2.3.4 Strength and Limitation using Remote Sensing and GIS in Flood Risk and Human Wildlife Conflict

The remote sensing and geographic information systems (GIS) are highly powerful methods for assessing and managing flood risks and human wildlife conflict. Remote sensing is the science, technology, and art of collecting information about an object or region without physically approaching the object or area of interest (Lillesand, 2008). First and foremost, the strength is remote sensing gathers information at short intervals over vast areas. It will provide fast information of scales and resolutions (Grindgis, 2017). Remotely sensed images easy to be located. It can be used to delineate flood plains, map flood-prone areas, map land use, detect and forecast floods, map rainfall, schedule evacuations, and assess damage. Furthermore, remotely sensed data, such as satellite images, provide a broad perspective that can be used for a variety of purposes, including mapping the variability of terrain features required for flood research (Grindgis, 2017). Additionally, GIS enables the entry, management, analysis, and manipulation of massive volumes of data collected for flood risk assessment and management by providing a variety of tools for modelling flood-affected areas and finding or forecasting flood-prone areas (Meaden, 1996). Thus, remotely sensed data and GIS may be utilised efficiently to assess the extent and severity of damage caused by a disaster and to direct relief efforts and search and rescue operations in places where navigation is difficult (Mayhem, 2015).

There is also limitation in using remote sensing and GIS which is the price of high-resolution satellites is very expensive. There are 3 types of resolution which is low-resolution, medium-resolution and high-resolution. To achieve a high-level detail, high-resolution needed (Earth Observing System, 2019). Moreover, when remote sensing is coming to measuring or analysing smaller areas it is costly to evaluate frequent images if various aspects of the photography features must be analysed. Furthermore, remote sensing analysis involves a unique type of preparation. However, Malaysia lack of experts in the use of GIS software and need to pay more for hire foreign worker. Therefore, local authorities do not use GIS or remote sensing in making of urban development and not convinced of the use of GIS or remote sensing for final decision.

2.4 Summary

This table have been summarized about 8 journal studies. There are in global and local article about flood risk and human wildlife conflict.

AUTHOR	YEAR	TITLE	JOURNAL	COMMENTS/ REMARKS	DATA
AhrisYaakup, Susilawati Sulaiman	2002	GIS as Tools for Monitoring the Urban Development in Metropolitan Region:	A Case of Klang Valley Region, Peninsular Malaysia	Advantages: - - Using GIS to development and planning analysis such as to support ten application modules. Disadvantages: - - Not provide methodology of the project - Just provide tools of planning	- AGISwlk - ARC/INFO
Ismail Elkhrachy	2015	Flash Flood Hazard Mapping Using Satellite Images and GIS Tool	A case study of Najran City,	Advantages: -	- SPOT

			Kingdom of Saudi Arabia (KSA)	- For this project, it uses DEM for the hydrological modelling to get Flood hazard maps. - It quite similarly with my project Disadvantages: - - Many sources of error in DEMs - Error covers random and human random in data acquisition including error caused by measurement equipment	- SRTM DEMS
Abdelfattah Al Masri, Özge Özden, Can Kara	2019	European Journal of Sustainable Development	Green Corridor Development as an Approach for Environmental Sustainability in Jordan	Advantages: - - More explain to green corridor and important in the protection of nature - Briefly explain the benefits of green corridor Disadvantages: -	- ArcGIS - Google Earth

				- Only using ArcGIS 10.0 and Google earth	
Abdulrahman Sa'adu Danjaji, Mariani Ariffin	2017	International Journal of Environment and Sustainable Development	Green infrastructure policy for sustainable urban development	Advantages: - - Provide knowledge about policy for sustainable urban development - State about comparison between urban green space provision in Kuala Lumpur and Putrajaya Disadvantages: - - More focus to green infrastructure (GI) policy	- Not stated
Fateen Nabilla Rasli, Kasturi Devi Kanniah	2008	Green Corridors for Liveable and Walkable City	A Case of Kuala Lumpur	Advantages: - - Explain about ways to creates or improve the green corridor at Kuala Lumpur	- Google Earth

				- Producing 6 different route of green corridor by using Google earth. Disadvantages: - - Only using Google earth for the methodology	
Hussam Al-Bilbisi	2018	Spatial Monitoring of Urban Expansion Using Satellite Remote Sensing Images	A Case Study of Amman City, Jordan	Advantages: - - This article explains about anthropogenic and natural factors Disadvantages: - - The matter not similar with my project	- GLCF - OLI
Syarifuddin Misbari, Mazlan Hashim,	2015	Spatial Analysis on Relationship Between Wildlife-Human Conflicts	In Senai-Desaru Expressway (Sde) In 2009-2015	Advantages: - - Provide important input about HWC occur in Senai Highway	- ENVI 5 - ArcMap

Shinya Numata, Tetsuro Hosaka				- Mostly the methodology similar with my project - It also provides the ways to reduce the HWC occur in highway	

2.5 Summary of Flood Risk and Human Wildlife Conflict

Floods are especially harmful for residents who live in floodplains or in non-flood-resistant structures, who lack flood warning systems, or who are uninformed of the threat. There are two types of flood risk which is natural and combination. Therefore, natural flood due to climate change. However, the combination flood is a combination between human-made and natural such as garbage proposal in drainage system cause clogging. The are some factors that causes flood risk is lack of green spaces and poorly maintained drainage system. Human-Wildlife Conflict (HWC) refers to interactions between wild animals and humans, as well as the negative consequences for people, their resources, or wild animals and their habitat. the issue of human-wildlife conflicts is mostly stated in terms of crop raiding, animal depredation, predation of controlled wildlife species or the killing of people. Furthermore, human wildlife conflict cause by lack of green space, human settlement, agricultural development, illegal grass collection, livestock overgrazing, and deforestation in national parks. This has a great negative impact in conservation of the wildlife. However, there are some factors that cause human wildlife conflict which is deforestation and agriculture expansion. GIS is a technological tool for comprehending geography and making intelligent decisions. It is important in urban planning. Therefore, urban planning has great importance in mapping and managing the natural risk of flash floods for future planning. In addition, GIS technology is an extremely useful method for managing, evaluating, and visualizing wildlife data in order to pinpoint areas in need of conservation practices. The remote sensing and geographic information systems (GIS) are highly powerful methods for assessing and managing flood risks and human wildlife conflict. However, has strength and limitation using remote sensing and GIS in Flood Risk and HWC.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This methodology, it several key main components involved in this study. Besides that, the workflow of this study is explained by correct techniques and data to achieve the objectives listed in Chapter 1. This chapter consists of three phases. At phases 1 it consists of data collection, data processing to achieve the first objectives in Chapter 1. Moreover, phases 2 consists of data presentation and to achieve the second objectives of the study. However, after the verifications process, it will through the map generation to produce final outcomes. The overall process is illustrated in flowchart as shown in Figure 3.1.

3.2 General Flowchart

Figure 3.1 shows the flowchart of methodology to construct Flood Risk and HWC analysis in achieves first and second objectives.

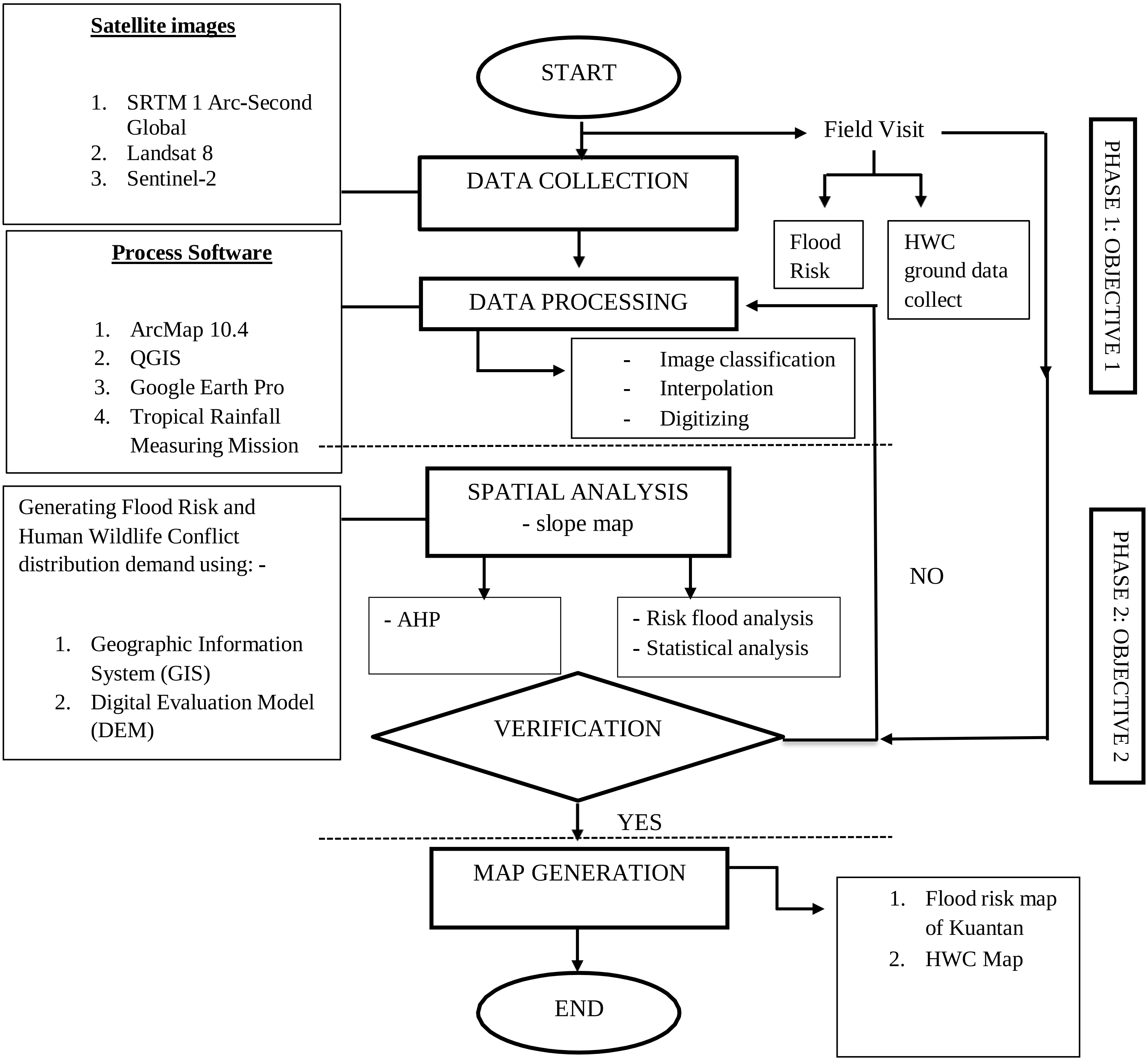


Figure 3.1 General flowchart of the Flood Risk and HWC

3.3 Data Collection

In this study, primary ground data through field visit have been collected. The field visit focused on area in the Kuantan District. Pahang as the pilot site with a variation of topological features, undulating surface, and current natural hazards. Besides that, the secondary data which is the software that been used in this study is multispectral satellites images with moderate spatial resolution (30 m) of Landsat series and Sentinel- 2 with 10m spatial resolution is accurately can be carried out in Kuantan District where it has a variation of topological features, undulating surface, and current natural hazards. Besides that, the secondary data that has been used in this study includes multispectral satellites images with moderate spatial resolution (30 m) of Landsat series and Sentinel- 2 with 10m spatial resolution.

3.3.1 Field Data Collection

Field visit has been conducted on 18/12/2021 at Kuantan area, which is Teluk Cempedak, Sungai Lembing and all the ways of Kuantan roads. This field survey was carried out for two main purposes: (i) to gather data of human wildlife conflict and (ii) to observe the natural hazards, topographic and land features. Handheld GPS and drone were the equipment that used for the data collection.

The Handheld GPS was used to record coordinate during field visit for data verification. GPS satellites provide continuous signals and data to enable GPS receivers to measure position, height, speed and time. Trilateration - a way to determine the relative locations of objects using triangle geometry in a similar way to triangulation (GPS World Staff, 2013). Therefore, the handheld GPS is providing the best level of accuracy because it sends information to 24 satellites that give back accurate information (Afgen, 2020). Just because it's small and light enough to carry around the work site without being a burden.

The other equipment that was used in field visit is drone. On Teluk Cempedak and Sungai Lembing area, this drone was used for topographic and land surveys by capture the aerial images of the area. By choosing the coordinate point in the drone software, the drone was generated the selected points and started flying. Additionally, using a drone to collect topographic and land data is up to five times faster and needs less people than using land-based approaches. Besides, the drone was provided accurate and exhaustive data. All the data was saved on the drone software and easily to access.

(a)

(b)

Figure 3.2 (a) Gather data of human wildlife conflict ; (b) observe the natural hazards, topographic and land features

Table 3.1 Summary of equipment used for data collection

<table>
<tr><th rowspan="2">Equipment Name</th><th rowspan="2">Model</th><th colspan="2">Functions</th></tr>
<tr><th>Teluk Cempedak</th><th>Sungai Lembing</th></tr>
<tr><td>Handled GPS
</td><td>Garmin GPSmap 76CSx</td><td colspan="2">To obtain coordinates of:
• Pinpointing present area
• Collect accurate geographical coordinates</td></tr>
<tr><td>Drone and remote controller

</td><td>Drone: T650A
Remote Controller: DJI GL6D10A</td><td colspan="2">• Captured the area features</td></tr>
<tr><td>Handphone
</td><td>Iphone 10</td><td colspan="2">• To captures photos of wildlife and natural hazards</td></tr>
</table>

3.3.2 Multispectral Satellites Images Data

In this study, multispectral satellite images data with moderate spatial resolutions and requirements can be used effectively, including Sentinel-2 Multispectral Band Data, Landsat 8 OLI, Landsat TM, and Landsat ETM+.

The Sentinel 2 satellites' Multi-Spectral Instrument (MSI) contains 13 spectral bands ranging from visible to shortwave infrared (SWIR). Bands are available in a range of resolutions from 10 to 60 metres, and the application determines their wavelength (Hatari, 2017). Additionally, the images from Landsat 8's Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) include nine spectral bands with a spatial resolution of 30 metres for Bands 1–7 and 9. Adding a new band 1 (ultra-blue) is beneficial for coastal and aerosol tests. Band 9 is very good for detecting cirrus clouds. The resolution of Band 8 (panchromatic) is 15 metres. Because thermal bands 10 and 11 are collected at a height of 100 metres, they are particularly beneficial for obtaining more precise surface temperatures. The scene encompasses an area approximately 170 kilometres north-south by 183 kilometres east-west (106 mi by 114 mi). Instruments for Landsat 9 (scheduled to launch in mid-2021) are being proposed as upgraded versions of those on Landsat 8. (USGS, 2016).

Moreover, Landsat 7 Enhanced Thematic Mapper Plus (ETM+) photos are composed of eight spectral bands, each with a spatial resolution of 30 metres. The resolution of Band 8 (panchromatic) is 15 metres. Each band can collect data with one of two gain settings (high or low) to optimise radiometric sensitivity and dynamic range, whereas Band 6 gathers data with both high and low gain for all situations. The scene encompasses an area of 170 kilometres north-south by 183 kilometres east-west (106 mi by 114 mi). Additionally, Landsat 4-5 Thematic Mapper (TM) images are composed of seven spectral bands, with Bands 1–5 having a spatial resolution of 30 metres. The spatial resolution of Band 6 (thermal infrared) is 120 metres, although it is resampled to 30-meter pixels. The landscape spans around 170 kilometres (106 miles) north-south by 183 kilometres (114 miles) east-west (USGS, 2016).

Table 3.2 Sentinel-2 data specification

Sentinel-2 Bands	Central Wavelength (µm)	Resolution (m)
Band 1 - Coastal aerosol	0.443	60
Band 2 - Blue	0.490	10
Band 3 – Green	0.560	10
Band 4 - Red	0.665	10
Band 5 - Vegetation Red Edge	0.705	20
Band 6 - Vegetation Red Edge	0.740	20
Band 7 - Vegetation Red Edge	0.783	20
Band 8 - NIR	0.842	10
Band 8A - Vegetation Red Edge	0.865	20
Band 9 - Water vapour	0.945	60
Band 10 - SWIR – Cirrus	1.375	60
Band 11 - SWIR	1.610	20
Band 12 - SWIR	2.190	20

(Sources: Hatari labs)

Table 3.3 Landsat 8-9 Operational Land Imager (OLI) data specification

Landsat 8-9	Wavelength (micrometers)	Resolution (meters)
Band 1 - Coastal aerosol	0.43-0.45	30
Band 2 - Blue	0.45-0.51	30
Band 3 - Green	0.53-0.59	30
Band 4 - Red	0.64-0.67	30
Band 5 - Near Infrared (NIR)	0.85-0.88	30
Band 6 - SWIR 1	1.57-1.65	30
Band 7 - SWIR 2	2.11-2.29	30
Band 8 - Panchromatic	0.50-0.68	15
Band 9 - Cirrus	1.36-1.38	30
Band 10 - Thermal Infrared (TIRS) 1	10.6-11.19	100
Band 10 - Thermal Infrared (TIRS) 1	11.50-12.51	100

(Sources: USGS)

Table 3.4 Landsat 7 Enhanced Thematic Mapper Plus (ETM+) data specification

Landsat 7	Wavelength (micrometers)	Resolution (meters)
Band 1	0.45-0.52	30

Band 2	0.52-0.60	30
Band 3	0.63-0.69	30
Band 4	0.77-0.90	30
Band 5	1.55-1.75	30
Band 6	10.40-12.50	60(30)
Band 7	2.09-2.35	30
Band 8	.52-.90	15

(Sources: USGS)

Table 3.5 Landsat 4-5 Thematic Mapper (TM) data specification

Landsat 4-5	Wavelength (micrometers)	Resolution (meters)
Band 1	0.45-0.52	30
Band 2	0.52-0.60	30
Band 3	0.63-0.69	30
Band 4	0.76-0.90	30
Band 5	1.55-1.75	30
Band 6	10.40-12.50	120 (30)
Band 7	2.08-2.35	30

(Sources: USGS)

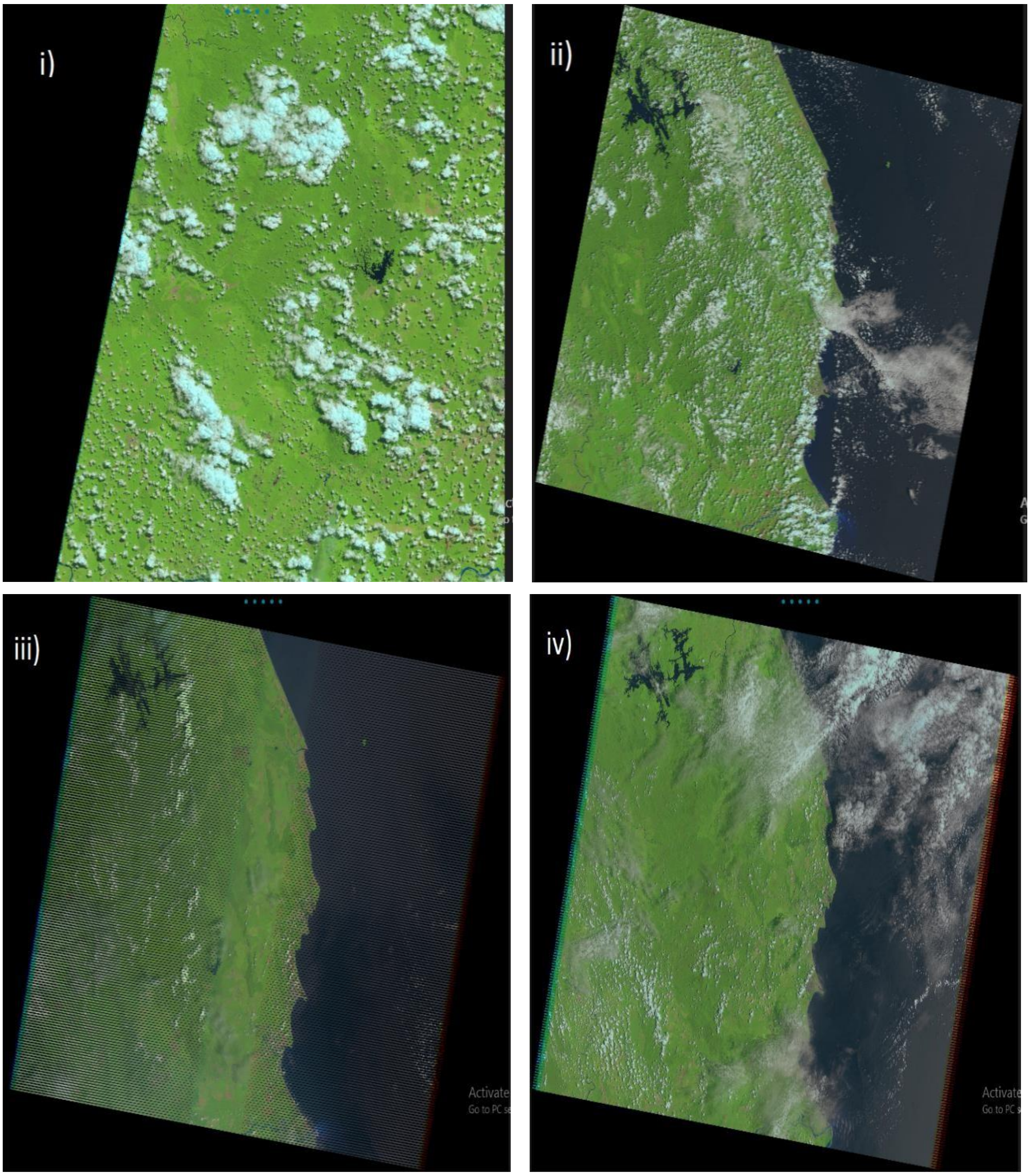


Figure 3.3 Raw image of (i) Sentinel-2 (ii) Landsat 8 OLI (iii) Landsat 7 ETM (iv) Landsat 5 TM for Kuantan area. This images was taken from satellite image supplier.

Table 3.6 Specification of satellite data will be used in this study for Kuantan area

Specification	Sentinel-2	Landsat 8 OLI	Landsat 7 ETM	Landsat 5 TM
Date launched	23rd June 2015	11th Feb 2013	15th April 1999	1st March 1984
Acquisition Date	a) 21st March 2021 b) 21st April 2021	a) 16 Feb 2021 b) 16 April 2021	a) 19 April 2014 b) 19 June 2014	a) 22 September 2007 b) 22 December 2007
Time Acquired	3:26:53 3:39:52	3:21:49 3:22:21	3:19:49 3:20:16	3:14:50 3:15:16
Altitude	786 km	705 km	705 km	705 km
Swath Width	290 km	185 km	185 km	185 km
Spatial Resolution	10-60 m	30 m	30 m	30 m
Temporal Resolution	5 days	16 days	16 days	16 days
Spectral Resolution	11 bands	11 bands	8 bands	7 bands
Orbit Type	Sun-synchronous			

3.4 Data Processing

In this study, the processing step is the most essential stage of the study because it is where all acquired data, both primary and secondary, are combined to create an output that corresponds to the study's purpose and specified specific objectives. Functionally, every data obtained on the ground during site visits was handled in a separate processing section prior to moving on to the next processing element. Similarly, digital data from satellite images and hydrographic will be handled at various points throughout the study. This data processing was synced with a Geographical Information System (GIS) programme for database construction in order to accomplish all of the study's objectives.

3.4.1 ArcMap 10.4

This section provides an overview of ArcMap, the central application of ArcGIS. ArcMap is a geographic information system (GIS) tool that displays and explores GIS datasets relevant to a particular research topic, assigns symbols, and generates map templates for printing or publishing. Additionally, ArcMap serves as the platform for creating and editing datasets. ArcMap visualises geographic data as a collection of layers and other map elements (Esri, 2016). Additionally, the foundation layer is a geographical map, which can be collected from a variety of sources depending on the type of presentation required (satellite, road map, etc). This software enables users to view a huge number of them and also provides live feed layers with traffic information. The first three layers are referred to as feature or vector layers, and each of these layers comprises separate platform-defined functions. These include points such as landmarks and buildings, lines such as highways and other 1D schemata, polygons such as political and spatial census data, which are together referred to as 2D data, and raster images such as a base vector layer such as an aerial photograph (Shaktawat, 2020).

ArcMap is ArcGIS's core function; it is used to perform both standard GIS activities and advanced, user-specific functions. ArcMap performs a variety of activities related to map-related work. It can open and work with ArcMap documents in order to explore data, navigate within existing map documents, toggle layers on and off, query features to get the rich attribute data hidden behind the map, and visualise geographic information (Shaktawat, 2020). Moreover, compiling and editing GIS databases using software such as ArcMap is a beneficial technique for optimising geodatabase datasets (ESRI, 2016). ArcMap supports scalability for full-feature editing. Further, ArcMap includes tools for packaging and sharing GIS data with other users, including maps, layers, geoprocessing models, and geodatabases. This includes the ability to share maps and data from geographic information systems (GIS) via ArcGIS Online (Esri, 2016).

3.4.2 Google Earth Pro

Google Earth Pro enables visualize, evaluate, overlay, and create geospatial data. This approachable resource is often a valuable intermediary for those interested in learning more about GIS and wish to begin with more fundamental processes and resources (Ottawa, 2021). Additionally, the Google Earth Pro offers all the easy-to-use functionality and detailed images of Google Earth, along with advanced tools for measuring area, range, length and 3D buildings, printing high resolution images, importing address tablets and instantly viewing point maps with batch geocoding and creating custom videos with the filmmaker function (Ngucha, 2021). Besides that, google earth pro very helpful to produce automatically geo-locate geographic information system (GIS) images. It also helps in environmental management by view historical and contemporary imagery of significant locations, particularly remote areas, to aid in environmental planning and recovery planning, including the following such as view of historical images to evaluate soil disturbance areas and vegetation coverage shifts. Furthermore, viewing proximity of sensitive areas to proposed activities/projects. Google Earth pro includes software for quickly measuring distances and areas around points of interest, such as wetlands (Ngucha, 2021).

3.5 Spatial Analysis

After the data processing completed, the process was through to spatial analysis which the processed of modelling a problem or issue geographically, deriving results through computer processing, and then analysing and interpreting those model results (Brown et al.2017). This technique has been shown to be extremely successful for assessing the geographic suitability of specific locations for specific purposes, estimating and forecasting outcomes, interpreting and comprehending change, and detecting significant trends concealed within this research, among other things (Esri , 2018) Furthermore, beyond mapping, spatial analysis enables the study of the characteristics of places and their relationships. Spatial analysis enlightens the decision-making.

By combining data from multiple sources and applying a collection of spatial operators, spatial analysis may combine data from numerous sources and generate new data. This array of spatial analysis techniques enables to tackle the most difficult spatial problems. Statistical analysis can be used to determine the relevance of observed patterns, to analyse many layers to determine the suitability of a place for a certain operation, and to discover changes over time using picture analysis. These techniques enable the evaluation of complex topics and judgments that are beyond the scope of basic visual inspection (Esri, 2018). Additionally, spatial analysis aids in the generation of demand for Flood Risk and Human-Wildlife Conflict distribution through the use of Geographic Information Systems (GIS) and Digital Evaluation Models (DEM).

3.5.1 Geographic Information System (GIS)

A geographic information system (GIS) is a database management system that enables the gathering, management, and analysis of data. GIS is a geographic information system (GIS) that combines many data kinds. Through the use of maps and 3D sceneries, it analyses spatial position and organises data layers into visualisations. Due to GIS's unique potential, it can provide users with greater insights into data, such as patterns, relationships, and conditions, in order to assist them in making more informed decisions (Esri, 2016). Besides that, Geographic information systems (GIS) are a science and a technology. It is built on the simple principle of arranging data into different layers that are spatially referenced (georeferenced). Additionally, geographic datasets are represented in GIS as a series of intricate, stacking map layers spanning a specific area (area). These layers are capable of representing virtually any item (fixed or moving), boundary, event, or spatial phenomenon. Moreover, Earth-based georeferenced information layers are the main characteristic of GIS that allow the display, combination, and analysis of different types of data in the popular geographic space (Brown et al.2017).

Other than that, things that a map layer is capable of representing which are building, roads, parks, trees, vegetation health, utility networks, demographic data and satellite imaginary.

3.6 Rain fall Data

The data that was used in this process is Tropical Rainfall Measuring Mission (TRMM). TRMM is a NASA-Japan National Space Development Agency collaborative space mission designed to monitor and research tropical and subtropical precipitation and the related energy release. Besides, this data was used to analysed in terms of monthly and yearly average of rainfall. Furthermore, an important measure in the analysis of rainfall data is to study the variability in the rainfall. The data was taken from December 2020 until November 2021. The pixel results for TRMM rain data are 16 bits.

3.7 Digital Elevation Model Elevation Assessment

In this study, digital elevation model (DEM) serves as the major input for hydrological modelling, which is used to generate flood hazard maps. The precision with which watersheds are calculated is directly connected to the scale and precision of topographic maps (Elkhrachy, 2015). As a result, it employed a single resolution DEM from the Shuttle Radar Topography Mission (SRTM). Additionally, the data sets were analysed and flow directions were calculated. A worldwide SRTM 1 arc-second image with a resolution of 30 metres was retrieved from the website (SRTM source).

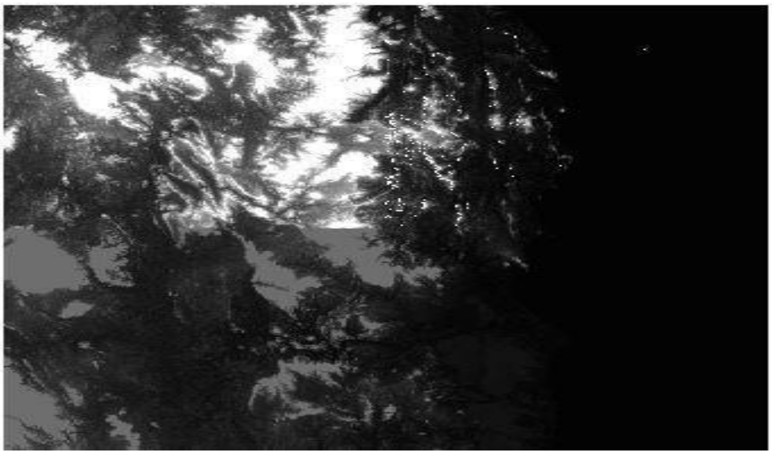


Figure 3.4 Raw digital elevation models of the study area

3.8 Hydrology Flow

Table 3.7 Types and function of hydrology flow

Types	Function
Fill Sinks	Fill Sink is a function that modifies the elevation value in order to eliminate the issues associated with filling these grids.
Basin	These basins are defined inside the analysis frame by detecting ridge lines between basins.
Flow Direction	The process of understanding the direction of flow from each cell in the raster is critical for obtaining hydrologic parameters of a surface.
Flow Accumulation	This function generated by calculating the flow direction. The flow accumulation value for each cell is determined by the number of cells that pass through it at Kuantan district.
Stream Links	The sections of a stream channel that connected the two subsequent junctions, a junction and the outflow, or a junction and the drainage division are referred to as links. It provides a unique identification for a raster linear network between intersections.
Stream Order	Stream order help to allocates a number order to segments of a raster showing linear network branches.
Watershed	A watershed is an upslope area that supplies water to store and transports it from the land surface to a body of water and eventually to the ocean.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, all data obtained is processed whereas qualitative & quantitative data collected is displayed using tables, graphs, maps, and descriptive explanation. The results section will show the results output to answer the objectives in the first chapter. The first discussed about flood risk map. The next part is discussed about the Human Wildlife Conflict. Then, with these results obtained it discuss indeed in this chapter. Accuracy assessment tables, graphs and maps presented in this chapter has successfully achieved objectives of the study.

4.2 Pre-processing Results

The results of pre-processing are described in this section. Satellite images were subsets in order to focus on study areas. For Kuantan district, high resolution such as SRTM 1 arc-second was used for DEM in this study. The map projection used is Kertau (RSO)/RSO Malaya (m)-EPSG: 3168. Furthermore, the DEM was clipping by referring to Kuantan district and it was clipping by using Arcmap 10.8. In figure 4.1 shown the DEM that had been clipped to Kuantan district.

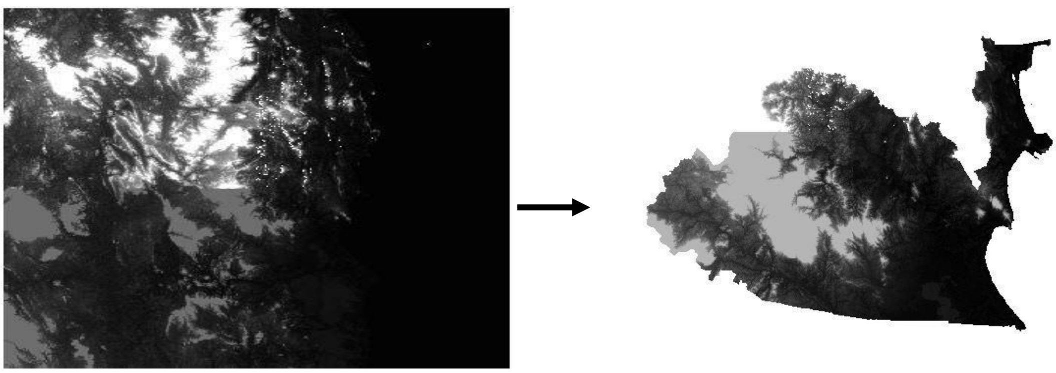


Figure 4.1 Raw digital elevation model was clipped referring to Kuantan district

4.3 Processing

4.3.1 Flood Risk Map for Kuantan District

4.3.2 Hydrology Flow

The hydrological modelling tools proposed by spatial analysis provide methods for describing the physical components of a surface or basin This mapping was covered Kuantan district and the map was generated by using hydrology tool in ArcMap 10.8. Besides, A water system model was created by using digital elevation model (DEM) raster. This procedure was designed to establish hydrological properties, simulate surface hydrological processes, and estimate future surface hydrological conditions. Although raster analysis is used to generate data on the DEM, the fill sink, the basin, the flow direction, the flow accumulation, the stream link, the stream order, and the watershed.

Fill sinks was shown in the map which are high value is 1483 and low is 0. The high value spotted at North side of Kuantan. Next, the basin was categorized into 5 basin and 19 sub-basin that covered Kuantan. The largest basin was green colour that covered north side of Kuantan district. For the direction of flow from each cell to its neighbour with the steepest slope, which has a value between 1 and 255. The cells flow toward their nearest neighbour in one of eight compass directions represented by the coordinates East = 1, SE = 2, S = 4, SW = 8, W = 16, NW = 32, N=64, and NE=128. Besides, the flow accumulation generated 11-120 runoff flow at Kuantan district.

Furthermore, stream link generated the outlet of flow which is the value was 1-159. Meanwhile, the stream order was classified into 4 group. The red colour represents of primary river, blue colour for secondary river, the yellow colour for tertiary river and the grey colour represents others river. Eventually, based on the results in the watershed map, Kuantan district covers around 19 watersheds. The largest watershed is a grey colour which is located at west side of Kuantan.

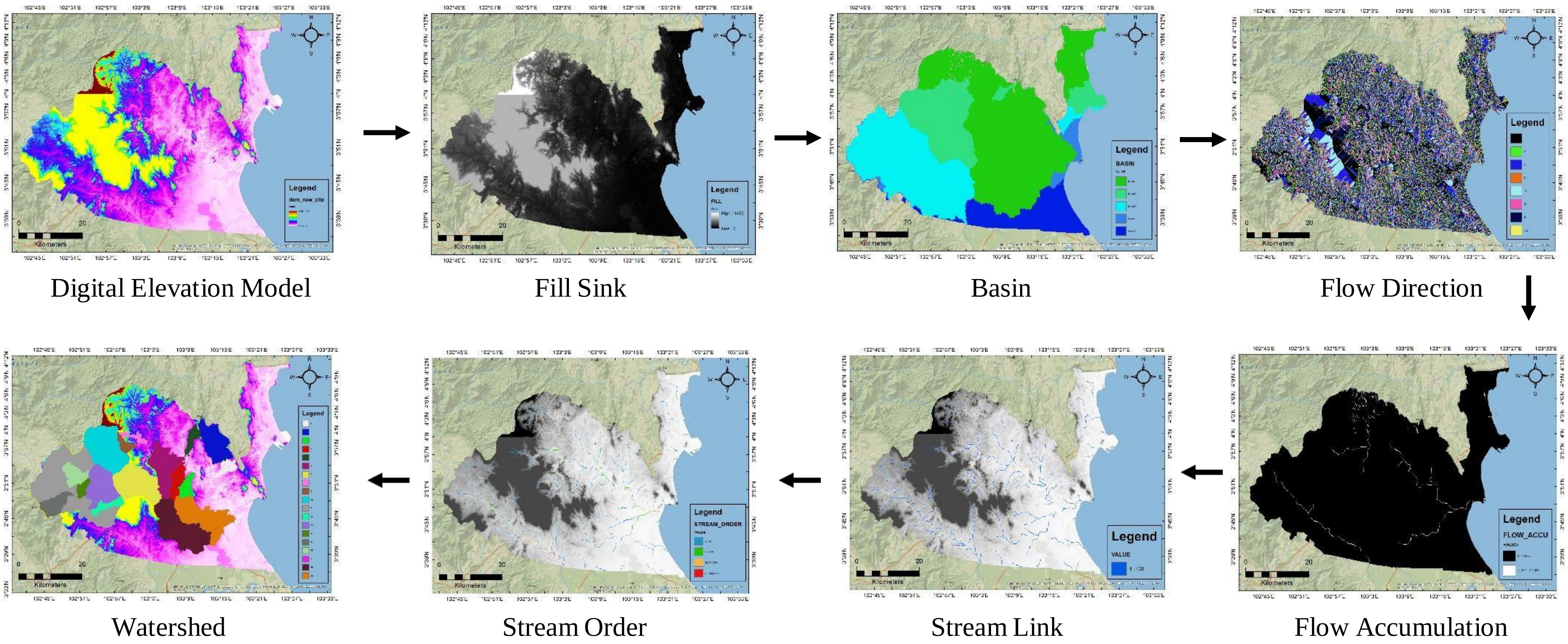


Figure 4.2 Different type of flow maps that was extracted by Hydrology tools.

4.3.3 Satellite images for precipitation

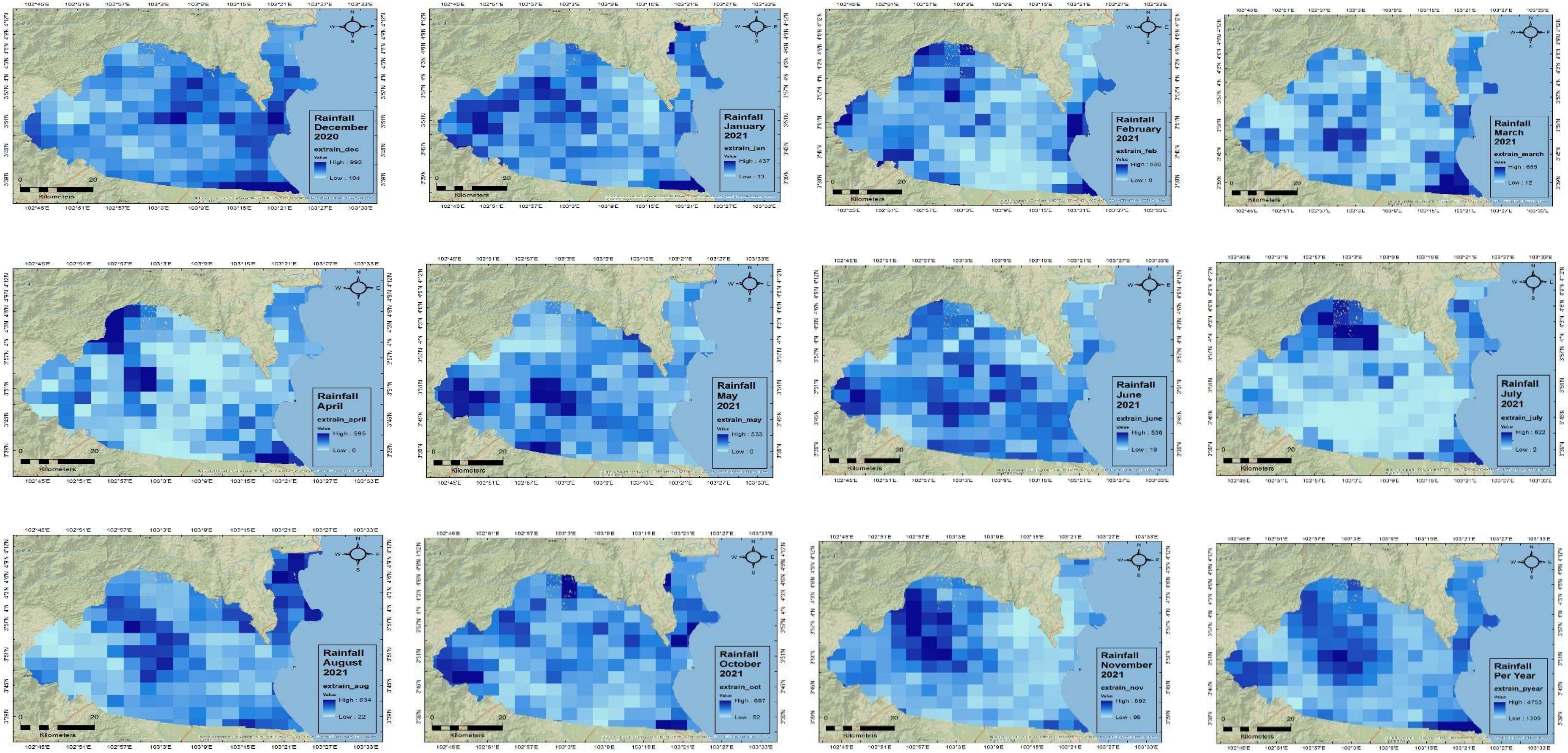


Figure 4.3 Maps of monthly rainfall data from December 2020 until November 2021 and average annual rainfall map

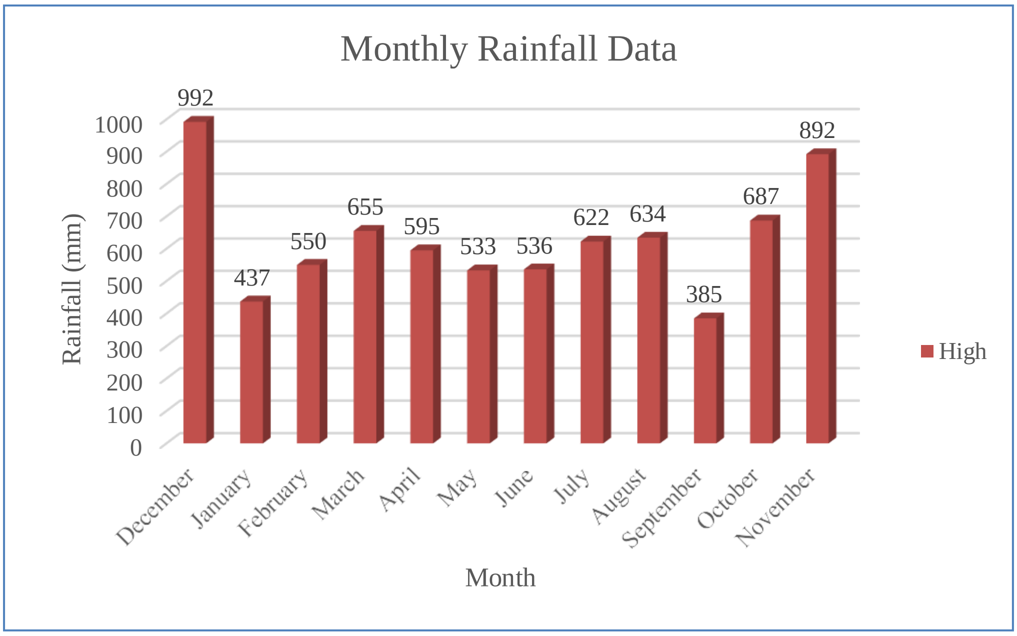


Figure 4.4 Monthly rainfall data value

According to the figure 4.4, the rainfall data was taken from December 2020 until November 2021 and average annual rainfall. The rain fall data was covered area Kuantan district. The highest value of rainfall data was represented by dark blue colour. Based on the figure 4.4, the highest value of rainfall was December 2020 which is 992 mm. Besides, highest rainfall on 2021 was followed by November 2021 which is 892 mm and the lowest of rainfall data in September which is 385 mm. Basically, monsoon season started on the end of the year which is November to March.

4.3.4 Data input of Analytical Hierarchy Process (AHP)

4.3.4.1 Topographical map

In this section, the topographical was used is digital elevation model. This mapping was cover Kuantan district. Based on the results, the high value of DEM is 1483 and low value is -2. The highest value of digital elevation model at the North side of Kuantan district.

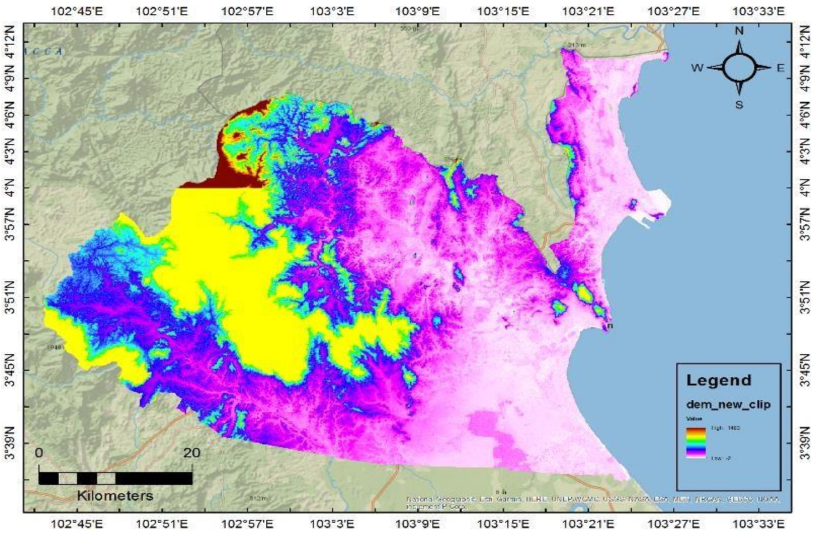


Figure 4.5 Digital elevation model of Kuantan District.

4.3.4.2 Slope mapping using DEM SRTM

At each cell, the Slope tool determines the steepness of a raster surface. The slope value represents the slope of the terrain, and the steepness of the terrain is indicated by the slope value. As a result, the slope map supports the prevalence of platform structures in the Kuantan District, as indicated by the map's green to blue colour. In Figure 4.6, the green colour indicates low terrain (0-13), whereas the red colour indicates high terrain (331-554). The area north of Kuantan district was covered by high terrain. (331-554).

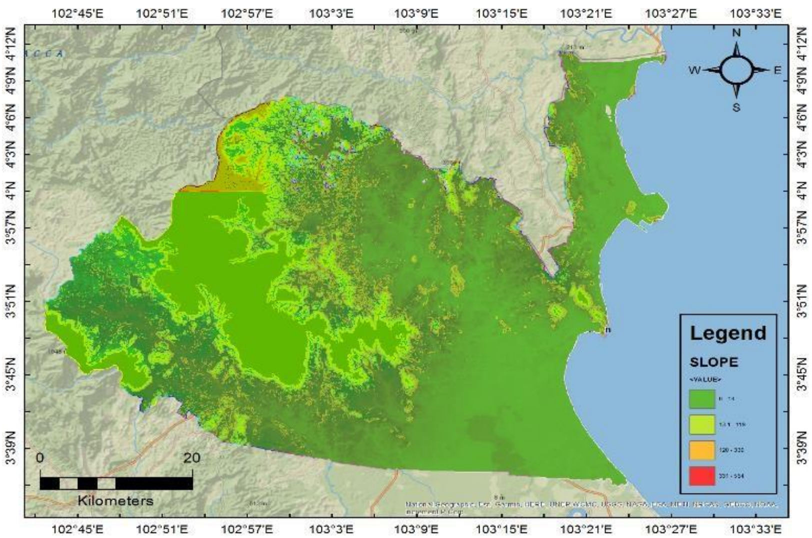


Figure 4.6 Slope Map

This map was used as data input of Analytical Hierarchy Process (AHP). Data used for this rainfall per year is Tropical Rainfall Measuring Mission (TRMM). According to the map below, the high precipitation is dark blue colour (4753 mm) and the low precipitation is light blue (1309 mm). Based on the result, the highest precipitation was cover at the South side of Kuantan district which is Tanjung Lumpur area.

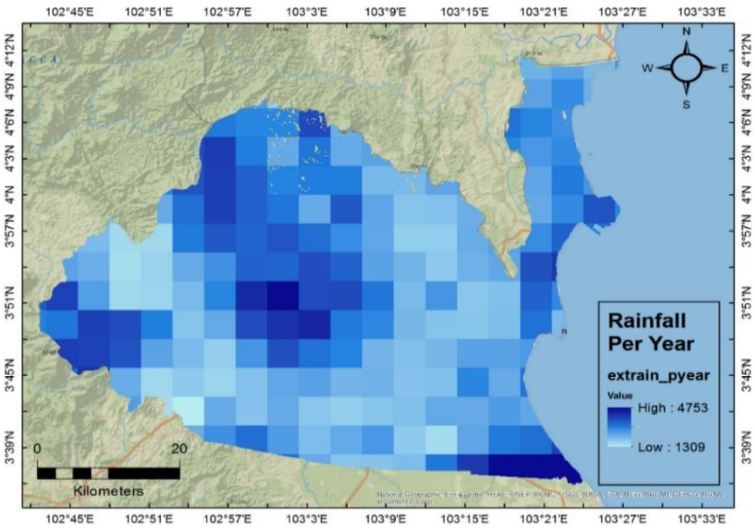


Figure 4.7 Precipitation map per year

4.3.4.3 Soil map

The soil was cover area Kuantan district and it was categorized into 5 types of soil which are cherrywood brown (dystric histosols), raw umber colour (thionic fluvisols), olivenite green (rhodic ferralsol), spruce green (orthic acrisols) and dark green (ferric acrisols).

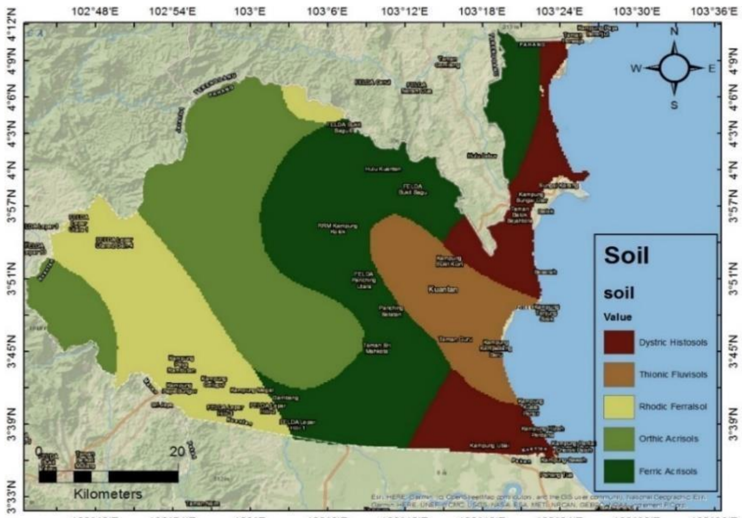
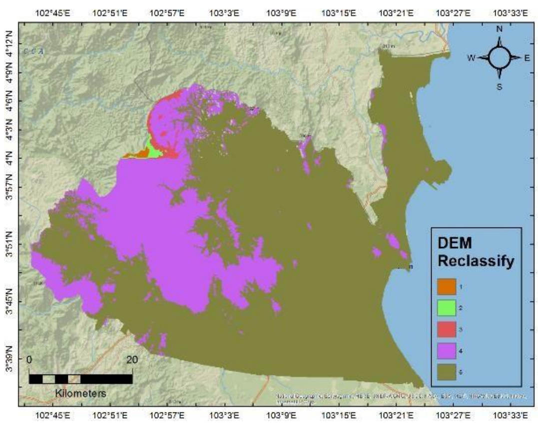


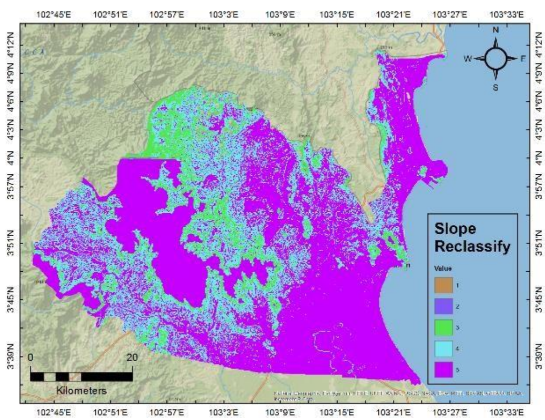
Figure 4.8 Soil map in Kuantan district

4.5 Reclassify and resampling of raster dataset

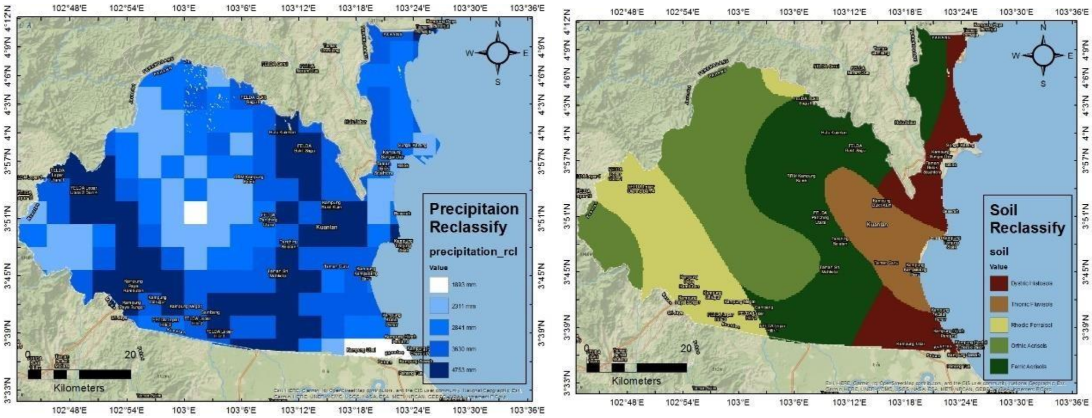
Reclassification is the process of assigning new output values to individual values or groups of values using alternative fields; based on a given interval (for example, divide the values into ten intervals); or by area. The tools are intended to make it simple to modify a large number of values in an input raster to desired, specified, or alternate values. This method is important for analytical hierarchy process (AHP) due to calculate the weighted of combined datasets.



Digital Elevation Model



Slope



Percipitation Soil

Figure 4.9 4 types of maps has been reclassified to obtain new output values

4.6 Analytical Hierarchy Process for flood risk analysis

In this section, after constructing a pairwise comparison matrix, an analytical hierarchy approach was employed to determine the relative significance of the relevant components (Seejata et al., 2018). The weights assigned to each parameter are defined after variables have been rated in order of relative relevance. The relative relevance rating scale has been set to 1 to 9, with lower values suggesting less importance and higher values indicating substantially greater importance.

Table 1 illustrates the pairwise comparison matrix using a 4 x 4 matrix with diagonal components equal to 1. Each row's values are compared to each column's values to determine the row's relative relevance and thus the rating score. Furthermore, AHP incorporates precipitation, slope, soil, and a digital elevation model. Precipitation is substantially more essential than slope, as indicated in Table 4.1, and hence gave the number 8.

Table 4.1 Parameter for flood risk in AHP

	precipitation_rcl	slope_rcl	soil	dem_rcl
precipitation_rcl	1	8	4	3
slope_rcl	.125	1	3	3
soil	.25	.333	1	2
dem_rcl	.333	.333	.5	1

Therefore, precipitation is the most critical factor in determining the likelihood of a flood disaster. Increased rainfall typically raises the likelihood of flooding in areas where other characteristics may be relevant. Average rainfall from 2020-2021 was used in this process and covered Kuantan district. Next, the slope was determined to be the second critical feature in the AHP weighting score. The redefined slope was divided into five categories, with flat areas connected with lower slope areas that are typically prone to flooding. Naturally, slope characteristics are comparable to those of a DEM. The area with the lowest slope and elevation is assigned the highest risk level, suggesting that it is more exposed to flood dangers. Additionally, soil permeability is a critical element in flood-prone areas. These soil types are reclassified into five classes namely dystric histosols, thionic fluvisols, rhodic ferralsol, orthic acrisols, and ferric acrisols.

4.7 Flood Risk Map from AHP

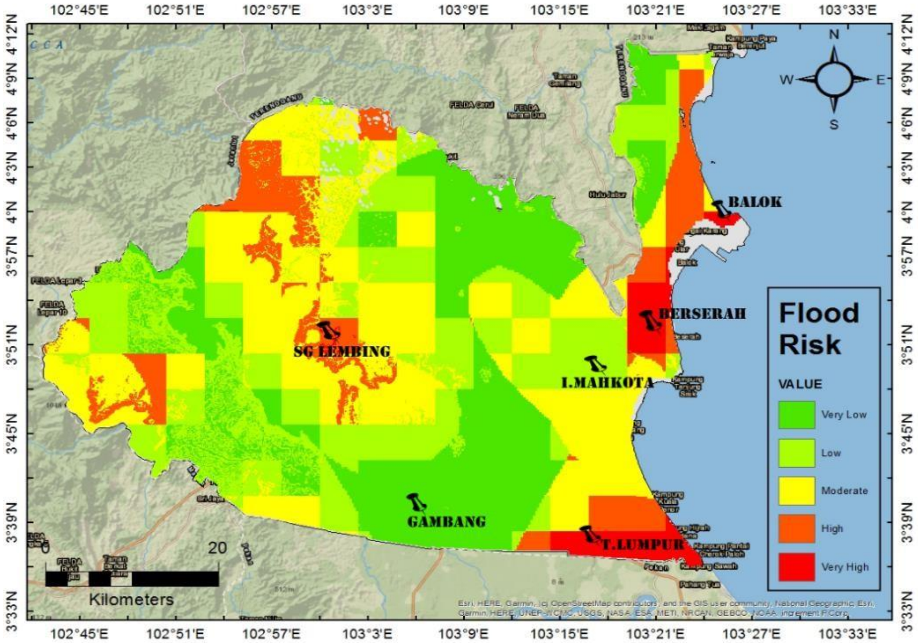


Figure 4.10 Flood risk map from AHP

Based on the Figure 4.10, this map illustrates the flood pattern influenced by precipitation parameters as a result of the high weight assigned during the AHP method. The selected four factors which are precipitation, slope, soil, and DEM have been weighted to be used in AHP which to produces flood risk map. Besides, it has been categorized in five levels of risk classes which are very low, low, moderate, high, and very high zones of flood. The results show that the very high flood areas were cover Tanjung Lumpur, Berserah and Balok. From this study, area that very vulnerable to flooding was successfully identified due to geographical characteristic of the country, rainfall, overflows river and low surface slope.

4.8 Human Wildlife Conflict for Kuantan District

In this study, GIS and remote sensing is applied to analysis of HWC data. The outcome reveals that this method has excellent potential for understanding HWC in Kuantan district and next part will discuss in detail on this aspect. All recorded animal in table displays various size of animal from medium to large mammal or reptile such as Asian lizard monitor water, civet, tapir, snake and monkey. It reveals high chance of certain animal species exposed to HWC in Kuantan area. Casualties was documented involving at least four species including Asian lizard monitor water, civet, tapir and snake.

Table 4.2 Type of animal, locations and images of evident

No	Type of Animal	Location	Images
1	Asian lizard monitor water (1)	Gambang Lat: 3°42'14.65"N Lon:103°3'35.69"E	
2	Asian lizard monitor water (1)	Gambang Damai Lat: 3°42'0.72"N Lon: 103° 3'2.25"E	
3	Asian lizard monitor water (1)	Teluk Cempedak Lat: 3°48'51.81"N Lon: 103°22'19.46"E	
4	Civet (1)	Gambang Lat: 3°42'18.86"N Lon: 103° 3'40.50"E	

5	Blue Malayan coral snake (1)	Perumahan Makmur Gambang Jaya 1 Lat: 3°42'40.82"N Lon: 103°6'20.62"E	
6	Cobra Snake (1)	Gambang Lat: 3°42'48.79"N Lon: 103° 4'29.26"E	
7	Phyton Snake (1)	Teluk Cempedak Lat: 3°48'51.85"N Lon: 103°22'19.60"E	
8	Tapir (1)	Highway LPT-Gambang Lat: 3°44'52.23"N Lon: 103° 7'18.78"E	
9	Tapir (1)	Ladang Gambang Lat: 3°44'52.23"N Lon: 103° 7'18.78"E	

10	Tapir (2)	Perumahan Bukit Rangin Lat: 3°48'15.40"N Lon: 103°15'23.11"E	
11	Monkey (8)	Masjid Gambang Lat:3°42'24.46"N Lon: 103° 6'50.96"E	
12	Monkey (6)	Taman Bandar Kuantan Lat:3°50'7.73"N Lon: 103°17'47.71"E	
13	Monkey (3)	Balok Lat: 3°59'19.58"N Lon: 103°20'35.98"E	
14	Monkey (15)	Teluk Cempedak Lat: 3°48'51.92"N Lon: 103°22'19.76"E	

15	Monkey (3)	Jalan Gambang Lat:3°42'50.10"N Lon: 103° 1'56.73"E	
16	Monkey (7)	Damansara Kuantan Lat:3°53'42.61"N Lon:103°20'14.85"E	

4.8.1 Google Earth Pro on HWC map

In this section, google earth pro was using to add placemark of animal found in public area and casualty. This process was helping to locate the longitude and latitude of the animal area. After all data was collected, it was export to Arcmap tools.

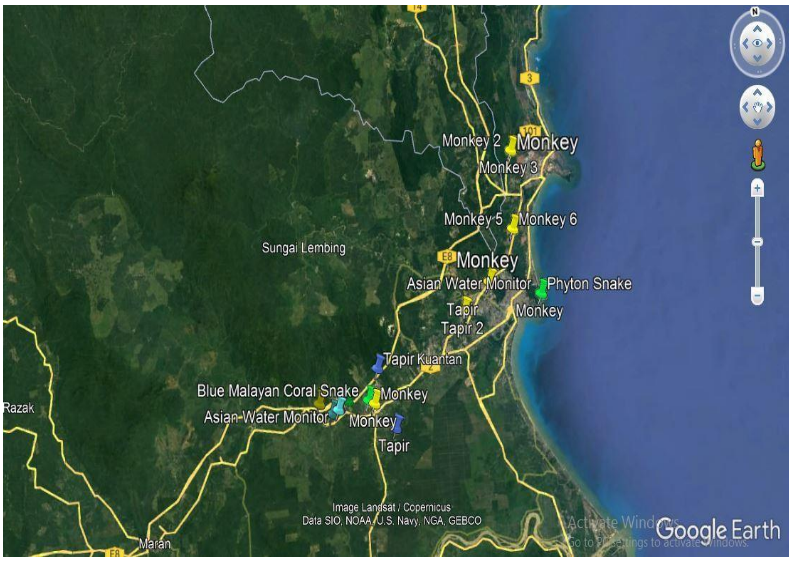


Figure 4.11 Pin animal landmark in google earth pro

4.8.2 Reclassify Kernel Density for HWC map

In this section, kernel density was used to calculates the density of wildlife habitat in Kuantan district. Kernel density estimation is a commonly used approach in spatial analysis for converting sets of geographically dispersed data to dense clusters inside a GIS environment. According to the figure 4.12, the kernel density was reclassified into 5 categories which are very high (red), high (orange), moderate (yellow), low (light green) and very low (green). The value show that the east sides of Kuantan district have highest value of kernel density. Besides, the red colour was covered Teluk Cempedak, Kuantan.

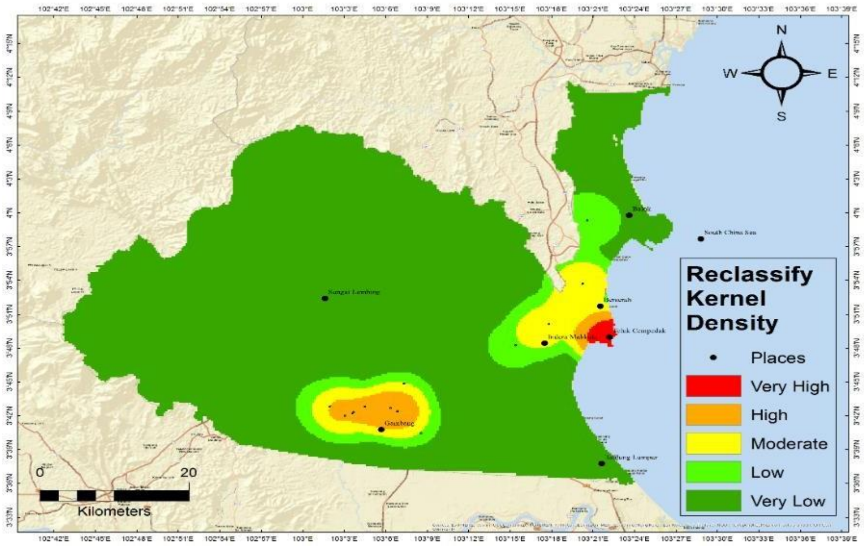


Figure 4.12 Reclassify kernel density map

4.8.3 Human Wildlife Conflict map from NDVI combination

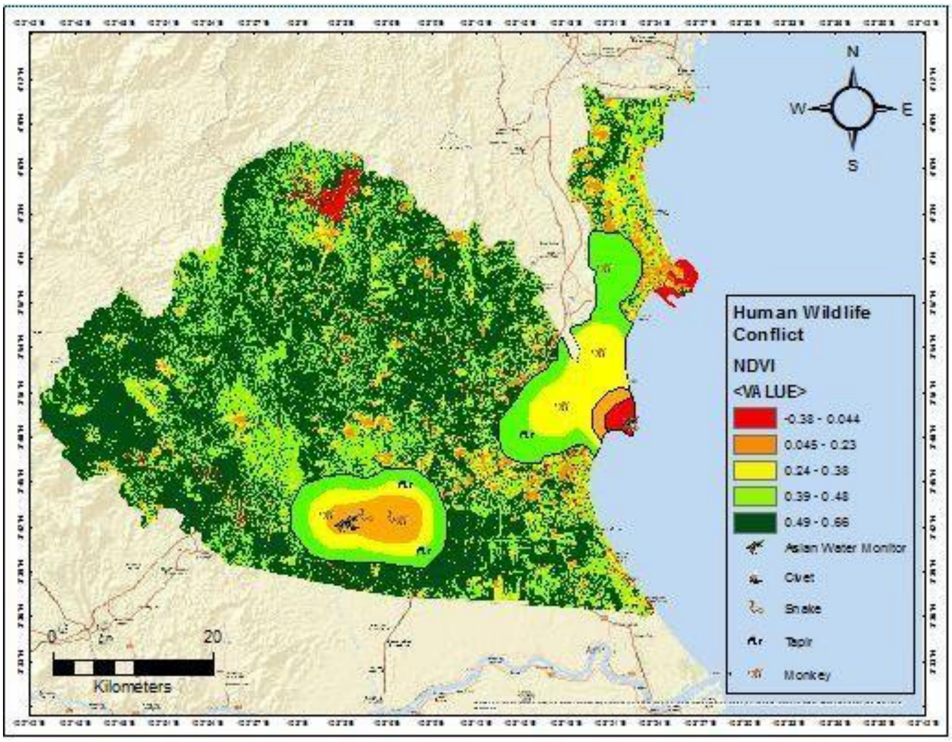


Figure 4.13 HWC map from NDVI combination

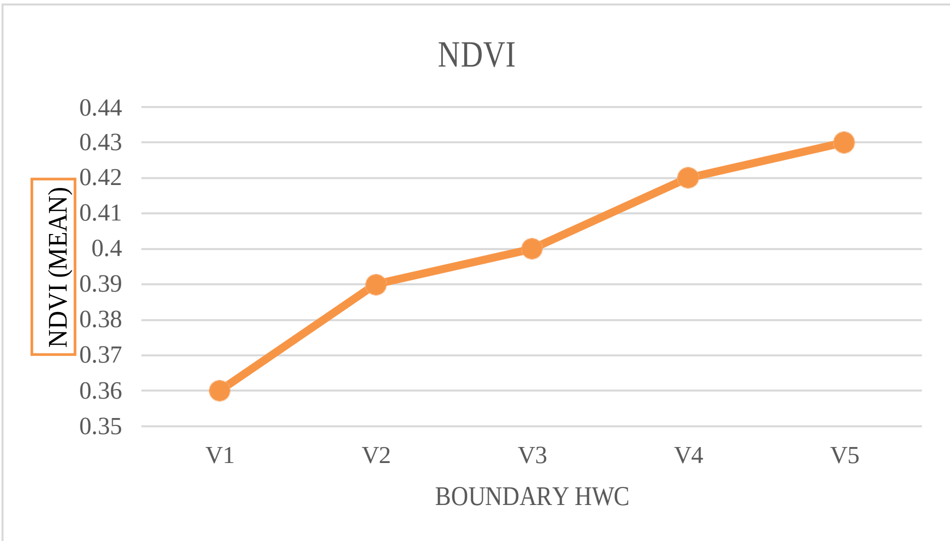


Figure 4.14 Combination of NDVI and Boundary HWC

Based on the Figure 4.12, this map was generated to identify of hotspot of HWC in Kuantan district and types of animals involved in casualty. According to the map outcome, this map is regressed with Normalized difference vegetation index (NDVI) value that produced from red and near infrared band of Landsat. Besides, the buffer zones were generated by using kernel density tools and there are 5 categories of HWC hotspots which consists ofvery high (red), high(orange), moderate (yellow), low (light green) and very low (dark green). Furthermore, all recorded animal in Kuantan district shows different size of animal from medium to large mammal or reptile such as asian water monitor, civet, snake, tapir and monkey. Indirectly, this result was recorded in 2021. Based on the results, the highest hotspot was recorded at east side of Kuantan district which is Teluk Cempedak area.

CHAPTER 5

CONCLUSION

5.1 Introduction

The study involves an efficient methodology to accurately delineate the flood risk map and human wildlife conflict map. The flood risk map was using 1 arc second global for digital elevation model. Besides, the human wildlife conflict data was collected by using conventional approach techniques. Thus, ArcMap tools are used to extract the hydrological process and human wildlife conflict process for the study area. Moreover, it was carried out in Kuantan district, Pahang. From this study, the following conclusion are summarized:

i. The final flood risk map was constructed by integrating hydrological characteristics such as precipitation, soil, slope, and digital elevation model in Analytical Hierarchy Process (AHP).
ii. Using various data inputs for AHP execution from GIS technology, flood risk map of Kuantan district has been generated where a total of 25% of Kuantan area was indicated as the most vulnerable zone for flood hazard, 40% moderate risk and 35% identified as low risk zone. This flood risk map provides a crucial improvement of flood control strategies and preparing an evacuation plan.
iii. The buffer zones of human wildlife conflict were generated by using kernel density tools and there are 5 categories of hotspot. All recorded animal in Kuantan district shows different size of animal from medium to large mammal or reptile such as Asian water monitor, civet, snake, tapir and monkey.
iv. The combination of NDVI and HWC is important because the highest vegetation index, the lowest human wildlife conflict occur. Thus, the location with the highest vegetation index was selected as green corridor.

5.2 Recommendation

The following recommendation are made for future studies:

i. Higher volume of field-based data for GI, HWC and flood-affected area using drone technology for improvement of result's accuracy without interruption of MCO due to the pandemic season of Covid-19.

ii. Availability of higher spatial resolution of commercial satellite imageries, rainfall satellite data and digital elevation data which typically needs high expenditure.

iii. Pool of ground-based data sharing by relevant agencies including precipitation data and soil types to construct robustness of RS-GIS approach in achieving all objectives of study.

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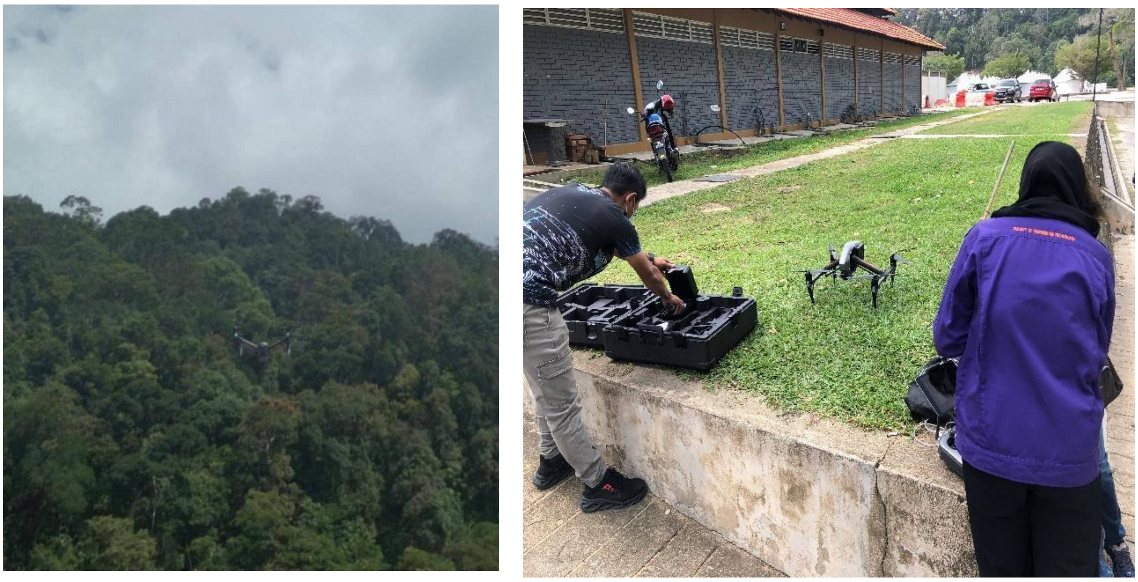
APPENDICES

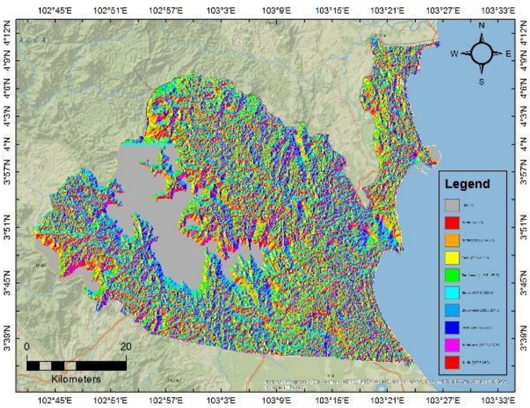
Appendix A: Data collection from site visit

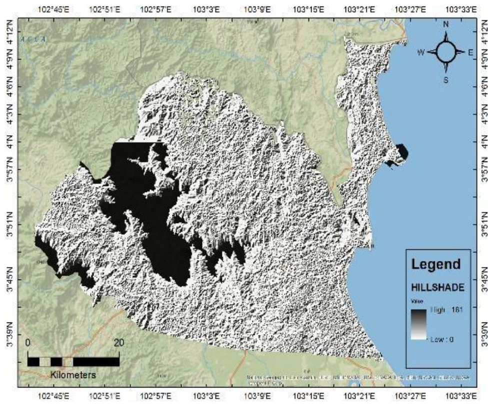


Site visit at Teluk Cempedak and Sungai Lembing for data collection by using drone

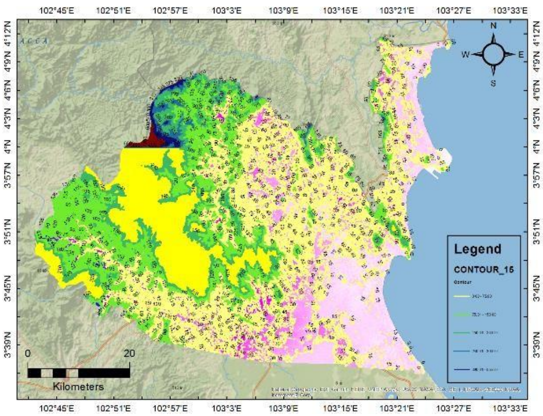
Landslide data collected at Sungai Lembing

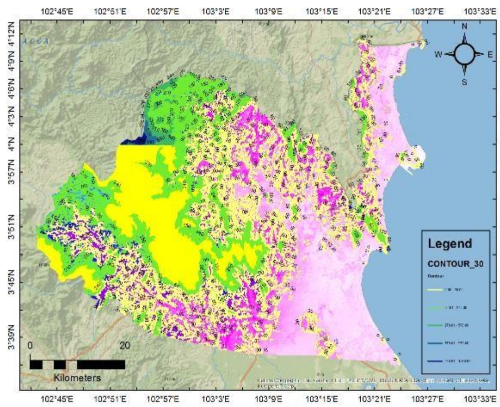
Appendix B: Generating map by using ArcGIS tools in Flood risk map



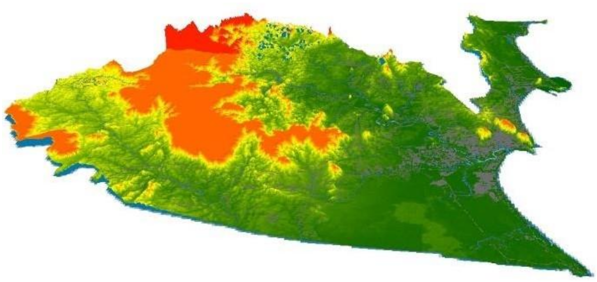


Aspect and hillshade maps was generated in flood risk map





Contour 15 and 30 maps was generated in flood risk map



Flood risk simulation in 3D was created by using Arcscene