IMPLEMENTATION OF GIS TECHNIQUES IN MAPPING THE CHARACTERISTICS OF TEMPERAH AND TUI RIVER'S CATCHMENT

NURUL FARHANA BINTI AB MANAF

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Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

Tui River's catchment and Temperah River's catchment are located in Lipis District, Pahang. In 2013, the flash floods occur in several villages. It was because the mining activities near the area, causing Tui River overflow quickly when there is heavy rainfall. It was also due to the blockage of drainage. It causes a lot of damages to houses and structures. Some of residences submerged due to flood as examples some population places near to Temperah River are Kampung Kembuai, Kampung Paya Bah, Kampung Paya Tada and Kampung Temperah. During flood, residents moved to evacuation centres for flood victims. Flood destroys the property and structures that cause residents suffered losses. Implementation of Geographic Information System (GIS) techniques in mapping the characteristics of Temperah and Tui River's catchment was a process to identify the characteristics of the catchments as a first step of flood mitigations project. The objectives of this research were mapping the area and land used in Tui River's catchment and Temperah River's catchment by using Geographical Information System (GIS) and identify the characteristics at Tui River's catchment and Temperah River's catchment, Lipis. This research was important to give initial information of characteristics of catchment to the local authorities such as Department of Irrigation and Drainage. The catchments was mapped using ArcMap 9.3 version. The characteristics of catchment that have been considered were the type of land use, type of soil in the catchment and the elevation of the catchments. Based on the result, the type of soil for both catchment were sandy clay loam, clay loam, silt loam and mining land which are medium soil in term of proportion of particles. They also have very low infiltration rates when thoroughly wetted. That is why some flood mitigation projects need to be done to overcome flood problem.

ABSTRAK

Kawasan tadahan Sungai Tui dan Sungai Temperah terletak di Daerah Lipis, Pahang. Pada tahun 2013, banjir kilat berlaku di beberapa kampung. Ia adalah kerana aktiviti-aktiviti perlombongan berhampiran kawasan itu, menyebabkan Tui Sungai limpahan dengan cepat apabila terdapat hujan lebat. Ia juga adalah disebabkan oleh penyumbatan saliran. Ia menyebabkan banyak kerosakan kepada rumah-rumah dan struktur awam. Beberapa kediaman tenggelam akibat banjir sebagai contoh, penduduk berhampiran Sungai Temperah ialah Kampung Kembuai, Kampung Paya Bah, Kampung Paya Tada dan Kampung Temperah. Semasa banjir, penduduk dipindahkan ke pusat pemindahan mangsa banjir. Banjir memusnahkan harta dan struktur yang menyebabkan penduduk mengalami kerugian. Pelaksanaan pemetaan ciri-ciri kawasan tadahan Temperah dan Tui menggunakan Sistem Maklumat Geografi (GIS) teknik adalah satu proses untuk mengenal pasti ciri-ciri kawasan tadahan sebagai langkah pertama projek mengurangkan kadar banjir. Objektif kajian ini ialah memetakan kawasan dan tanah yang digunakan di kawasan tadahan Sungai Tui dan Sungai Temperah dengan menggunakan Sistem Maklumat Geografi (GIS) dan mengenal pasti ciri-ciri kawasan tadahan Sungai Tui dan Sungai Temperah, Lipis. Kajian ini adalah penting untuk memberi maklumat awal tentang ciri-ciri kawasan tadahan kepada pihak berkuasa tempatan seperti Jabatan Pengairan dan Saliran. Kawasan tadahan telah dipetakan menggunakan ArcMap 9.3. Ciri-ciri kawasan tadahan yang telah dianalisis adalah jenis penggunaan tanah, jenis tanah di kawasan tadahan dan ketinggian kawasan tadahan. Berdasarkan keputusan, jenis tanah untuk kedua-dua kawasan tadahan ialah lempung berpasir tanah liat, tanah liat gembur, tanah liat dan kelodak tanah lombong yang berada di dalam kategori tanah sederhana dari segi perkadaran zarah. Tanah ini juga mempunyai kadar penyusupan yang sangat rendah apabila dibasahkan dengan teliti. Itulah sebabnya beberapa projek tebatan banjir perlu dilakukan untuk mengatasi masalah banjir.

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Symbol	Item
MASMA	Manual Saliran Mesra Alam
GIS	Geographic Information Sytem
SMART	Kuala Lumpur. Storm water Management and Road Tunnel

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Land use and land management practices have a major impact on natural resources including water, soil, nutrients, plants and animals. Land use information can be used to develop solutions for natural resource management issues such as salinity and water quality. For instance, water bodies in a region that has been deforested or having erosion will have different water quality than those in areas that are forested. Forest gardening which is a plant-based food production system is believed to be the oldest form of land use in the world. Land use can give some impact to environment, for example, the development or any activities that disturb watershed can affect an area and may cause flooding in the area. Flood is an overflow of water that submerges land which is usually dry. It also defines as a covering by water of land not normally covered by water. Flooding may occur as an overflow of water from water bodies such as river and lake. It also may occur due to excessive rainwater on saturated ground in areal flood. Flood is a major natural disaster to human and environment. The impact of flood can be more significant as it endanger human, animal life and cause economic losses where it cause damages to any type of structures and things such as bridges, canals, cars, building, sewer system and

roadways (Smith & Ward, 1999). Even worse, it also can cause human and livestock die due to drowning and can also lead to disease.

Flood is frequently happen in Malaysia especially during monsoon season. Malaysia covers the population about 26 millions of people and area of about 330,000km^2. The average annual rainfall is estimated at 3,000 mm and relative humidity is about 80% (Zainab Hashim, 2010). Mitigation is the cornerstone of emergency management. It is on-going effort to lessen the impact of disasters on people and property. The non-structural methods of mitigation of flood hazards are less expensive as compared to structural ones which are dams and dikes. Among non-structural methods, modern flood forecasting and data collection systems have grown favour in countries prone to flood hazard. However, flood mitigation and control in Malaysia are disintegrated and systems not available to be used for flood monitoring, mitigation and control. The development of system for flood mapping and risk assessment requires a proper planning in flood database design and developments. This is the major role of Geographic Information System (GIS) to be used as tool for flood modelling and analysis on various issues related to flood mitigation. There are several data will involve in this research. GIS can provide innovative solution to flood mitigation. It is a tools that allows users to create interactive queries, analyse the spatial data, edit data and present the results of all information.

1.2 PROBLEM STATEMENT

Lipis is a district located in north-west of Pahang, Malaysia. The district covers an area of 5,198km^2. Lipis is bordered by Cameron Highlands and Perak on the west, Jerantut on the east, Kelantan and Raub on the north and south, respectively. The largest sub district in Lipis is Ulu Jelai. The district capital is Kuala Lipis. The main river in Lipis is Jelai River. The tributary of Jelai River are Tui River and Temperah River. The population places near to Tui River are Kampung Taban, Bukit Betung, Kampung Selima, Kampung Keledik, Kampung Telang, Gua Sai, Kampung Kuala Tui, Kampung Bukit Kota and Kampung Bukit Betong. In 2013, the flash floods occur in several villages. It is because the mining activities near the area, causing Tui River overflow quickly when there is heavy rainfall. It is also due to the blockage of drainage (Sinar Harian, 2013). It

causes a lot of damages to houses and structures. Some of residences submerged due to flood as examples some population places near to Temperah River are Kampung Kembuai, Kampung Paya Bah, Kampung Paya Tada and Kampung Temperah. During flood, residents moved to evacuation centers for flood victims. Flood destroys the property and structures that cause residents suffered losses.

It is important to study the characteristics of catchment area to overcome the flood problem. The changes in land use affect the characteristics of a catchment as natural areas are transformed to impervious surfaces such as roads, building and parking lots. The increased fraction of impervious surfaces leads to changes to the storm water runoff characteristics. Besides that, a variety of anthropogenic activities in urban areas generate a range of pollutants such as nutrients, solids and organic matter. These pollutants accumulate on catchment surfaces when it is removed and transported by storm water runoff. It can contribute pollutant to the area. Urbanisation can influences the storm water characteristics of a catchment including hydrology and water quality (Ashantha & Egodawatta, 2015).

1.3 OBJECTIVES

The objectives of this study are:

i) Mapping the area and land used in Tui River's catchment and Temperah River's catchment by using Geographical Information System (GIS). The location of building, structures and any geographical features will be mapping using GIS.

ii) Identifying the characteristics at Tui River's catchment and Temperah River's catchment, Lipis. It is to know the land use or any structures in the catchment.

1.4 SCOPE OF STUDY

There is several scope of study in this research. First, the mapping would be carried out by using GIS technique. The techniques that will be use are ArcMap and ArcCatalog. ArcCatalog is use to manage GIS information such as documents, layer files and GIS datasets. While the ArcMap is used to display geographic data and create maps,

interactively query and explore data, and edit geographic data. Next, this study will focus on Temperah River and Tui River which is connecting to Jelai River and Lipis River in Lipis. It is needed to study catchment area, altitude of catchment, type of soil and the physical features exist on it. The data will be transfer into GIS format and overlay with the base map to analyse the land use in the study area. It is important to know the type of land use in catchment area to know the activities of human in that area.

1.5 SIGNIFICANCE OF STUDY

The study of implementation in mapping characteristics of catchment by using GIS at Lipis is very importance. It is because this study provides initial information for development of system, Department of Irrigation and Drainage and others to reduce the flood effect and damages.

i) Villages or residence: The residents know the low altitude area and can avoid build up residence in that area. Basically the location of house or building is near to the river. So, residents will know the suitable location to build up house, structures and planting.
ii) Hazard zone: To show the area that is in flooding area to reduce the impact of flood by using GIS.

1.6 EXPECTED OUTCOME

The catchment area and land use in Lipis will be determined and identified. The percentage of land use can be estimated by using GIS analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 FLOOD

The most severe natural disaster experiencing in Malaysia is flood. Flooding is a result of heavy or continuous rainfall exceeding the absorptive capacity of rivers, streams and coastal areas. This caused a watercourse to overflow its bank onto adjacent lands. Floodplains are those lands most subject to recurring floods, situated adjacent to rivers and streams. Floodplains are therefore "flood prone" and hazardous to development activities exceeds an acceptable level. The major type of flood occur in this country are monsoon flood and flash flood. The monsoon flood occur mainly from Northeast Monsoon which prevails during the months of November to March with heavy rains to the east coast states of the Peninsular, northern part of Sabah and southern part of Sarawak (M.Safie,2006).

Flooding is the most significant natural hazard in Malaysia in terms of population affected, frequency, area extent, flood duration and social economic damage. Having 189 river basins throughout Malaysia including Sabah and Sarawak, the rivers and their corridors of floodplains fulfil a variety of function both for human use and for the natural ecosystem, where they are fundamental parts of the economic, natural and social system wherever they occur. However, these rivers pose a threat of flooding the surrounding

areas if unnatural periods of rain occur (Ministry of Natural Resources and Environment Malaysia, 2007).

The floods happen when the river capacity is not enough to carry the water that has entered the river network and bank overflow, which called floodplain. There are several factors how to determine the size of flooding, rainfall intensity and duration, dry and wet land, topography and many more. Therefore, the flooding is the complex natural phenomenon. Figure 2.1 and 2.2 show the articles about flood happen in Lipis. Figure 2.1 shows floods caused by water channel in the Tui River clogged with debris and mud. The date of this article is 10 September 2014 taken from website of Utusan Harian. Figure 2.2 shows an article from Sinar Harian. The flood is arising from the implementation of a specific project near the village. Besides that, rubbish and waste stuck in a sewer drain, causing the water to overflow into the village.

Figure 2.1: Flood's article happen at Lipis

Sebuah rumah berdekatan Sungai Tui dinaiki air sedalam satu meter di Kampung Beramah, semalam.

< 1/1 >

KUALA LIPIS - Sebanyak 15 rumah di kawasan Padang Tengku, di sini dinaiki banjir kilat akibat hujan lebat selama dua hari, semalam.

Kawasan yang terlibat adalah Kampung Kechau Tui, Felda Kechau Satu, Kampung Melaka, Kampung Darling dan Kampung Beramah dinaiki air sedalam satu meter.

Adun Padang Tengku, Datuk Mustapa Long berkata, kejadian dipercayai berpunca akibat penyelenggaraan projek tertentu berdekatan kampung terbabit.

"Sampah-sarap dan bahan buangan tersekat di saluran pembetung sehingga menyebabkan air melimpah ke kawasan kampung," katanya ketika melawat kejadian di Kampung Kechau Tui, semalam.

Hadir sama, Pemangku Penghulu Mukim Telang, Abdullah Zawawi Kamaluddin dan Ketua Kampung Kechau Tui, Azmi Mat Ludin.

Mustapa yang juga Naib Ketua Umno Lipis berkata, kejadian juga disebabkan kegiatan perlombongan berdekatan kawasan itu sehingga menyebabkan air Sungai Tui melimpah dengan cepat ketika berlaku hujan lebat.

Menurutnya, kerajaan negeri dan pihak berkuasa tempatan memantau kegiatan beberapa projek membabitkan pembinaan pembetung kecil supaya pihak berkenaan segera membaik pulih untuk memudahkan laluan air jika hujan lebat.

"Pemaju sesebuah projek perlu prihatin dengan senario berkenaan bagi mengelakkan kejadian berulang sekali gus mengganggu keselesaan penduduk pada masa akan datang," katanya.

Beliau berkata, dalam kejadian itu air masuk memenuhi kawasan dapur dan menyebabkan kerosakan perabut dan peralatan dapur.

Figure 2.2: Flood's article happen at Lipis

2.2 TYPES OF FLOOD

Flood are categorized and named in several distinct ways. At the geography, the physical features are the source of the flood water which is river, sea and urban.

2.2.1 River flooding

This is the most common type of flooding. When the capacity of river is larger than capacity channel, river will overflow and cause the flood alongside the river.

2.2.2 Flooding from the sea or coastal floods

Coastal flood usually occur along coastal areas. When there are hurricanes and tropical storms which will produce heavy rains, ocean water may be driven onto the coastal areas and cause coastal floods. Heavy storms or other extreme weather conditions combined with high tides can cause sea levels to rise above normal and force sea water to the land and cause coastal flooding.

2.2.3 Urban flooding

In most of the urban area, roads are usually paved. With heavy rain, the large amount of rain water cannot be absorbed into the ground and leads to urban floods.

2.3 FLOOD CAUSES

Flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to convey excess water. However, floods are not always caused by heavy rainfall. They can result from other phenomena, particularly in coastal areas where inundation can be caused by a storm surge associated with a tropical cyclone, a tsunami or a high tide coinciding with higher than normal river levels. Dam failure, triggered for example by an earthquake, will result in flooding of the downstream area, even in dry weather conditions. Other than that, the increased of floods occurrences especially in urban area largely due to urbanization process that result in increase of impervious surface which shortened the time of concentration and increase the magnitude of the runoff discharge. It also decreases the amount of infiltration of the rainfall thus causing the water to accumulate and flash flooding occurs.

It also occurs when the ground becomes saturated with water that has fallen too quickly to be absorbed. The runoff collects in low-lying areas and rapidly flows downhill. Flash floods most often occur in normally dry area that recently received precipitation, but may see anywhere downstream from the source of the precipitation. Besides that, one of the reasons is due to clogging of drain. The clogged drains and poor drainage system are the main factors causing flash floods. The rubbish inside the drain prevents the smooth flow of water. When heavy rainfall occur, the drain unable to support the amount of water thus an overflow occur causing flash flooding.

2.4 PREVENTION

There are ways to prevent it from repeating itself. Flood plains can be created and the stream also can be widened. It helps by hindering the accumulation of water by providing a route for the drainage of water. Also, the protection of wetlands helps to maintain a natural drainage system to provide a place for the excess water to gather. Such devices allow the water evaporate before it can accumulate, creating flooding conditions.

Other ways of preventing floods include placing sandbags along the riverbank to serve as levees and placing large rocks on banks to prevent erosion, which prevents riverbanks from deteriorating, remaining high enough so that flooding will not occur as frequently. Levees also impede the collecting of water. With levees, a huge amount of rain water can be accumulated before flooding occurs. However, one drawback to their use is that if water is able to get past the levees, then the flooding is significantly worse and causes several times more damage.

In Malaysia, there are several project that been done in order to reduce the flash flooding such as in Kuala Lumpur. Stormwater Management and Road Tunnel (SMART) had been built to divert large volumes of flood from the holding pond, bypass tunnel and storage reservoir.

2.5 FLOOD MITIGATION MEASURES

From previous studies, various methods have been proposed to reduce flood problems. The methods that have been carried were known as structural and non-structural measures. Structural measures are based on engineering methods to solve the flood problems. It is including the engineering works or idea to solve the problems happen after flood. While non-structural measures are proposed where engineering measures are not applicable or required. There are several flood mitigations that can be used to reduce the flood problems

2.5.1 Structural

Structural measures are actually engineering methods which include the following:

i) Flood control dam

Dam is constructed to retain flood water in order to protect areas downstream of the dams. Basically, the purpose of construct dams is not only for flood control but frequently utilised for other purposes such as water supply. Some of dams are constructed for hydroelectric purposes also have a portion of their capacity allocated for flood detention.

ii) Canalisation and related works

Canalisation works include the widening and deepening of channels as well as lining the banks and beds of the channels. They also include the replacement of undersized structures such as bridges. These works are necessary, as the original channels have become undersized as a result of the increase in flood flows caused by development.

iii) Storage ponds

Basically, pond can be used for flood storage. It objective is to divert the flood through such ponds and regulate the outflow.

iv) Channel or tunnel

2.5.2 Non-structural

Non-structural measures are more for preventing floods from occurring and aim to minimise losses due to flooding. These methods reduce the flood magnitude through the management of catchment conditions as well as reducing flood damage.

i) Resettlement of population

It is one positive measure to reduce damage potential or losses of life in flood prone area. The population should have been resettled in the states minimise the damage of things.

ii) Flood forecasting and warning system

It is one of the practical and lost cost measures to minimise flood losses. It enables to earn people living in flood prone area to be warned so they can evacuate themselves and their belongings before the flood happen.

iii) Preparation of guidelines and design standards

Suitable guidelines and design standards have been prepared with clear specification or requirements for river, reservoir, flood mitigation and urban drainage projects. It will minimise the occurrence of floods if the standards are followed strictly.

2.6 HYDROLOGIC CYCLE

The hydrological cycle is a conceptual model that described the storage and the movement of water. The water of this earth can be stored in reservoirs, such as ocean, lakes, rivers and others. Water moves from one reservoir to other reservoir by process like condensation, evaporation, precipitation, sublimation, deposition, runoff, transpiration, melting, infiltration and groundwater flow. Oceans supply more evaporated water in atmosphere. From the evaporated water, only 91% of it is returned to the ocean basins by way of precipitation. The remaining 9% is transported to areas over landmasses where climatological factors induce the formation of precipitation. The resulting imbalance between rates of evaporation and precipitation over land and ocean is corrected

by runoff and groundwater flow to the oceans (Michael, 2011). The flows of the hydrologic cycle refer in the Figure 2.3.

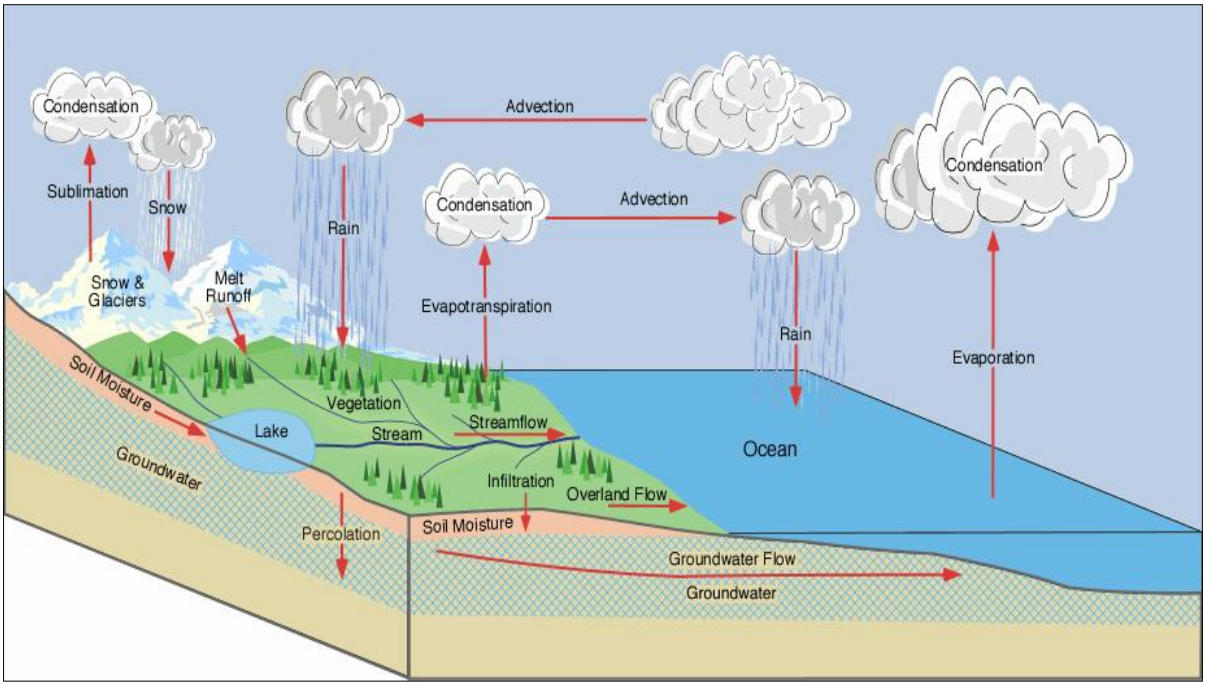

Figure 2.3: Flow of hydrologic cycle

2.7 LAND USE

Land use is the human use of land. Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. Land use change has significant impacts on hydrologic processes at the watershed level. There are two types of land use change which are direct anthropogenic changes and indirect changes. Examples of anthropogenic changes are deforestation, reforestation and afforestation, agriculture and urbanization. Indirect changes are those changes in climate or in carbon dioxide concentrations that force changes in vegetation.

2.7.1 Direct anthropogenic changes

The effect of land use on the climate depends on the type of land cover which present within an area. As an example, the transpiration which mean evaporation of water from leaves leading to warmer temperatures will less in that area. On the other hand, the usage of irrigation on farmland will cause more water transpired and evaporated from moist soils which will cools and moistens the atmosphere. The additional transpiration can also affect the levels of precipitation and cloudiness in an area. Another factor that can affect the climate in the land use is urbanization. The local climates tend to be warmer due to the increased amount of heat released in the densely populated area. The temperature in a city can increase even more due to the high density of construction materials. Examples of construction materials are pavement and roofing materials. This type of materials tend to absorb sunlight rather than reflect it. There is phenomenon that known as urban heat island effect which mean the temperature of urban area is higher compared to the temperature in surrounding rural areas.

2.7.2 Indirect changes

The main ways that changes in climate can alter land use is through higher mean annual temperatures, altered precipitation patterns, more frequent and extreme weather events. Many plant species depend on temperature and rainfall patterns. As climate change affects these patterns, many types of trees and vegetation are forced to shift to higher altitudes and latitudes when the climate change affect the patterns. Greater variability in rainfall patterns can decrease overall plant growth and the increase of temperatures can extend growing seasons. It is possibly allowing more than one cropping cycle during the same season or the expansion of agricultural land toward the higher elevations.

The changes of temperature and rainfall can also increase the risk of insect infestation outbreaks, detrimental to forests and other plants. An extreme weather events can cause a lot of damage to trees and other vegetation from high winds, flooding and storm surges. Floods and storms can also alter water flows, hurting the overall health of the forest, agricultural area, or ecosystem. In other areas, changes in climate could