

PERPUSTAKAAN UMP



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ASSESSING FLOW ACCUMULATION AREA OF SUNGAI KUANTAN
WATERSHED USING GIS TECHNIQUES

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ABSTRACT

Flooding is the most significant natural hazard in Malaysia in terms of population affected, frequency, area extent, flood duration and social economic damage. Recent years, flooding occurred in areas that have been developed. This cause a lot of cost to be borne by the government and public. The study is constructed to establish dataset consisting topography map and to analyze geographic distribution of flow accumulation at Sungai Kuantan watershed. The Geographic Information System (GIS) have been used to deal with spatial problem for this study that is development planning. It is useful in assisting planners from developed flow accumulation area. From this study, planners can identify flow accumulation area and floods occurrence developed area in Kuantan district can be avoided. Suggestion listed give further purification guide in upgrade development planning in Kuantan district. This will indirectly help involved parties carrying out works planning development with more easily and effectively.

ABSTRAKS

Banjir merupakan bencana alam yang paling ketara di Malaysia dari segi penduduk yang terjejas, kekerapan, kawasan setakat, tempoh banjir dan kerosakan ekonomi sosial. Sejak kebelakangan ini, banjir sering berlaku di kawasan yang telah dibangunkan. Ini menyebabkan banyak kos yang terpaksa ditanggung oleh kerajaan dan orang awam. Kajian ini dijalankan untuk menubuhkan pangkalan data yang terdiri daripada peta topografi dan untuk menganalisis taburan geografi kawasan pengumpulan air di kawasan Sungai Kuantan. Sistem Maklumat Geografi (GIS) telah digunakan untuk kajian ini untuk menangani masalah perancangan pembangunan. Ia berguna dalam membantu perancang dari membangunkan kawasan pengumpulan air. Daripada kajian ini, perancang boleh mengenalpasti kawasan pengumpulan air terkumpul dan kejadian banjir di daerah Kuantan boleh dielakkan. Cadangan yang disenaraikan member panduan selanjutnya dalam perancangan pembangunan di daerah Kuantan. Ini secara tidak langsung akan membantu pihak-pihak yang terlibat menjalankan perancangan pembangunan dengan lebih mudah dan berkesan.

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LIST OF ABBREVIATIONS

DEM	-	Digital Elevation Model
GIS	-	Geographical Information System
JBA	-	Jabatan Bekalan Air
JKR	-	Jabatan Kerja Raya
JPS	-	Jabatan Pengairan dan Saliran
JUPEM	-	Jabatan Ukur dan Pemetaan Malaysia
LULC	-	Land Use Land Cover
MPK	-	Majlis Perbandaran Kuantan
TNB	-	Tenaga Nasional Berhad
SRTM	-	Shuttle Radar Topography Mission

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Flooding is the most significant natural hazard in Malaysia in terms of population affected, frequency, area extent, flood duration and social economic damage. Naturally floods can occur in river when flow exceeds the capacity of the river channel, particularly at bend and meanders. Floods occur more in the low-lying areas or the areas below the sea-level. It is because river flow slowly in these area. The volume of water increases in the low-lying areas. When the level of water increases in these areas, it will cause flooding. It usually happened during heavy rains from monsoon which caused runoff from sustained rainfall exceeding the capacities of river channel.

Recent years, rapid development within river catchment has resulted higher runoff and deteriorated river capacity. Flooding always occurred at developed areas which are residential and industrial area. Flooding killed a lot of people, damage houses and cause extensive destruction. Flooding incidents have been occurred due to development made over flow accumulation area. This affects the way water runoff into bodies of water. The development near to the flow accumulation area such as paving roads, adding parking lots and built new buildings will decrease the amount of open ground space. Water will not absorb into concrete or asphalt, so it will runoff into areas

where it will absorb. This can cause the funneling of a heavy amount of water into a small area which will cause flooding. Sometimes, flooding are caused due to poor dams that cannot hold great volume of water. Hence, there are always different causes of flooding. However, human causes flooding can be avoided. Human should let the nature go its own way.

These all affects have in turned resulted in an increase in the flooding frequency and magnitude. Therefore there is a need to take a step by identify flow accumulation area to address this problem in order to avoid further damage. There are various data will involve in flow accumulation management. Geographic information system (GIS) is increasingly becoming an important tool in hydrology and water resources development. Geographic information system (GIS) provides innovative solution to watershed management. GIS is a tool that allows users to create interactive queries (users created searches) analyze the spatial information, edit data, and present the results of all these information.

In context of this study, a multiple of spatially related river in Kuantan district data concerning geographic information, location of human activity and predicted flow accumulation established using the GIS techniques.

1.2 Problem Statement

Recent years, flooding occurred in areas that have been developed (**Fig 1.1**). This caused a lot of cost to be borne by the government and public. This could be avoided if planners have idea from developing flow accumulation area map.



Figure 1.1: Floods occurrence inundated development area

1.3 The Objective of Study

The objective of this study:

- a) To establish database of study area that consisting topography map of flow accumulation map.
- b) To analyze geographic distribution of flow accumulation at study area.

1.4 The Scope of Study

The scopes of study are following:

- a) The project site selected is in Sungai Kuantan Watershed as its case study.
- b) Analysis will be carried out using GIS techniques.
- c) Built-in-command in software will be used for this study.
- d) Topography map will be collected from Jabatan Ukur Dan Pemetaan Maaysia (JUPEM).

1.5 Study Area

Sungai Kuantan is a river in Pahang, Malaysia. It flows from Sungai Lembing through city of Kuantan before flowing out into South China Sea. It is located at latitude 3.8°N and longitude 103.35°E . Area of Sungai Kuantan watershed is about 1684km^2 . The highest height of Sungai Kuantan is at Gunung Tapis which is 1502m flowing to the lowest height at Kuantan Town which is 5m height from sea level.

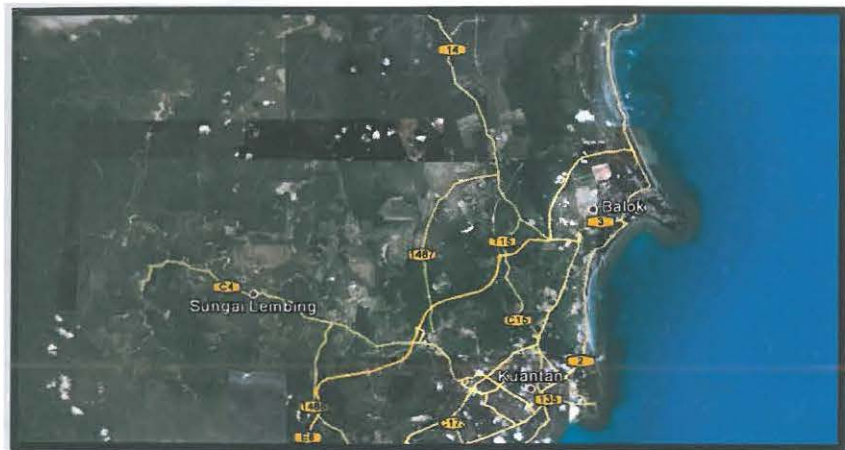


Figure 1.2: Study Area

1.6 Significant of Study

The study of flow accumulation management by using the GIS at Sungai Kuantan is very importance. This study will provides initial information for planner and local authorities to manage Sungai Kuantan flow accumulation

1.7 Structure of Thesis

This report consists of five chapters. A brief summary of each is outlined below:

Chapter 1 comprises the introductory section which develops the reason for the direction of this investigation. It also states the background of the study, the study problems, the objectives of the study, the scope of the study, signification of study and the outline of the thesis in each chapter.

Chapter 2 describes the key terms used in this research. In the first part of the literature review, this chapter defines of hydrologic cycle, urban development, weather and floods occurrence in Malaysia. Also, this chapter defines the process of flow accumulation mapping by using GIS as tools.

Chapter 3 presents the research design and methodology, including the research plan, the method of data collection, the reliability and validity of the data collected from the survey.

Chapter 4 explains the outcomes of the flow accumulation area mapping with helping by GIS as a tools.

Chapter 5 presents the conclusions and recommendations for the future study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter consist literature review that explains about development planning, hydrologic cycle, weather, floods occurrence in Malaysia and study area, flow accumulation, GIS techniques and summary.

2.2 Development Planning

Development patterns are often classified according to the “three D’s,: which are density, diversity, and design (Cervero and Kockelman, 2008). Two additional D’s which are destination accessibility and distance to transit have also been suggested (Ewing et al, 2008). Comprehensive planning is essential in order to ensure new development does not produce negative impact on the society, economy and environment of a region experiencing urban land use change (Kivell, 1993; Devas and Rakodi 1993).

2.2.1 Planning Approval Procedure at Majlis Perbandaran Kuantan (MPK)

There is a few process should be done in implementing planning development of one area. For any project, it will involved a few involved party among them was the planner development, land owner and MPK.

2.2.1.1 Application for Planning Approval

To get planning approval, there are a few document should be provided such as:

- a) A form
- b) Application letter official from mastermind
- c) Land owner copy
- d) Admit plan copy
- e) Whole area picture
- f) Layout plan
- g) Perspective plan
- h) Topography plan
- i) Road proposal plan, sewerage, hydraulic by engineer
- j) Quit rent
- k) Information application report

At the same time, layout plan and pre-computation plan were of paramount importance and has to be attached with planning application

2.2.1.2 Development Planning Approval from MPK

Every single application would be brought to “Mesyuarat Jawatankuasa Pusat Setempat” gives obtain approval from all involved party. Also needed attached with the pre-comp plan for reference application. Each application which made should satisfy the condition was prescribed such as:

- a) Cater to amendment plan ceremony.
- b) Coordinate this proposed development with lot adjoined.
- c) Comply procedure and plan improvement use by.
- d) Satisfy the condition “Jabatan Teknikal Dalaman dan Luaran” will involve with this development.

2.2.1.3 Procedure must be followed before Developed Construction

There is some condition should be complied before work construction conducted. Among them is should satisfy the condition part infrastructure from MPK. It constitute standard traffic design and specification standard plan MPK, paintwork road line including plot position vehicle and get road segment approval in MPK.

In case, Jabatan Pengairan dan Saliran Pahang (JPS) all drainage could not fill or redirected or disturb except by approval legitimized by “Drain Director and Taliair Pahang state”. All count should be based on “Urban Drainage Design Standard and Procedure for Peninsular Malaysia” with plan refers to catchment area. For drain along “Jabatan Kerja Raya”(JKR) road must abide those limits demonstrated at, **Table :2.1**.

Table 2.1: Drainage Propose

JKR Road's Reserve	Broad Drain Allowed within JKR Road's Reserve
< 40ft	2 ft
50 ft – 66 ft	3 ft
>66ft	4 ft

Other than that, there is also condition that is need to be abide by Tenaga Nasional Berhad (TNB) which is the substation building should be comply that is fixed by TNB.

Jabatan Bekalan Air (JBA) also has it own condition before beginning any construction. Consulting engineer must submit design and implement proposal system of water supply at related area. The confirmation of approval will be made by JBA District Engineer of Kuantan.

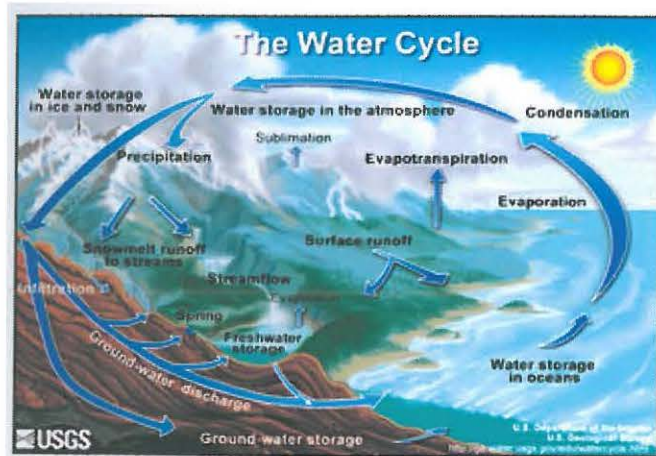
All of the work regarding construction of road should be legitimize by JKR. The construction works are including lane acceleration and deceleration, sewerage, slope roadside and others according to condition that is set should be legitimized by Jurutera Daerah Kuantan (JKR).

2.3 Hydrologic Cycle

Hydrologic cycle is the cycle of evaporation and condensation that controls the distribution of the earth's water as it evaporates from bodies of water, condenses, precipitates and returns to those of water (Fig 2.1).

The sun's heat provides energy to evaporate water from the earth's surface. Plants also lose water to the air which is called transpiration process. The water vapor eventually condenses, forming tiny droplets in clouds.

When the clouds meet cool air overland, precipitation is triggered, and water returns to the land. Some of the precipitation soaks into the ground. Some of underground water is trapped between rock or clay layers which are called groundwater. But most of the water flows downhill as runoff (above ground or underground), eventually returning to the seas as slightly salty water.



(Source: USGS, 2011)

Figure 2.1: Hydrologic Cycle

2.4 Weather, Flood Occurrence Malaysia and Study Area

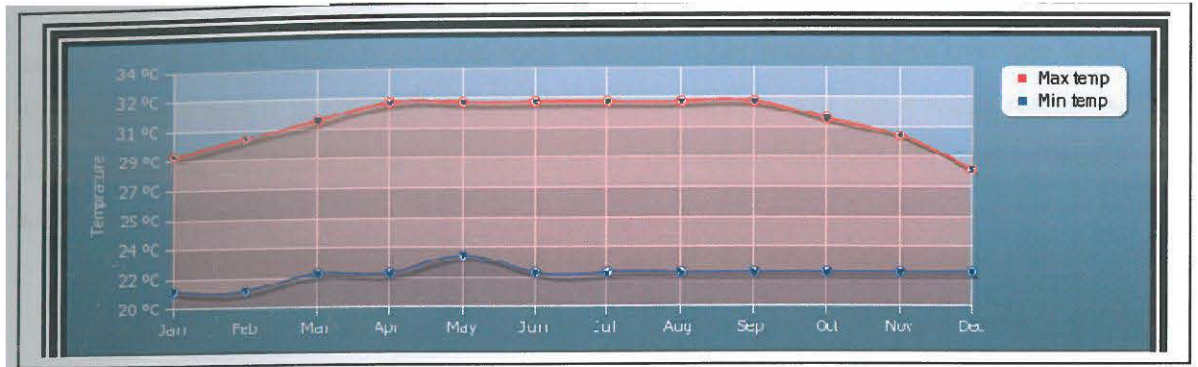
2.4.1 Weather

Malaysia is fortunate that is not directly affected by serious disasters like hurricanes, typhoon, earthquake, tornadoes, tsunamis and volcanic eruptions. This country is also rich in water resources, receiving an abundant amount of rain every year. The average annual rainfall is 2400mm for Peninsular Malaysia, 3800mm for Sarawak and 2600mm for Sabah. Increasingly, as we move towards the year 2020, the country is expected to face serious challenges relating the floods during wet season due to the excessive water (Ahrif, 2008).

Climatic factors that influenced erosion are precipitation, temperature, wind, humidity and solar radiation. Temperature and wind effect evaporation and transpiration. Wind changes the speed and angle of raindrop impact.

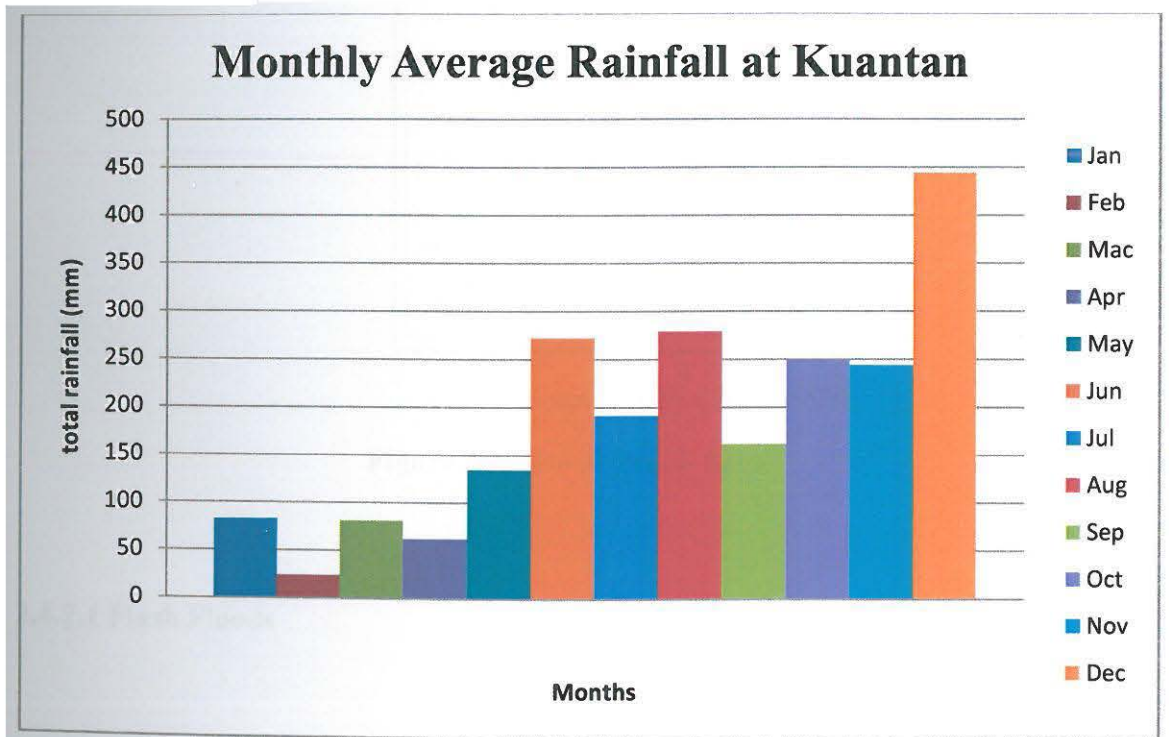
Precipitation is formed from water vapor in the surrounding of atmosphere. The water vapor form when the sun's heat evaporates water from oceans and parts of other water on earth, including plants through transpiration. Warm and cools air down as it rose into the atmosphere. This will reduced the amount of water vapor that can be incurred by the atmosphere. Temperature at which air can hold the level of total water vapor called dew point. The water vapor condensed forming cloud when the temperature drops below the dew point. Water droplets form tiny particles called condensation nuclei. During the formation of water vapor, the heat released cause the heating of clouds. This allows the clouds to rise higher and eventually become cooler again. The formation of raindrops will flow as the river runoff.

The rate of evaporation depends on temperature and relative humidity that affect the amount of water which will results in an increase of groundwater supply.



(source: USGS,2009)

Figure 2.2: Average Temperature in Kuantan

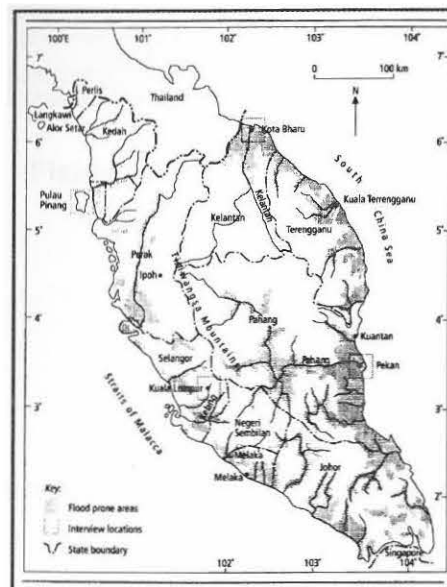


(Source: JPS,2010)

Figure 2.3: Monthly Average Rainfall Data at Kuantan

2.4.2 Floods Occurrence In Malaysia

Surface runoff is the water flow that occurs when the soil is infiltrated to full capacity and excess water from rain, melt water or other sources flows over the land. When surface runoff is not fully absorbed by the ground, it will cause water retention. The increasing of water level in river due to the same condition is one of water accumulation factor.



(Source: N.W.Chan, 1997)

Figure 2.4.: Flood Prone Area

2.4.2.1 Flash Floods

Flash floods are sudden flooding that occurs when floodwaters rise rapidly without warning within several hours of an intense rain. Flash floods are resulting from intense rainfall from slow moving thunderstorms or sudden release from an upstream