A STUDY ON CA[illegible]S IN PAHANG

AIN AMIRA BT ABD RAHIM

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Faculty of Civil Engineering and Earth Resources

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ABSTRACT

Flood risks in Malaysia are increasing due to urbanization which is the continued development of already densely populated flood plains, encroachment on flood-prone areas, destruction of forests and hill slope development. The urbanization processes decrease the infiltration process of the rainfall and increase the volume of surface runoff flowing towards the drainage system. When the runoff discharge is higher than the design peak discharge for an urban drainage system, flood will occur. Since Pahang state is an urban catchment, it is facing high risks of flooding. Catchment is an initiative of the Department of Irrigation and Drainage (JPS) to overcome the flood particularly in urban and developing areas. The main function of the catchment area is to regulate the flow rate after development that is under the permissible level for management purposes or flood forecasting. Objectives of this study are to identify the characteristics of the catchment area, and the factors that influenced the effectiveness of the watershed as well as to identify the boundaries of the watershed in the state of Pahang. Site is being surveyed by observing the land use. By using GIS, the catchment area and boundaries in the state of Pahang can be obtained. Characteristics of the catchment were analyzed based on three main features such as catchment boundaries, stream length, and pervious and impervious area. These catchment characteristics can be obtained through the topography map and satelite study. As we know that, every region has an area and different types of topography. All data and information required for the study was obtained from the local authorities in the Pahang state. From the data collected, Pahang state has a lot of catchments that need to be preserved to ensure that each catchment can fulfill its function as catchment areas.

ABSTRAK

Risiko banjir di Malaysia semakin meningkat kerana pembandaran yang berterusan pembangunan dataran sudah padat dengan penduduk banjir, pencerobohan ke atas kawasan banjir, kemusnahan hutan dan pembangunan bukit curam. Proses pembandaran mengurangkan proses penyusupan hujan dan meningkatkan jumlah air larian permukaan mengalir ke arah sistem saliran. Apabila larian permukaan adalah lebih tinggi daripada menunaikan puncak rekabentuk untuk sistem saliran bandar, banjir berlaku. Sejak negeri Pahang adalah tadahan bandar, ia menghadapi risiko tinggi banjir. Tadahan merupakan inisiatif Jabatan Pengairan dan Saliran (JPS) untuk mengatasi banjir terutamanya di kawasan bandar dan membangun. Fungsi utama kawasan tadahan adalah untuk mengawal kadar aliran selepas pembangunan yang di bawah paras yang dibenarkan untuk tujuan pengurusan atau ramalan banjir. Objektif kajian ini adalah untuk mengenal pasti ciri-ciri kawasan tadahan, dan faktor-faktor yang mempengaruhi keberkesanan kawasan tadahan air dan untuk mengenal pasti sempadan kawasan tadahan air di negeri Pahang. Dengan menggunakan GIS mendapatkan kawasan tadahan dan sempadan di negeri Pahang. Menganalisis ciri-ciri tadahan berdasarkan tiga ciri utama seperti panjang sungai, kekerapan aliran dan kawasan yg dpt tembus dan tidak telus. Ini ciri-ciri kawasan tadahan boleh didapati melalui peta topografi dan kajian satelite. Seperti yang kita tahu bahawa, setiap kawasan mempunyai kawasan dan jenis topografi. Semua data dan maklumat yang diperlukan untuk kajian ini diperolehi daripada pihak berkuasa tempatan di negeri Pahang. Daripada keputusan ujian, negeri Pahang mempunyai banyak kawasan tadahan yang perlu dipelihara untuk memastikan bahawa setiap tadahan dapat memenuhi fungsinya sebagai kawasan tadahan.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Rain is a natural phenomenon that occurs in Malaysia. However, continuous rain will lead to the problem of flooding. Rain can be classified into several types depending on the duration and intensity of the affected areas. Recently, this phenomenon has been influenced due to several factors. Among these are natural factors, rapid development and activities of the local population.

The most important factor is the rapid development. This development, will resulted in an increase to the impervious area. Before the development is carried out, the forest will be cut down and cleared. This will cause reduction and limiting natural resources like plants that play an important role in the infiltration of rainwater into the ground. When this happens, it will result in reduced groundwater levels but at the same time will be advancing rate of runoff.(Guo,2001)

Due to this, the capacity and the time will change. Therefore, flooding will occur and affect many aspects such as facility damage, erosion and landslides and also loss of life. This problem will get worse if the local authorities do not take any action to solve it. In addition, the floods also contribute to other critical problems that water pollution especially in urban areas. It is happening because of the constraints of the existing system improvements and construction of flood retaining structures.

Besides, the floods also contribute to other critical problems of waters pollution, especially in urban areas. This is happening because of the constraints of the existing system improvements and construction of flood retaining structures. Therefore, changes in the type and form of drain is most appropriate for this situation. Consequently, the high cost required to achieve this plans and which is the main aspect that would be avoided by the local authorities.

In Malaysia, Jabatan Pengairan dan Saliran (JPS) has introduced Eco-Friendly System User Manual (MSMA) in 2000. This system serve as a guide to applying the solution starting from the basic resources to protect the natural resources. Besides that, this guide also provides detailed information about the construction of the temporary catchments to collect surface runoff before it is discharged into the drainage system.

1.2 PROBLEM STATEMENT

Worldwide natural disasters are occurring every year and their impact and frequency seem to have increased in recent decades, mostly due to environmental degradation, brought on by human intervention to nature: deforestation, intensified and unplanned land use and increasing population. Rapid urbanization and industrialization of the areas in the Pahang river basin have significant impact on the increment of damages caused by flood. The Department of Irrigation and Drainage in Malaysia stated that the recent flooding which has occurred in December 2007 was the largest flooding after more than 30 years since 1971. (Muhammad, 2007) stated that the peak flow increased rapidly in the Pahang river basin because of natural land has been converted to be concrete surfaces and this phenomenon increases in the surface runoff.

The basin has been known for its large tropical forests reserve like Taman Negara at the northeast and the swamp forest at the southeast coast. But nowadays most of these forests have been changed into hard surfaces such as houses, concrete surfaces or asphalt roads due to rapid increase in population and urbanization. As a consequence, the basin has been affected by many floods related problems. The major flooding seasons are mainly related to Northeast monsoons which cause heavy rainfall.

Flood risks in Malaysia are increasing due to the urbanization which continued development of already densely populated flood plains, encroachment on flood-prone areas, destruction of forests and hill sloped development. The urbanization processes decrease the infiltration process of the rainfall and increase the volume of surface runoff to flow toward the drainage system. When the runoff discharge is higher than the design peak discharge for an urban drainage system, flood is occurred. Since Pahang state is urban catchment, it is facing high risks of flooding. Therefore , to avoid flooding and to develop an effective flood control, the location inside the catchment need to be identified.

1.3 OBJECTIVES

1) To determine the catchment boundaries in Pahang by using GIS.
2) To obtain the catchment characteristic (main stream length) for catchment in the whole of Pahang by using GIS.
3) To analyse the land use percentage in Cameron Highlands catchment for year 1997 and 2002.

1.4 SCOPE OF RESEARCH

Toachievethe objectives, the following scope has been planned to carry out this research. The research will be focus around Pahang state.Figure 1.1 shows that the map of Pahang State, that will be the scope of the researchThe simulation use in this study is ArcGis Software Version 9.3. By using ArcGis Software the catchment boundaries in the state of Pahang will be identified. Then, the characteristics of the catchment based on two main features such as stream length, and land use factors would be identified. The land use factors characteristic would be analyse for Cameron Highlands catchment only. The catchment characteristic can be obtained through the topography map and satelite study. As we know that, every region has an area and different types of topography.

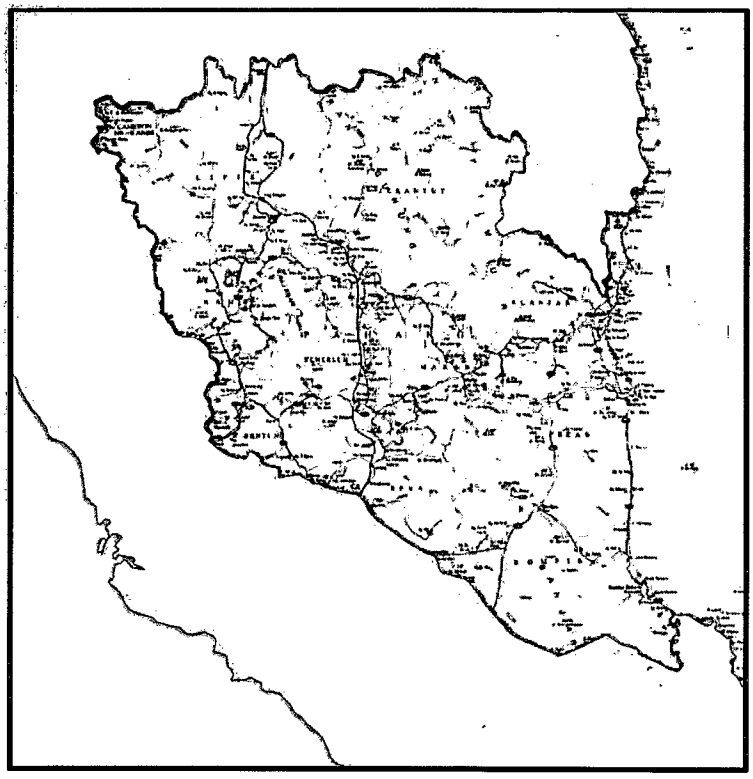

Figure 1.1: Map of Pahang State

1.5 SIGNIFICANCE OF RESEARCH

This study is very important to know the catchment boundaries in Pahang. Before this the catchment in Pahang was divided according to the number of district in Pahang. That means one catchment in one district. This research will identify the catchment boundaries in every district in Pahang. This research will provide supportive information based on the result of the analysis to any concerned bodies such as the government, community or river authorities in the catchment. Other than that, the findings are also useful to the authorities to control and reduce the use of land for catchment area.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Flooding is a major disaster that ever hit many countries in the world each year. It is a natural phenomenon that can not be avoided in all rivers and natural drainage systems. Flooding can cause loss of life, the lack of natural resources and the economic loss and health.

Flood is defined as the excess flow from the river or drainage, and this stems from the accumulated total water capacity exceeds the capacity of a system capability accommodates the water. Dry land areas adjacent to waterways where in the event of a flood, it was covered with water can be defined as a flood plain. generally, flood categories depending on the location area, the rain, and rain intensity.

In Malaysia it is regarded as increasingly important to carry out a thorough analysis of flood events with the help of available river models to understand the flood

behaviour before any structural measures are undertaken. Therefore, before any amendments are implemented within a catchment and the flood plain, river engineers must evaluate the potential extent and impact of flood events and advise the implementing agencies as to what steps need to be undertaken to provide further preventative measures to avoid the anticipated flood problems that might occur (Ghani et al., 2009).

2.2 FLOOD

In Malaysia, there are two types of flood that is flash flood and monsoon floods. Drainage and Irrigation Department (JPS) estimates that about 29,000 square kilometers or 9% of the total land area affected by rain per year. This also included some 4.82 million residents (Ghani et al., 2009).

In Malaysia, flash floods are common phenomena. Flash flood is sudden flooding in low lying areas. It is caused by continuous heavy rain but in the short term. Except that this phenomenon also affected by the drainage system can not cope with surface runoff, rapid development and waste and material deposited along the drainage system. All these factors affect the impervious areas of rain.

Whilst monsoon floods are governed by heavy and long durations of rainfall, more localized flooding, which occurs especially in newly developed town areas, has been reported more frequently in recent years. In October 2003 major flooding affected a large area in the northwestern part of the Peninsular, including the states of Kedah, Penang and Northern Perak. The December 2007 flood, on the other hand, occurred in the state of Pahang, after more than 30 years (DID, 1974) since the last similar floods of 1971 (Figure 2.1). Flash floods have occurred more frequently in the country since the 1980s, with these types of floods often having a drastic impact on parts of the country.

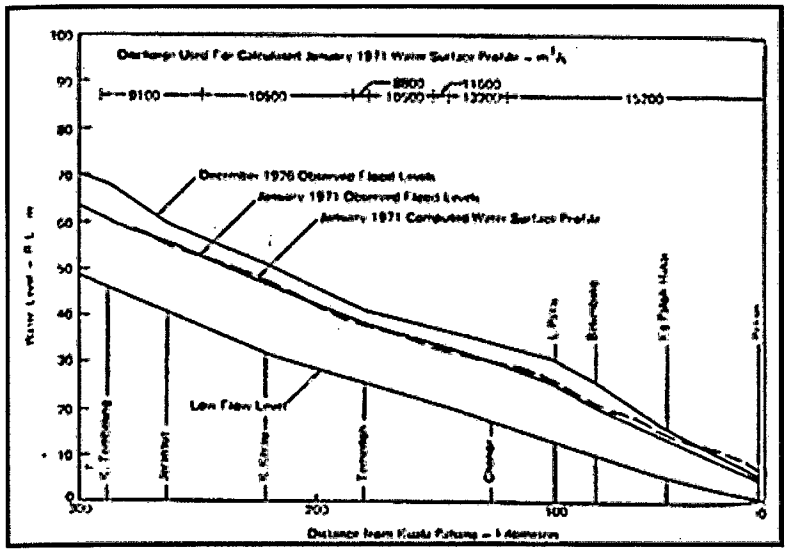

Figure 2.1: January 1971 flood profile (DID, 1974)

2.2.1 Methods of Flood Control

To prevent flooding especially in urban areas, there are several methods that can be implemented. Among them is building a retaining wall to control the flow of abundant surplus, maintaining the existing drainage system, diverts the flow of water by the addition of drainage channels and build a temporary retention pond.

2.3 SURFACE RUNOFF

Surface runoff occurs when rain flooded catchments in quantities that exceed the infiltration rates of the soil or ground cover plants. This is one of the main sources of the water cycle on Earth. Runoff rate depends on the ratio of the intensity of rainfall infiltration rates. However, the amount of runoff depends on the weather and watershed characteristics.

For any project or activity that depends on the supply and control of water, information on surface runoff is very important. Without this information, the project or activity is impossible or difficult to implement. For its retention pond, which involved the slope parameter, area, river flow, types of vegetation, land use factors and soil types in the catchment area.

2.3.1 Weather Factors

The weather is dependent on the position of a place. Among the factors that influence is the intensity of the rain, the rain, the frequency of rainfall, soil moisture and rainfall distribution in the catchment area.

2.3.2 Type of Plants

For the watershed, plants act as interceptor to rain before it infiltrates into the ground. Thus, plants with large leaves or high density can help increase the capacity of rainfall to infiltrate into the ground. With this, the amount of runoff generated is low.

2.3.3 Type of Soil

Soil types can be distinguished depend on the pattern of the arrangement and shape of a rock. Gravel is a rock that size and arrangement, also have a lot of air pores. Soil consists of small stones while the order was packed. Therefore, the water more easily infiltrate into the ground against the pebbly area landed area. Therefore, surface runoff is directly proportional to the rate of soil permeability.

2.4 CATCHMENT

A catchment is defined as the land area that contributes runoff to some areas. Catchment is a basin shaped area of land, bounded by natural features such as hills or mountains from which surface and subsurface water flows into streams, rivers and wetlands.

Catchment area built from a combination of several small areas within a predetermined range. Retention pond will be built in each catchment area. In the downstream watersheds outlet structure will be designed and built. Water that contributes to the average structure due to the overflowing rain catchment. In addition, it is also attributed to the use of water from residential and street drains. Used applications based on the concept of "water down from the high to the low-lying areas". Normally, rainfall is considered uniform throughout the Basin.

Therefore, there are some aspects of the catchment area are a priority for the engineers during the process of designing and building the outlet structure. The catchment characteristic is catchment slopes, catchment orientation, Annual average rainfall stream frequency,base flow index (BFI), lake and reservior, soil moisture deficit and main stream length.

2.4.1 Catchment Slope

Catchment slope, it can be defined as the rate of change in the level of the distance along the water course. It is also used to identify the catchment concentration time. The more steeply the ground surface is sloping the more rapidly will surface runoff travel , so that concentration times will be shorter and flood peak higher. Infiltration capacities tend to be lower as slopes get steeper, since vegetation is less dense and soil more easily eroded, thus accentuating runoff.

Slope can be enumerated by covering a catchment contour map with a rectilinear grid and evaluating the slope, perpendicular to the contour lines at each grid point. A frequency distribution of these numbers can then be plotted. Different catchments can be compared with the same plot, the relatively steep frequency curves indicating catchments of fast runoff and flat curves the converse.

2.4.2 Catchment Orientation

Orientation is important with respect to the meteorology of the area in which the catchment lies. If the prevailing winds and lines of storm movement have a particular seasonal pattern, as they usually have, the runoff hyrograph will depend to some degree on the catchment's orientation within the pattern.

2.4.3 Baseflow Index (BFI)

This is an index calculated as the ratio of the flow under the separated hydrograph to the flow under the total hydrograph. It is a good indicator of the catchment's underground storage, which is dependent on the solid geology.

2.4.4 Stream Frequency

The pattern of stream development in a catchment can have a marked effect on the runoff rate. A well-drained catchment will have comparatively short concentration times and hence steeper flood-rise hydrographs than a catchment with many surface depressions, marshy ground and minor lakes for example. One way is to measure the stream density of the catchment, by measuring the length of stream channel per unit

area: another way (STMFRO) used in the flood studies report is to express it by the number of stream junctions per unit area, using standard scale maps.

2.4.5 Soil Moisture Deficit

This is a climatic parameter that is dependent on rainfall and evapotranspiration. There are other factors in addition to these, including altitude (with its effect on temperature and the presence of snow in winter), land use (whether forested or arable grassland), the proporation of urban development and the condition of stream channels.

2.4.6 Main Stream Length

This is measured in km from the gauging station or catchment outfall. When measuring from maps it is usual to use a standard routine to remove subjectively (for example, set dividers at 0.1 km on a 1:25000 scale map).

2.4.7 Land Use Factor

Rain forest with a dense plant populations produce little runoff from developed areas or open areas. This is because, plants acts as interceptor and help rain infiltrate into the ground. Developing areas, impervious area is vast and indirectly limit the number of successful rain absorbed by the ground. Therefore, surface runoff is inversely proportional to the water permeable.

Forest plants and increase soil infiltration and storage capacity. Furthermore, it causes considerable retardance to overland flow. So cover crops reduce the peak flow. This effect is evident in the small catchment area less than 150 km2. Furthermore, the effects of crop protection is crucial in small storms.

Though the basin has been known for its forest reserve, unsustainable logging and other forms of development activities are seriously threatening resulting in degradation of land in some areas (DWNP, 1987).

Agriculture sector mainly consists of cultivation of a paddy, rubber, oil palms and cocoa plantations (Takeuchi et al., 2007). An area extending up to 6km to the north and south of River Pahang is gazette as Malay Reserve; unalienated land to be used by Malay people (Malaysia Wetland Working Group, 1988).

With regard to urbanization, although the overall level of urbanization in Peninsula Malaysia increased from 20.4 percent in 1950 to 29.4 percent in 1980 there weas nevertheless consider-able variations in the rate and tempo of urbanization. Between 1947 and 1957 all ten states with urban areas experienced an increase in the level of urbanization, but the largest increase is being registered in Pahang followed by Selangor. The inflow of migrant into Pahang can be traced to be the major factors for the extensive land development program undertaken in Pahang (Sharon et al., 2003).

2.5 DETERMINATION OF CATCHMENT CHARACTERISTICS

2.5.1 GIS System

The step in doing any kind of hydrologic modeling involves delineating river netwotk and catchments, and getting some basic catchment properties such as area, slope, flow length, main stream length, and stream frequency. Normally, this has been done manually by using contour maps. In this study Geographical Information System (GIS) and ArcGis is used for the delineation of catchments and sub-catchment.

2.6 PREVIOUS STUDIES

2.6.1 A study on Watershed Characteristics and Rainfall Runoff Relationship

The study is about the knowledge of watershed characteristics and rainfall-runoff relationship are an essential tool in design of urban drainage networks to avoid flash flood. Urban flooding is specific in the fact that there is lack of effective drainage system in urban area. In most countries, there are plenty of rainfall records but limited runoff measurements. Thus, in order to estimate the measurement for runoff, a suitable modelling for rainfall runoff relationship is needed. The study area carried out is located at one of the main river in UTM, Universiti Technology Malaysia, Skudai. The watershed area is about $0.22km^2$ with the slope of 0.002, land use coverwith 32 % of impervious area. The rainfall data and observed outflow for analysis were collected for one month, from 9th February 2010 until 3rd March 2010. The rainfall runoff relationship of the catchment was established by using simple linear model, the correlation, R^2 obtained is 0.978. A hydraulic modeling used to simulate the runoff of flow is HEC-HMS software programming which is user friendly and suitable to simulate the future flow due to the urbanization. 22 February 2010 storm event was selected for calibration process and the efficiency percentage yield is 66.37%.