EVALUATION OF ICS IN PAHANG

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ABSTRACT

Catchment is one way to overcome the problem of flooding, particularly in rapidly growing urban areas. The main aim of the design of a catchment area is for collecting water that falls to earth as rain, and make sure all of water will flow from the catchment area into the same outlet. Catchment outlet is the main stream where it flows into the river or the place where it empties into the lake, estuary, wetland, or ocean. The objectives of this study are to examine the physical characteristics of a catchment and to identify patterns of rainfall in the state using the physical characteristics of the catchment. This catchment study involves two physical characteristics of catchment namely area and average rainfall in each catchment area. The data required for this study was obtained from the Department of Irrigation and Drainage (DID) Pahang. In addition, data on rainfall and catchment area were also obtained through Graphic Information System (GIS). With annual rainfall data, the average monthly rainfall for each catchment area can be analyzed. At the end of the study, the physical characteristics appropriate to the selected catchment areas in Pahang will be identified. In addition, this study can verify the functionality of the existing catchment areas in the state that can be used as the initial planning to the relevant authorities such as Department of Irrigation and Drainage (DID) or government to prevent the occurrence of unwanted disaster.

ABSTRAK

Kawasan tadahan adalah salah satu kaedah untuk mengatasi masalah banjir, khususnya di kawasan bandar yang berkembang pesat. Tujuan utama rekabentuk kawasan tadahan adalah untuk mengumpul air yang jatuh ke bumi sebagai hujan, dan seterusnya rangkaian air ini mengalir dari seluruh kawasan tadahan ke salur keluar yang sama. Salur keluar kawasan tadahan adalah aliran utama di mana ia mengalir ke dalam sungai atau tempat di mana ia dikosongkan ke dalam tasik, muara, paya atau laut. Objektif kajian ini adalah untuk mengkaji ciri-ciri fizikal sesuatu kawasan tadahan dan untuk mengetahui corak taburan hujan di negeri Pahang menggunakan ciri-ciri fizikal kawasan tadahan. Kajian kawasan tadahan ini melibatkan dua ciri fizikal iaitu luas kawasan tadahan hujan dan purata taburan hujan di setiap kawasan tadahan. Data yang diperlukan untuk kajian ini diperolehi daripada Jabatan Pengairan dan Saliran (JPS) Pahang. Selain itu, taburan hujan dan data tentang luas kawasan tadahan juga diperolehi melalui Sistem Maklumat grafik (GIS). Dengan data hujan tahunan, kadar purata hujan setiap bulan bagi setiap kawasan tadahan boleh dianalisis. Pada akhir kajian, ciri-ciri fizikal yang sesuai untuk sesuatu kawasan tadahan yang dipilih di Pahang dapat dikenalpasti. Selain itu, dengan kajian ini dapat memastikan keberkesanan fungsi kawasan tadahan yang sedia ada di negeri Pahang supaya dapat dijadikan perancangan awal kepada pihak-pihak tertentu seperti JPS untuk mencegah daripada berlakunya bencana yang tidak diingini.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Pahang is one of the fastest growing states on the east coast with a total population of 1.51 million people. The largest number of population is in Kuantan district which has a total of 461,906 people. (Pahang Population Data 2010). Pahang have about 11 of district where are In line with its position as the capital and administrative center, Kuantan city is the center of the development is more developed and also the negative effects of development became increasingly felt.

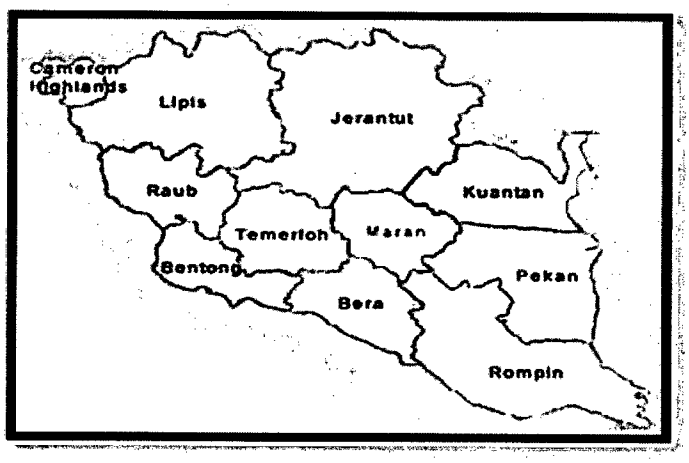

Figure 1.1 : District in Pahang State

With the increasing development activities in Kuantan city, which is in the catchment area will cause an increase in peak flow in catchment areas and increase flooding problems. Increases in surface runoff caused by rainfall that many will cause

an increase in peak flow. Prior to development, a lot of storm water to seep into the soil and very little exists as surface runoff. But when the area was developed, the ground has to be impermeable surfaces such as concrete. These conditions reduce the quantity of storm water that is absorbed by the soil. Based on the study, the rapid development of 0-40% resulted in a flow rate of double increase. (DID 2009)

Therefore, the Department of Irrigation and Drainage (DID) introduced one of the solution methods by providing information about the construction of a functional retention pond or the catchment to collect runoff water before it flowed slowly to the river or sea.

According to the study, the catchment area of influence area of Kuantan city's is about 2250 square kilometers and there are at least 26 major river systems. With a catchment area that is so wide, storm water management for the city of Kuantan is very important especially during rainy season every year.

A catchment is defined as the drainage area that contributes water to a particular point along a channel network (or a depression), based on its surface topography. The catchment forms a landscape element (at various scales) that integrates all aspects of the hydrologic cycle within a defined area that can be studied, quantified, and acted upon. Catchments are typically open systems with respect to both input and output of fluxes of water and other quantities (Dooge, 2003), and can be termed complex environmental systems- although with some degree of organization (Sivapalan, 2005).

Water catchment area which is naturally mitigated through landscape where rain water and water that flowed out of the area will flow into the lakes, rivers and sea. The purpose of this catchment is to supply raw water source, as recreational areas, plant and animal habitats and the flora and fauna, irrigation and fisheries. But the catchment area should be created is different in terms of physical characteristics according to the topography of the area. The solution is to avoid any untoward incidents such as floods and also the effectiveness of the watershed itself.

1.2 PROBLEM STATEMENT

Rainwater management is very important especially during the rainy season every year. This is because the river or drainage system can not support with the amount of excess runoff caused by high rainfall intensity or long periods of rain. If this problem occurs, it will cause flooding problems. Increased peak flow in the catchment is also due to the development in the catchment and will increase the problem of flooding in the downstream side of the catchment area (Bengstson, 2010). Therefore, an effective flood control system is needed to prevent the flooding will have an impact on human life and property. One method of solution is the construction of the flood control like catchment that is used to control runoff before it is released slowly into the river, lake or sea. Low area such as Tok Sira, Kg Kurnia, Mega Mall, Kg Jawa, Kg. Tiram, Kg. Sungai Isap and Bukit Rangin is an area that has been flooded and have experienced flooding in 2001 and 2007.

1.3 OBJECTIVES

i. To determine the area of catchments in Pahang using GIS.
ii. To analyze the pattern of rainfall in each catchments within Pahang.

1.4 SCOPE OF STUDY

To achieve the objectives, the scope has been designed to study the basic information and references related to the characteristics of the catchment area of the Department of Irrigation and Drainage (DID), and also the analysis of rainfall information for the information to be correlated with flood control. This study is dedicated to the catchment areas in Pahang. Analysis was performed on several physical characteristics such as area of catchment and average annual rainfall data in Pahang that were obtain from Department of Irrigation and Drainage (DID) and using the software which is Geographical Information System (GIS) and also topography map. This study is to identify the catchment and through the topographic maps. Furthermore, the scope of this study is to obtain an analysis of rainfall data were obtained.

1.5 SIGNIFICANCE OF STUDY

Catchment characteristic are among the most important in sure the effectiveness of function of catchment to to supply raw water source, as recreational areas, plant and animal habitats and the flora and fauna, irrigation and fisheries. However, the limited understanding of the roles of these catchment characteristics in has constrained the implementation of efficient catchment function.

A comprehensive understanding of the relation between rainfall characteristics, catchment characteristics can help the DID to select and identify the suitable of characteristic catchment to predict the flood discharge, water level and rainfall for the next events.

Hopefully, this research can help the government agency for the early planning to ensure the appropriate catchment so that prevention can be carried out before the hazard occurred.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Flooding is a major disaster that ravaged many parts of the world every year. These floods are natural phenomena that can not be avoided in all rivers and natural drainage systems. The impact of this flood can cause loss of life, property and economic loss and health. Natural disasters are most frequently encountered in Malaysia is flooded. There are two main types of flooding that often occurs in Malaysia, monsoon floods and flash floods. Drainage and Irrigation Department (DID) has recorded that about 29 000 km^2, or 9% of the total land area in Malaysia and more than 4.82 million people (22% of the population) are affected by floods every year. The amount of damage caused by floods is also estimated to be approximately US310 million (Chan, 2003).

Flooding is defined as the excess of water in streams or drainage resulting from the cumulative total water capacity exceeds the capacity capability of a system to accommodate the amount of water. Flooding often occurs when an area of the, usually low-lying areas, flooded with water. This phenomenon also occurs when soil and vegetation can not absorb all the water into. Among the factors that cause this flooding is continuous rain, rain catchment urbanization and forest destruction.

2.2 FLOODING

There are several categories of flooding in Malaysia. Among them are flash floods, seasonal flooding, or tidal flooding. Additionally, the flood is also described based on the location, characteristics, cause, duration and time when it occurs. While monsoon floods are govered by heavy and long-duration rainfalls, more localized flooding, which occur especially in newly developed town areas, has been reported more frequently in recent years.

In Malaysia, the risk of human vulnerability to flash floods, especially in large urban areas with dense population distribution and the area is booming lately. This is proven by the flash floods that have occurred in the vicinity of major cities such as Kuala Lumpur, Ipoh, Kota Bharu and others. Flash flood have occured more frequently in the country since the 1980s, with this type of floods often having a drastic impact.

Usually, the main reason is that flash floods rapid surface flow due to changes in land use, watercourses and drains are blocked, reduced capability through the river sedimentation and storm events such as heavy rainfall convective storm.

According to historical records, Floods December 2007 can be considered as the third largest flood that occurred in the state where the mean rainfall in the Pahang River in the mean 8 days of rain. At that time, the water level was above the danger level in Lubok Paku, Temerloh and Pekan station.

2.2.1 Flood Control

To overcome this flooding problem, there are several methods that can be implemented. Among them is to build 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 catchment. Recent hydrologic methods have been developed which have changed the basic approach, and give a closer insight lnto the physical and flow processes (Chen and Shubinski, 1971)

2.3 SURFACE RUNOFF

Surface runoff occurs when rain flooded catchments in quantities that exceed the infiltration rate 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 rate. But, the amount of runoff depends on the weather and watershed characteristics.

For any project that depends on the supply and control of water, information on surface runoff is very important. Without this information, projects or activities those verses are difficult to implement.

2.3.1 Weather Factor

The weather is dependent on the position of a place. Among the factors that influence the weather and climate in Malaysia is the position, the monsoon winds, the islands and the height and intensity of rainfall and rainfall frequency.

2.3.2 Soil Type

Soil types are distinguished depending on the arrangement of patterns and shapes of rocks. Soil serves as a medium that allows water to infiltrate the soil surface. In general, the size of the pores that allow water to move into the soil and infiltration rate depends on soil particle size, strength and arrangement of soil aggregates and soil particles aggregate. Significant changes in the production volume of runoff peaks can be seen through the soil with high moisture content (Alexander, 2001). Therefore, surface runoff is directly proportional to soil permeability.

2.3.3 Type of Plants

For the catchment, plants act as interceptor to rain before it infiltrates into the soil. 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. Plants are an important effect on the infiltration capacity of the soil in which densely covered with plants will produce less runoff than areas that are more vulnerable. Total interception storage of rain water on the foliage depends on the type of vegetation and growth.

Kobatake et. al. (2000) assess the impact of regeneration on the characteristics of runoff in the watershed Ashio, Japan where in 1974 to 1998, the occurrence of large floods and studies conducted have shown peak runoff coefficient was reduced to 0:59 to 0:38 throughout the year. The ratio of total runoff hydrograph has also decreased from 1.25 to 0.91.

2.4 RAINFALL

Rainfall is also known as a loss of precipitation which would otherwise be available to the soil. Rain is liquid in the form of droplets that have condensed from atmospheric water vapor and then become heavy enough to fall to the ground under gravity. Rain is a major component of the water cycle and serves to channel most of the fresh water on earth. It provides ideal conditions for a wide variety of ecosystems, hydroelectric power plants and crop irrigation. The basic principles of the hydrologic cycle, when the rain falls, the first drops of water is intercepted by the leaves and stems of plants. This is commonly referred to as interception storage. Once the raindrops reach the soil surface, water will infiltrate into the soil until it reaches the stage where the rate of rainfall intensity exceeds infiltration capacity of the soil. Soil infiltration capacity varies depending on soil texture and structure. For example, a high percentage consists of sand where the water infiltrates through it is quite fast and much as it has large pores and good space. Meanwhile, the clay also has a low infiltration rate for having a small-sized pores. (Ritter, 2006).

2.4.1 Annual Rainfall

In general, frequent rainfall and the highest in Peninsular Malaysia is among the transitional period between the northeast (December to March) and southeast monsoon (June to September). Rain most commonly occurs inApril, followed by October and November (DID, 2000). However, the driest month and practically no rainfall of is the month of January (northeast monsoon) which covers only 4:57 per cent of the long-term average annual rainfall (Niemczynowicz, 1996).

In Peninsular Malaysia, receiving rainfall in almost the entire area with the average rainfall is between 100 mm to 300 mm. But in rural areas such as Pahang, Melaka and Negeri Sembilan recorded rainfall amounts of less that 20% to 40% below average, while the East, especially in Johor, North Perak, South Kedah and Selangor have received rainfall of more than 60% above the average. The east coast were recorded rainfall of less than 10 days. The lowest number of rainy days recorded was 6 days and rainy days was the highest recorded was 23 days.

2.5 CATCHMENT CHARACTERISTIC

2.5.1 Catchment Area

Catchment area is an extent or an area of land where surface water from rain converges to a single point at a lower elevation such as as river, lake, sea and ocean. A tributary stream of river which joints a smal river, which is tributary of a larger river that shown in Figure 2.1 to form the catchment area.

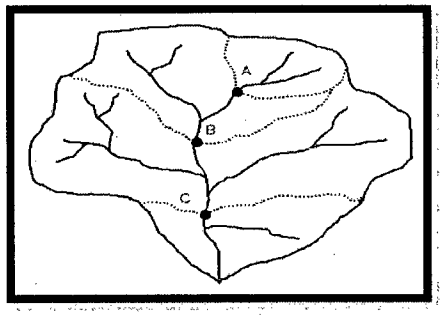

Figure 2.1 : Example of Catchment Area

Wilson (1990) defines a watershed as the amount of land and water at the surface will affect the runoff in a particular place or river cross sections and states that each control point on the river has its own sub-catchment.

However, Horton (2003) defines the difference between a catchment area of effective and ineffective. Effective catchment area is as described by Wilson (1990), while not effective catchment area is defined as the runoff can not reach out of the catchment.

Watershed influence both parameter describe the catchment response and the total volume of runoff from the entire catchment rainfall (Ward and Robinson, 1999; Alexander, 2001; McCuen, 1989).

2.5.2 Catchment Slope

Slope can be enumerated by covering a catchment contour map with rectilinear grid and evaluating the slope, perpendicular to the contour liness at each grid point. The more steeply the ground surface surface is sloping the more rapidly will surface runoff travel, so that concentration times will be shorter and flood peaks higher.There are a variety of methods to determine the average watershed slope (S). Among these rules is the grid method (Alexander, 2001), the empirical method (Schulze et al, 1992) and Neighborhood method (ESRI, 2006).

2.5.3 Catchment Shape

Shape retention is different in the manner in which the runoff will flow in time and space. Fan-shaped catchment area will be shorter reaction time with a production peak flow higher than narrow catchment area that will give a longer response.

In the catchment area of a circular turn, runoff from various parts of the retention pond will flow out into the river at the same time, while the elliptical catchment has an area at one end of the main axis of the act affecting runoff that can flow from time to

time, thus resulting in a smaller peak discharge compared with circular catchment area (McCuen, 1989).

2.5.4 Catchment Orientation

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

2.6 CHANNEL SYSTEM

2.6.1 Natural Channel System

Channel system plays an important role to drain runoff from the catchment area upstream to downstream reservoirs before being routed to the main river. Efficiency depends on the ability to accommodate runoff. There are two types of channels, namely natural and artificial channels channels.

2.6.2 Artifical Channel System

This system is formed naturally due to erosion during high flows from areas of low-lying areas. Hydraulic properties of the channel is constantly changing according to time and place. Such as rivers, streams and springs.

2.6.3 Characterisic of Suitable Channel

Good channel system is dependent on the use of land, rainfall intensity and topography area. The system features a good channel is a channel that can drain runoff to the lower area with a safe, built along the roads and in residential areas and also have a suitable gradient is neither too steep or too flat.

2.7 GIS Software

GIS is an information system that can store, display, analyze, and manipulate data associated with data spatial (spatial data). The ability of this system is not limited to the display of digital maps only otherwise it can do the work of analysis, analyzing attribute and spatial data, identify patterns of behaviour, and displays the results of the analysis are shown in the rating system has accurate reference point on the earth. Area for each catchment in Pahang determined using this method.

2.8 GIS Subsystem

GIS has four major subsystems that have different functions depending on the type of its own system. The main function. Each subsystem is data input, data storage and retrieval, data manipulation and analysis, and data output and display.

2.8.1 Data Input

The system works to allow users to do work such as taking pictures, collect, transform space and converts the data into digital form. Usually these data are derived from a copy maps, aerial photographs, remote sensing image, a report prepared by the relevant authorities, documents from previous study, and others.

2.8.2 Data Storage and Retrieval

System data storage and retrieval in a space that allows users to make analysis more quickly and accurately. In this database management system (DBMS), attribute data will be retained for use by the user and spatial data usually willencoded and maintained in proprietary file formats.

2.8.3 Data Manipulation and Analysis

The function of this system is to enable users to define and execute spatial and create procedures to analyze the information that has been obtained. These subsystems

are generally regarded as the heart of GIS, and the difference with other systems is have a computer-aided drafting (CAD) systems.

2.8.4 Output Data

Data output allows the user to generate reports with graphical displays, typically maps, tables and reports from the information obtained. Function of GIS is to design and analyze spatial data from existing information. GIS is a computer system that uses automation to integrate geographic data processing tools that are environmentally friendly and comprehensive and is not a new invention.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

To carry out this study , the area was chosen to conduct the study catchment area in the state of Pahang. The main factor for the selection of these areas is to obtain information on the physical characteristics of the catchment located in Pahang. Each area has different soil types that will change in the topography of the area, the natural hydrological cycle changes and disruption of surface runoff will occur. When it happens, it will contribute to increase the probability of flooding will occur. As a preventive measure, the catchment was built as a solution .

Methodologies are selected to achieve the objectives as set out in accordance with all appropriate work planned in scope of the study. To achieve this , the process of analyzing the information flow and Irrigation Department and the application of the calculation will be carried out. All calculations and formulas are based on the Urban Stormwater Management Manual (MSMA).

3.2 SITE DESCRIPTION

Pahang is one of the fastest growing east coast state with a total population of 1.51 million people. The highest population is in Kuantan district by 429 100 people (Pahang Population Data, 2010). Kuantan is the state capital and the seat of government in which development activities are concentrated in Kuantan and the negative impact of this development is also very high.

According to the study, the catchment is in the city of Kuantan is 2250 square kilometers and there are at least 26 major river systems involved. The catchment is bounded by the South China Sea to the east and Remand Cereh Forest to the west of the highest point in the catchment area is 1512m above sea level. Increased peak flow in the watershed is due to the development in the watershed and in turn will increase the problem of flooding in the downstream side of the catchment area (Bengstson, 2010).

The catchment area is so vast, storm water management for the city of Kuantan is very important, especially during rainy season every year. Low areas such as Tok Sira, Kg. Kurnia, Mega Mall, Kg Jawa, Kg. Sungai Isap, Permatang Badak and Bukit Rangin is an area that has been flooded and have experienced flooding in 2001 and 2007.

3.3 DATA COLLECTION

3.3.1 Site Visit

There were many station along the catchment involve in this study. The catchment are in all the district in Pahang. There are eleven district in Pahang such as Kuantan, Pekan, Temerloh, Maran, Bera, Kuala Lipis, Rompin, Jerantut, Cameron Highland, Raub and also Bentong. The catchment were chosen based on different district in Pahang. Annual rainfall data were collect from each catchment. Besides that, the Global Positioning System (GPS) is functional for define the coordinate of district in Kuantan. Aftet obtain and gather the information, the data will integrate to coordinate in GIS model.

3.3.2 Data from GIS

From GIS we can produce the catchment area providing a visual of where the boundary for the central location lies. We also able to anticipate an array of habitats and resources which would have exploited within this catchment with an energetic GIS provides the facilities to produce a data set of information that is seen as required in the form of digital data, analysis and modeling. This study was conducted with the full use