ASSESSMENT OF EFFECT OF FLOOD MITIGATION CONSTRUCTION AT PERKAMPUNGAN SUNGAI ISAP, KUANTAN

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Abstract

Throughout the last century flooding has been one of the most costly disasters in terms of both property damage and human casualties. The flooding in 2001/2002 at the basin Sungai Kuantan, the government has built Chereh Dam at upstream of Sungai Kuantan in 2008 and a bund along the Sungai Kuantan at Perkampungan Sungai Isap and surrounding villages. The flood-inducing rains incident in December 2013 at this area, raised concern in effectiveness of those mitigation infrastructures. The main objective of this study was to assess of effect of flood mitigation construction at Perkampungan Sungai Isap, Kuantan. The specific objective were; to analysis rainfall characteristics of study area during the flood-inducing rains, and to assess changes of flood prone of study area, pre and post of existing river bund. Rainfall for five months (Oct, Nov, Dec, Jan, Feb) for each year (2000-2001, 2001-2002, 2007-2008 pre-bund year; 2010-2011, 2013-2014 post-bund) data collected from the satellite were tabulated based on daily rainfall. Water balance model was used to calculate the possible retention depth water. The analysed of satellite-based rainfall data were compare to JPS flood report relating to flooding incident.

Abstrak

Sepanjang abad abad yang lalu banjir telah menjadi salah satu bencana yang paling besar kerugian dari segi kerosakan harta benda dan kematian. Banjir pada 2001/2002 di lembangan Sungai Kuantan, kerajaan telah membina Empangan Chereh di hulu Sungai Kuantan pada tahun 2008 dan ban di sepanjang Sungai Kuantan di Perkampungan Sungai Isap dan kampung-kampung sekitar. Hujan yang menjurus kepada kejadian banjir pada Disember 2013 di kawasan ini, menimbulkan kebimbangan dalam keberkesanan infrastruktur tersebut. Objektif utama kajian ini adalah untuk menilai kesan pembinaan tebatan banjir di Perkampungan Sungai Isap, Kuantan. Objektif khusus ialah; analisis kepada ciri-ciri hujan kawasan kajian semasa kejadian banjir yang menjurus kepada hujan, dan untuk menilai perubahan banjir yang terdedah kepada kawasan kajian, sebelum dan selepas ban sungai yang sedia ada terbina. Data hujan selama lima bulan (Oktober, November, Disember, Januari, Februari) bagi setiap tahun (2000-2001, 2001-2002, 2007-2008 tahun pra-ban; 2010-2011, 2013-2014 selepas-ban) yang diperoleh daripada satelit telah dijadualkan berdasarkan hujan harian. Model keseimbangan air telah digunakan untuk mengira kedalaman kemungkinan air tertahan. Data hujan yang berasaskan satelit yang dianalisis telah dihubungkaitkan dengan laporan banjir JPS berhubung dengan kejadian banjir.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Throughout the last century flooding has been one of the most costly disasters in terms of both property damage and human casualties. According to the UN Office for Disaster Risk Reduction (UNISDR), some 250 million people have been affected annually by floods over the last 10 years, and floods are the single most widespread and increasing disaster risk to urban settlements of all sizes (UNISDR, 2014).

According to Høybye (2009), there are three identified main sources of flooding in any e basin, heavy local rainfall, and extreme increase in river discharge and sea wave. The last fifteen years, parts of the Sungai Kuantan basin experienced severe floods, especially mid of North-east monsoon period (December-January). The remarkable year, 2001, 2007 and 2013, high intensity rainfall episodes in the few days, eventually are causing flooding (Ali, M.I., 2014).

The flood-inducing rains give impacts to many people, that were dislocated from their place, and government and private properties have been damaged causing huge impact on the country's economy. The major concern for communities and government agencies in areas with high risks of flood-inducing rains disasters is to reduce the vulnerability of the people and infrastructures by providing structure for mitigation (i.e. dam and levee at river bank) that seen as the most effective way to reduce the property damage and life loss.

1.2 PROBLEM STATEMENT

Since the flooding in 2001/2002 at the Sungai Kuantan basin, the government had built Chereh Dam at upstream of Sungai Kuantan in 2008 and a levee along the Sungai Kuantan at Perkampungan Sungai Isap villages. Floods are regular natural disaster that frequently occurs in Peninsular Malaysia, every'year during the monsoon season. Especially second inter monsoon to early North-east Monsoon (October to December). However, the flood-inducing rains incident in December 2013 at Perkampungan Sungai Isap, located at downstream of the Sungai Kuantan basin, raised concern in effectives of those mitigation infrastructures.

1.3 OBJECTIVE OF STUDY

The study main objective was to assess of effect of flood mitigation construction at Perkampungan Sungai Isap, Kuantan. The specific objectives this study were as follows:

i. to analysis rainfall characteristics of study area during the flood-inducing rains,
ii. to assess changes of flood prone of study area, pre and post of the levee structure.

1.4 SCOPE OF STUDY

This study was limited for the period between 2000-2013 which are mid of North-East monsoon period on December to January. The area of study was located in the watershed of Sungai Kuantan at E1032° and N3.8°. The residential area involves:

1) Perkampungan Sungai Isap
2) Taman Bukit Rangin
3) Taman Sepakat
4) Kampung Permatang Badak
5) Taman Permatang Badak
6) Kampong Batu Tujuh
7) Taman Tas
8) Taman Pandan Damai

1.5 THESIS STRUCTURE

This research consists of five chapters. Chapter one comprises the introduction section. It states the study background, problem statement, objectives of study and lastly scope of study. For chapter two, describe the key term in- purpose of these research and comprises the literature review that related and suitable for these research. Chapter three explains the research methodology that used for planning research type of data collected and the method of data analysis to be employed. For chapter four present the result that obtained from the study area and year of study and discussed the result from analysis. Finally, chapter five comprises the conclusion from the overall chapter and relates some recommendation for future work on research field.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Situation where lower ground level that can induce water increases during a rainy season is known as flooding. Several types of floods are described in this chapter, including river floods, flash floods, dam-break floods, ice-jam floods, glacial-lake floods, urban floods, coastal floods, and hurricane-related floods. Certain location where lower ground level occur water increases during a rainy season is known as flooding. In Malaysia, floods often occur mostly when the northeast monsoon, which in this situation malaysia receive cool air that brings cloud to the peninsula malaysia especially the eastern coast of the peninsula, namely Pahang, Terengganu and Kelantan. floods in Kuantan, Pahang, namely the most significant is heard, especially on the season. flood events always occur in connection with heavy rains and river water level rise sharply causing adjacent lower area affected. flood events that have taken place almost every year, which between 2000 and 2013 in december 2001, has accepted the great flood in Kuantan, which saw its season rate is quite high while the flood situation in the next year not so much as in 2001. In 2013, floods in Kuantan once again displays the events that are more severe than in 2001, which involved more victims and more areas affected. rainfall during the show Maggi of rainfall intensity over the years that no great influx of more than 200 mm of rain per day. The local government agreed to build flood mitigation along the river near the village of suction river flooding is frequent.

2.2 HYDROLOGY CYCLE

The hydrologic cycle is a conceptual model that describes the storage and movement of water. Water on our planet can be stored in any one of the following major reservoirs: atmosphere, oceans, lakes, rivers, soils, glaciers, snowfields, and groundwater. Water moves from one reservoir to another by way of processes like evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, melting, and groundwater flow. The oceans supply most of the evaporated water found in the atmosphere. Of this evaporated water, certain of it is returned to the ocean basins by way of precipitation. The remaining 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. Figure 1 shows the diagram of hydrology process.

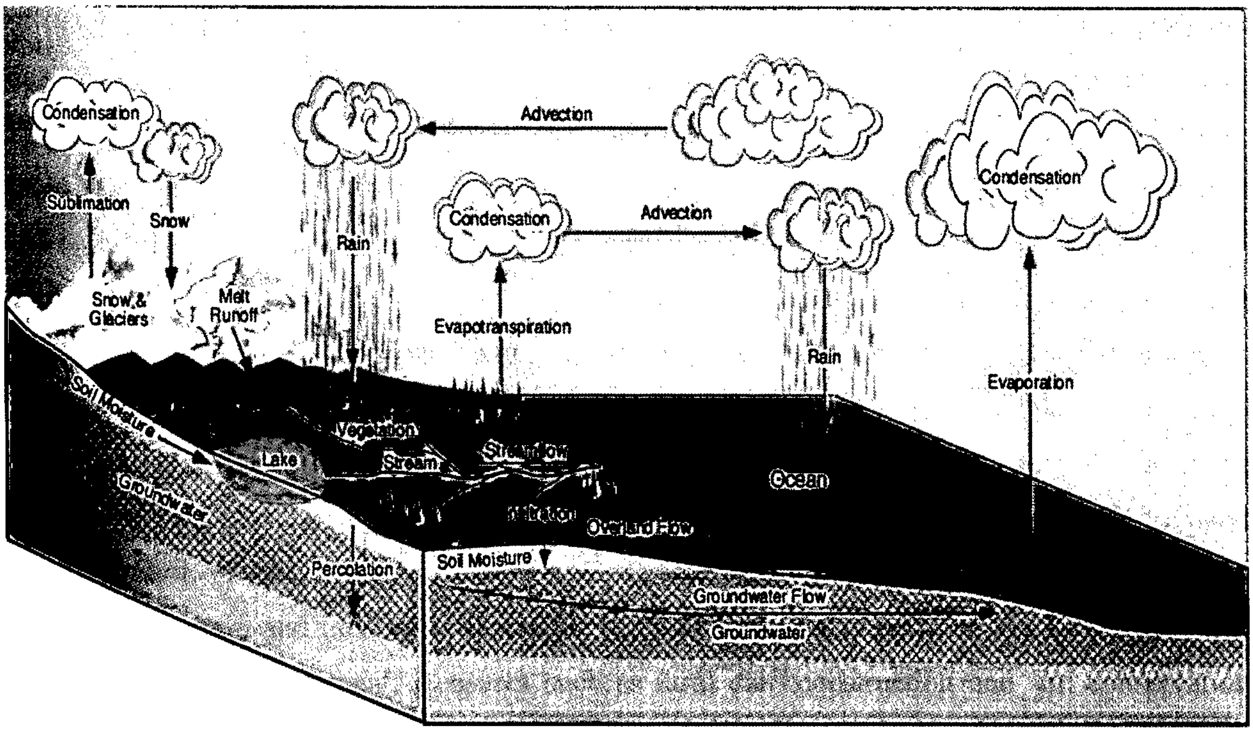

Figure 2.1: Hydrology Cycle Process

2.3 HISTORY OF FLOODING IN PAHANG

Flood occur during year 2000 to 2013 was has reminded us that major floods have occurred in a few years ago. Major flood events occurred in many countries Malaysia in certain years. Excerpts from the archives of the delegation Malaysia. Floods that occurred during the month of January 1971 it led the then Prime Minister, the late Tun Abdul Razak Hussein had declared an emergency and established two Cabinet committees whose role is to provide support and implement flood recovery. The worst-hit state is mainly in the area Pekan Pahang, the constituency represented Tun Razak (ARCHIVES:15/01/2007). This shows that the situation when this involves rivers in the country, including in the area of Kuantan, Pahang.

2.4 FLOODING RISK

Floods can be caused by runoff which exceeds the capacity of the drainage channels rivers and creeks in the rural environment, and storm water channels in the urban environment. The risk of flooding is measured by the probability with which a given flood height (or river flow) will be exceeded in any year. This is usually expressed as an Average Recurrence Interval (ARI) or an Annual Exceedance Probability (AEP). A flood event criterion commonly used in flood risk assessments is the 100 year ARI or the 1% AEP, This criterion is based upon the acceptance of a 1% chance of that event being exceeded within any one year. Statistics can be used to estimate the risk associated with occurrence of floods within the design life of a structures. The risk of flooding may also change over time due to changing development conditions within the catchment. Of potential changes to a catchment, one of the most dramatic is urbanization of part, or all, of a catchment. Urbanization generally increases the volume of runoff, flood peaks and flow velocities while decreasing the delay between the storm event and the flood. On the other hand, measures such as farm dam construction and soil conservation measures may reduce the flood risk by reducing the flood flows. The flood risk at a location is, therefore, not a constant risk but rather a risk which will change with time as development within a catchment changes.

2.5 FLOOD MITIGATION AND PREVENTION

Flood mitigation refers to any structural or non-structural measures undertaken to limit the adverse impact of disaster. Flood mitigation can be divided into three main purposes areas such as river control, land control and others. The river control area include construction of dams or retention basins or reservoir on mainstreams to store excessive water and release it gradually after the threat has passed. River bund or floodwalls can be constructed to confine flood water to a floodway, thereby reducing flood damage. The other side is can improve channel which is straightening to remove undesirable bends also deepening and widening to increase size of waterways. Flood mitigation also action as seepage control and raising the anchorage.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the phases involved in achieving the study objectives. There were FOUR (4) phases, namely:

i) Collecting Data

ii) Pre-processing

iii) Processing

iv) Results and analysis

Figure 3.1 shows the flow of the methodology for this research. Data collecting, pre-processing and the processing will be explained in the following sections in this chapter. While the results and analysis is described in Chapter 4.

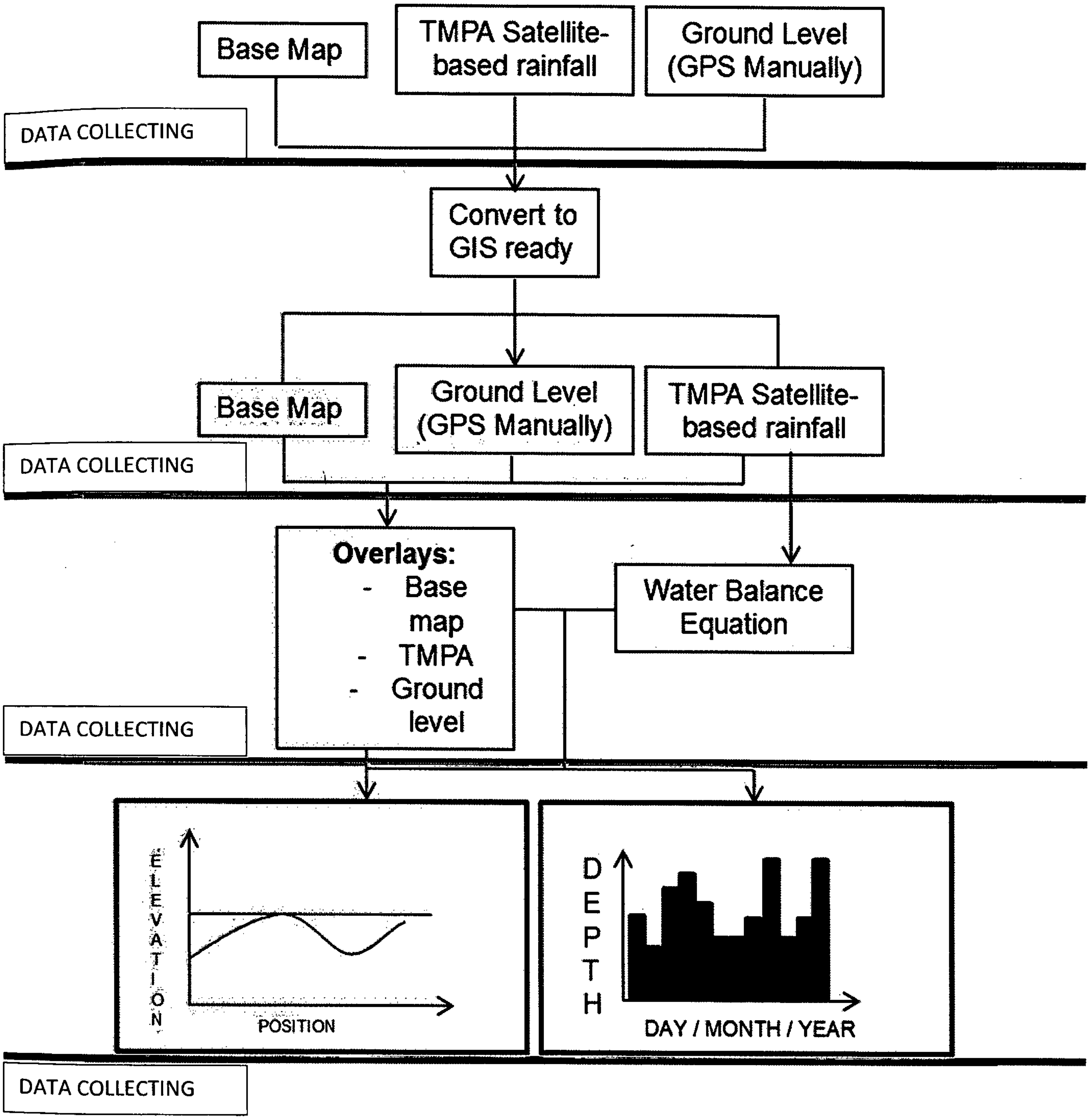

Figure 3.1: Methodology flow chart

3.2 COLLECTING DATA

The research will be starting with collecting rainfall data which is Tropical Rainfall Measuring Mission (TRMM). Multi-satellite Precipitation Analysis (TMPA) version 7 satellite-based daily rainfall data obtained from public domain. The rainfall data was obtained from the public domain for within the period of study in the month of October, November, December, January, and February. The rainfall data obtained in accordance with the daily rainfall per month. Rainfall data characteristics were obtained through the data according to a monthly average.

The reduce level of study area was collected by using Garmin Product (GPSmap 76CSx) in figure 3.2. Ground level at place point was taken at randomly and appropriate. These places also record flooded which on flood occur water level in the years that identify huge flood event occurred in 2001 and 2013. The flood water levels are taken out through interviews to the locals.

Figure 3.2: Garmin GPS 76CSx

3.3 DATA PRE-PROCESSING

All the data was converted to GIS ready. TRMM data have been overlaid with basemap layers (Google Earth) in Arcmap. Each layer has the project according to WGS 1984 in figure 3.3. This coordinate is for accuracy on a real location on earth.

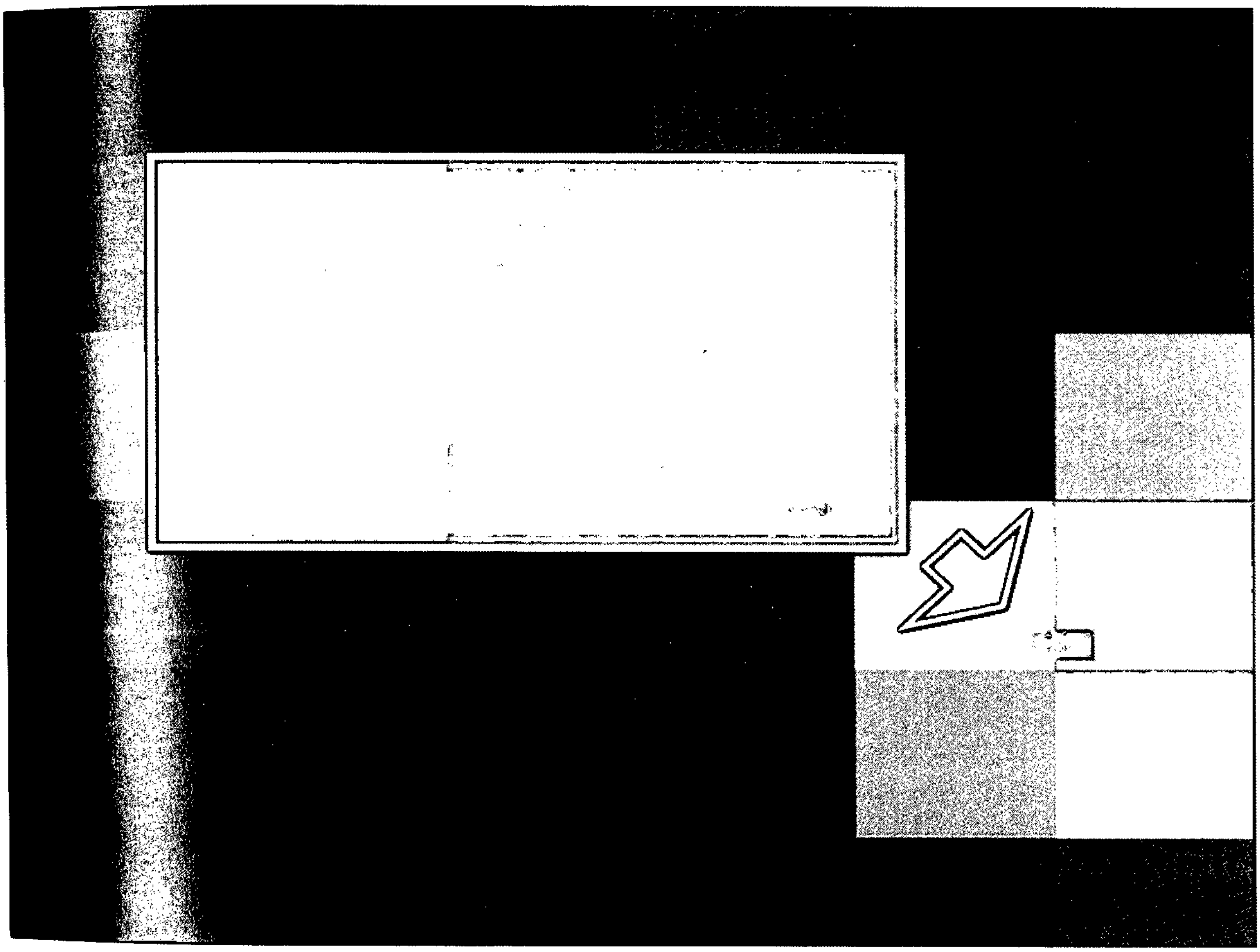

Figure 3.3: Basemap and TRMM overlaid

The reduce level also overlaid on the basemap in Arcmap. The reduce level in converted to GIS ready which is as X,Y and Z coordinates.

Figure 3.4: Basemap and Reduce Level (X, Y & Z) overlaid

3.4 Data Processing

To obtain the exact value of the retention depth, The rainfall data value was collected by gaining from Arcmap that the overlaid. All the data was collected and tabulated. The data was calculation by using the Water Balance Formula which is to obtain the retention depth on this study area. The figure 3.4 shows the diagram of water balance process.

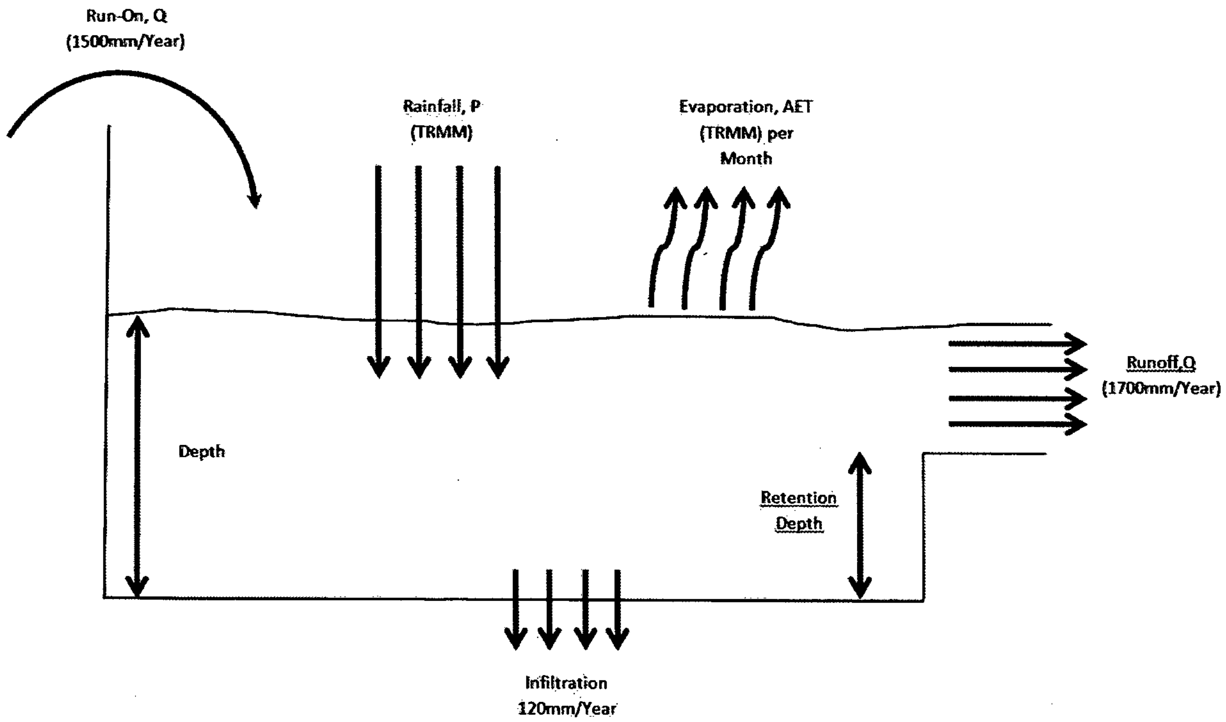

Figure 3.5: Water Balance diagram

Table 1 shows the example of the daily rainfall calculation on December 2013 that the flood occurred. The total (mm) shows the possible retention depth at study area.

Table 3.1: Daily rainfall data with water balance calculation

Tarikh	Rainfall depth (mm)	Rainfall depth (mm)	*Average (mm)*	Inflow per Year (mm)	*Inflow daily (mm)*	Outflow per Year (mm)	*Outflow daily (mm)*	AET per Month (mm)	AET per Month (mm)	Average AET per Month (mm)	*AET daily (mm)*	Infiltrate per Year (mm)	*Infiltrate daily (mm)*	Total (mm)
1/12/2013	74.638	93.596	84.117	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	80.508
2/12/2013	231.447	93.596	162.522	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	158.913
3/12/2013	347.847	398.444	373.146	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	369.537
4/12/2013	31.581	37.850	34.716	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	31.107
5/12/2013	0.151	5.164	2.658	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-0.951
6/12/2013	45.363	56.885	51.124	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	47.515
7/12/2013	30.183	31.581	30.882	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	27.273
8/12/2013	19.194	7.090	13.142	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	9.533
9/12/2013	5.164	0.357	2.761	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-0.848
10/12/2013	2.503	0.181	1.342	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-2.267
11/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
12/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
13/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
14/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
15/12/2013	3.595	7.418	5.507	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	1.898
16/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
17/12/2013	23.004	17.532	20.268	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	16.659
18/12/2013	6.476	0.010	3.243	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-0.366
19/12/2013	11.149	6.189	8.669	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	5.060
20/12/2013	13.362	14.628	13.995	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	10.386
21/12/2013	12.771	17.532	15.152	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	11.543
22/12/2013	1.328	3.762	2.545	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-1.064
23/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
24/12/2013	8.121	11.665	9.893	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	6.284
25/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
26/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
27/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
28/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
29/12/2013	10.656	15.306	12.981	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	9.372
30/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599
31/12/2013	0.010	0.010	0.010	1500.000	4.110	1700.000	4.658	84.377	85.010	84.694	2.732	120.000	0.329	-3.599

The example of calculation is show as below:

The equation of water balance is:

$$P + \textit{Run-on} - \textit{AET} - \textit{Runoff} - \textit{Infiltration} = \textit{Retention Depth}$$

P = Precipitation (TRMM)

Run-on = Water surface run-on (JPS)

AET = Actual Evaporation (NDVI)

Run-off = Water surface run-off (JPS)

Infiltration = Groundwater discharge (NWR)

Retention depth = Depth of water storage

Example for 1/12/2013:

P	= 84.117 mm
Run-on	= 4.110 mm
AET	= 2.732 mm
Run-off	= 4.658 mm
Infiltration	= 0.329 mm
Retention depth	= 80.508 mm

84.117mm + 4.110mm – 2.732mm – 4.658mm – 0.329mm = 80.508mm

**80.508mm is referred to the retention depth on that day.*

To obtain the cross section of the study area, the tabulated data was viewed on Arcmap overlaid on basemap shows in Figure 7.

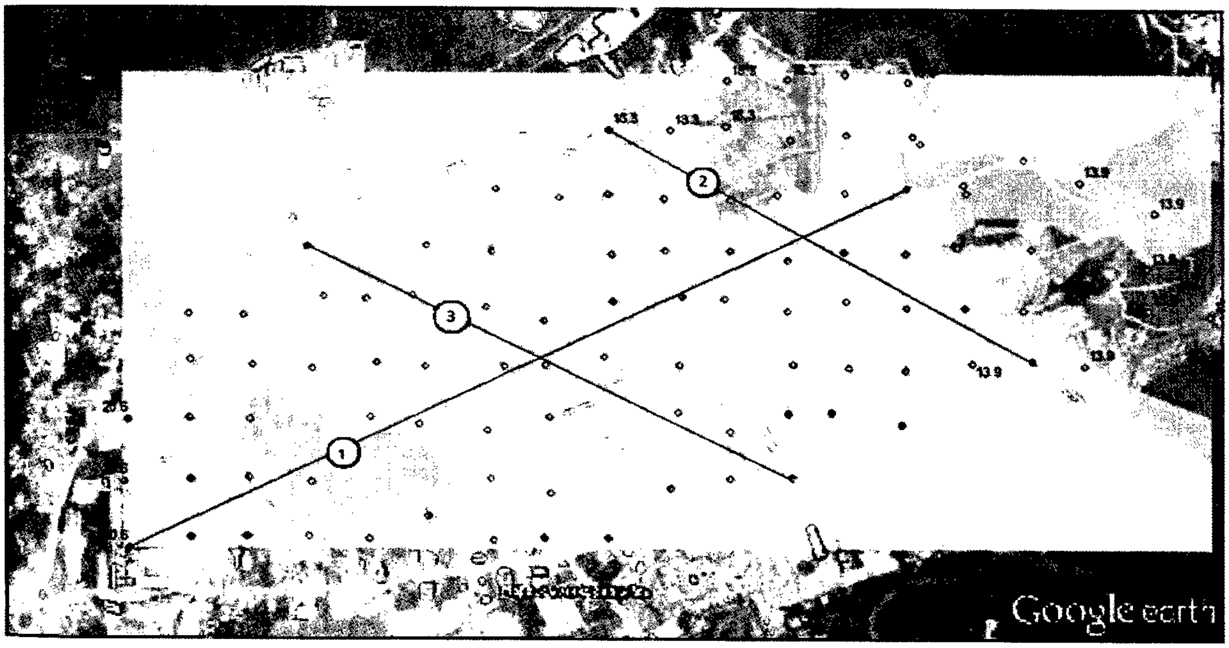

Figure 3.6: Line cross section

3.5 RESULTS SUMMARY

The result to answer the objective that will be calculated with the same method to example show in processing. The average of monthly rainfall was obtained from each month of the possible depth each table of rainfall calculation. The cross section graph also views in the next chapter.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the findings of which were obtained from Chapter 3, is shown in Table form. Further analysis will be conduct in this chapter.

4.2 RESULT AND DISCUSSION

4.2.1 Rainfall Depth

Based on the calculation of the rainfall into water balance equation, the possible depth was obtained and the graph to show the characteristic of the rainfall on the area and time period of study area. This following graph shows on flooding incident at 2001-2002 and 2013-2014.

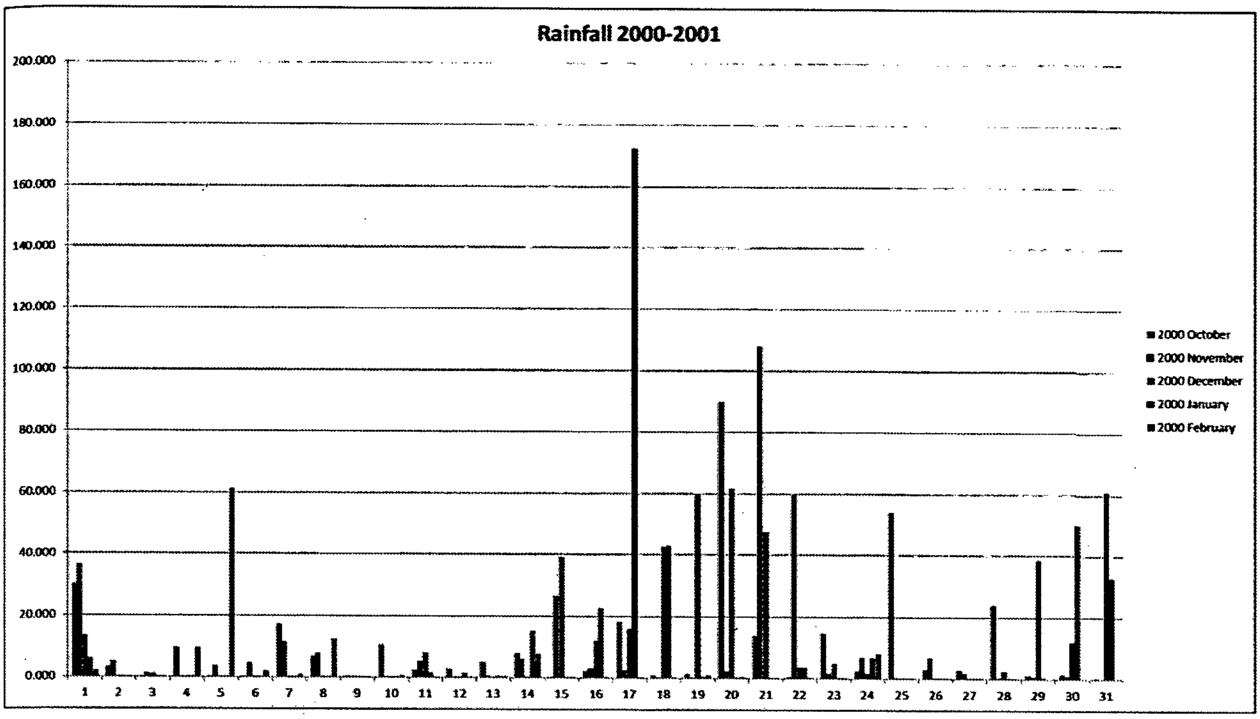

Figure 4.1: Rainfall on 2000-2001

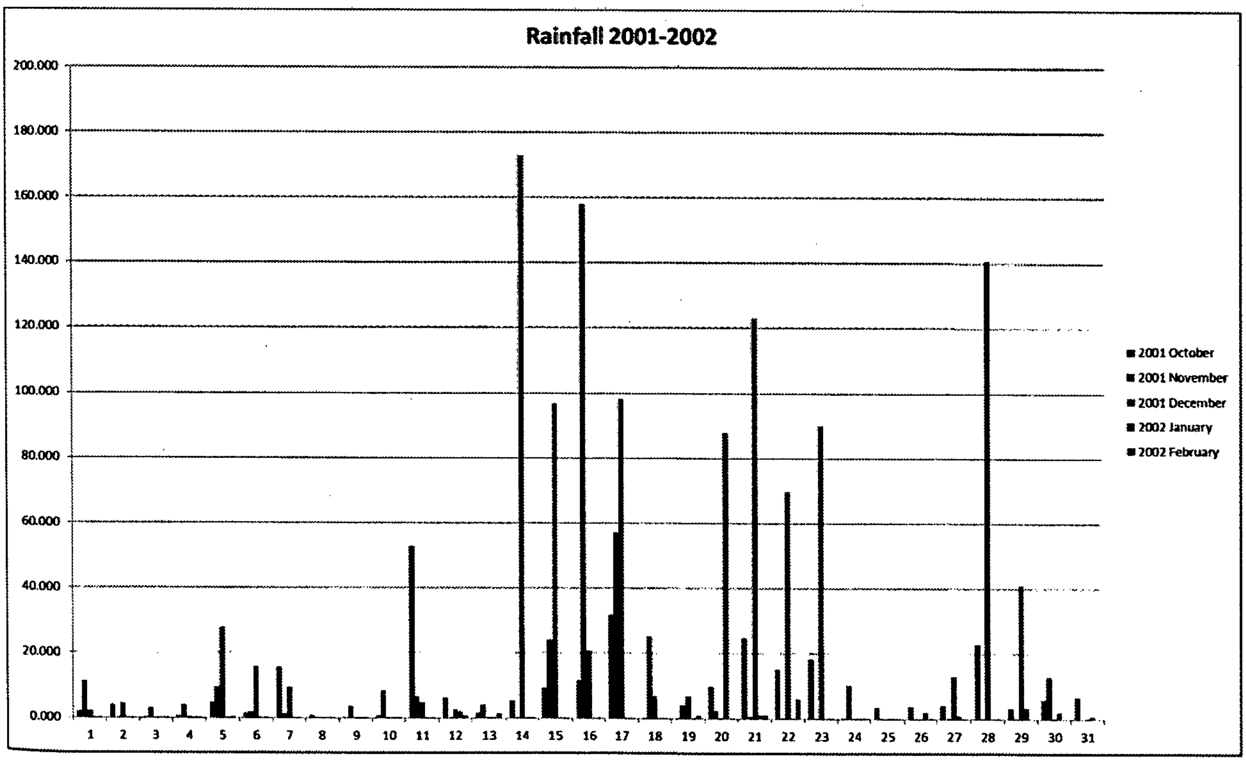

Figure 4.2: Rainfall on 2001-2002