ARAYAT STREAMFLOW MEASUREMENT

FIELDWORK REPORT

By

Paula Sauniveikau Tawakece

Hydrologist Trainee

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1.0 Introduction

Field practical work was carried out at Arayat river basin. The weather was fine during the days of field work with no rainfall and water level continues receding. There were twenty-six hydrologist trainees on this field exercise to demonstrate procedures required during hydrological field work especially on methods of river flow gauging.

2.0 Objective

The main purpose of this exercise is how to measure high flow measurement particularly Medium and Flood flow discharge by using indirect method slope –Area and float and direct method ADCP. All these measurement method has limitation that the flow has to be confining to its channel.

3.0 Site Description

From the recent typhoon Santi rainfall intensity experienced at the basin that caused flooding therefore the river water level overtopped its bank and inundated the flat area downstream and upstream of the bridge crossing the river. The flood left its trace of debris, high water level marks, loam soils and silt that is visible around the area.

There are two water level stations structure the telemetered water level recording station (sensor cable /electronic data logger system) is located at the approaching end of the bridge at right bank downstream .It is assume that the telemetered water level recorder site is on the safe height above historic highest flood mark. The other at upstream of bridge is the old water level recorder (counter weight system) structure where the station datum was established. The water level 0 - 5m staff gauge is attached to the bridge center pier with stacking debris covering it. The water level reading at that particular day was 5.4 meters just below half a meter from the flood critical level.

Looking at the river channel geometry the straight river reach is not possible to identify whereby at the flow monitoring site was conducted it can be said that the flow surface water distribution across the river channel is not uniformly straight .Appeared at near river bank flow were ripples, eddies, stagnant which took time to recover to its stretch flow regime.

At the left – bank upstream of the bridge on a inundated flat plain water propagation reached the elevated bank embankment curve alignment and turn in back to the river normal contraction near the bridge and propagated downstream at the right bank side extended beyond houses location.

At the high water level channel banks is partially covered with reeds, trees and low grass.

Figure 1.

Channel Shape

River Channel geometry bends at the old recorder site and form straight reaches at below bridge shown above. River x-section that was measured in dotted line.

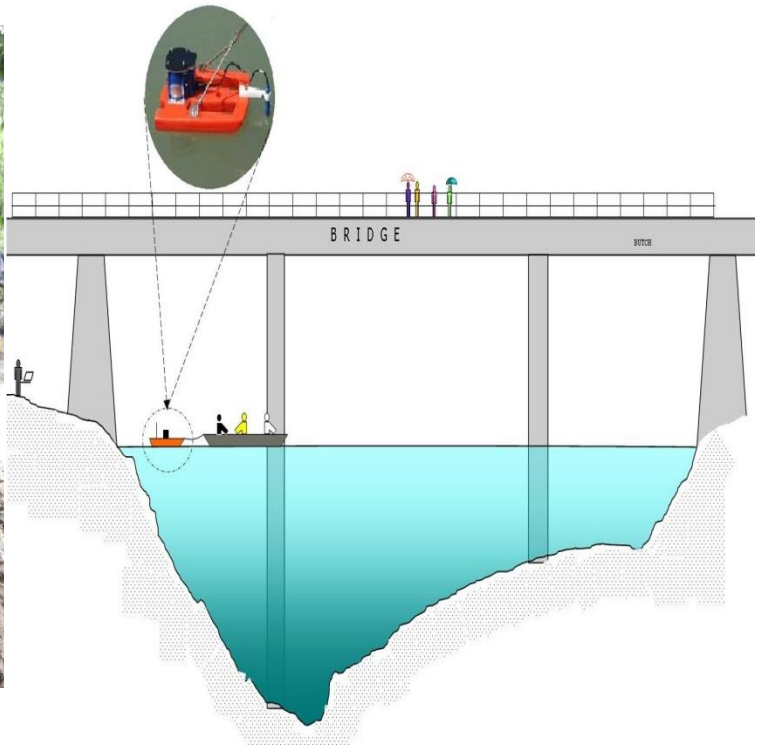
4.0 Method of Measurement taken

4.1 ADCP Doppler Current Profiler

Assembling of the instrument was carried out such as fitting of antenna, data logger and computer interface connection. Before taking the measurement the instrument was calibrated .Gauging site selected was about 50m above bridge and width of the river was 300m distance. The flow current still strong that the boat which guiding the ADCP Doppler find difficulties to transect across the river perpendicular to the flow. Adjusting the flow measurement repeated procedures of three cross-section measurement was taken to produce average flow value.

Figure 2.

ADCP Doppler Calibration



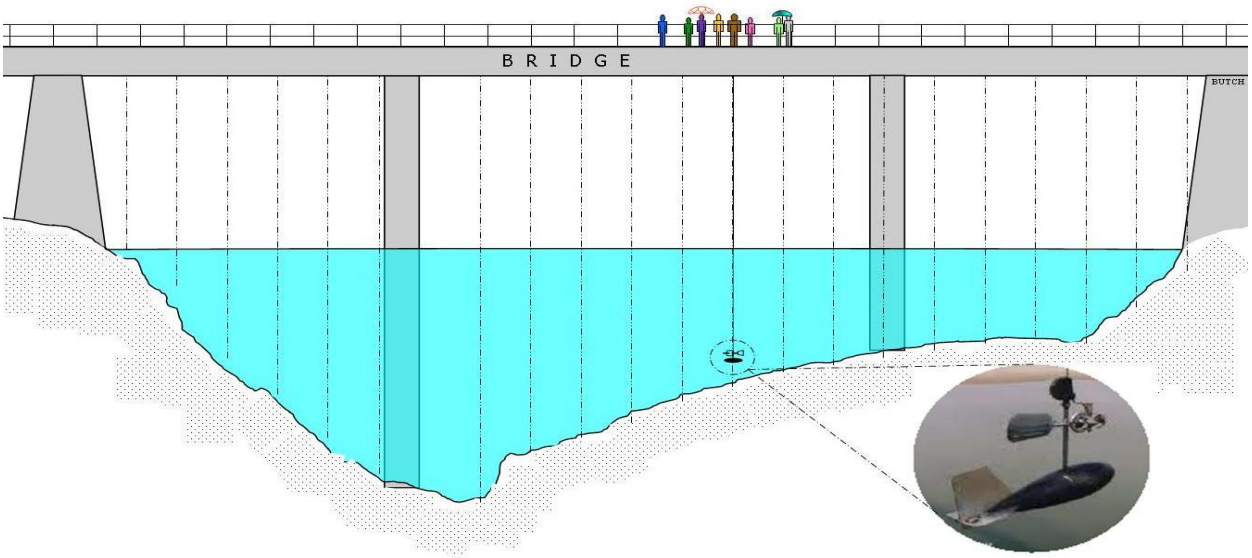
4.2 Bridge Gauging

The measurement was carried out on top of bridge by using conventional current meter .The width was divided into 5 m interval across the bridge. Measurement started from water edge left bank and suspension of Columbus and propeller was conducted in taking the depth from water surface to riverbed and applying 1point (0.6) 2 point (0.2 ,0.8) and 3 point (0.2,0.6,0.8) velocity profile method. Strong current flow which may drag length of the line out of the reel will not equal depth may apply dryline or wetline correction.

Procedures:

I. Winch out the first point of gauging
II. Lower the bomb until it touches the water. Zero your depth counter
III. Lower your bomb until it touches the bed. Raise (Lift) the bomb until there is a sag in the main cable.
IV. Read the depth counter. This gives the depth of water at that point. Write it down. Calculate your points (0.2, 0.8) or (0.2, 0.6, 0.8).
V. Raise – Lift the instrument until the propeller is on the surface of the water.
VI. Zero the depth counter. Lower your instrument to the calculated depth, on counter and stop.
VII. Hook up the counter to the cableway terminal and take the revolution counted in the time (60 secs).
VIII. Lower the instrument to the next depth (0.2, 0.8). Took a revolution
IX. For depth above 1m (0.2, 0.6, 0.8).
X. Read the staff gauge at the beginning , mid through , and at the end of the measurement

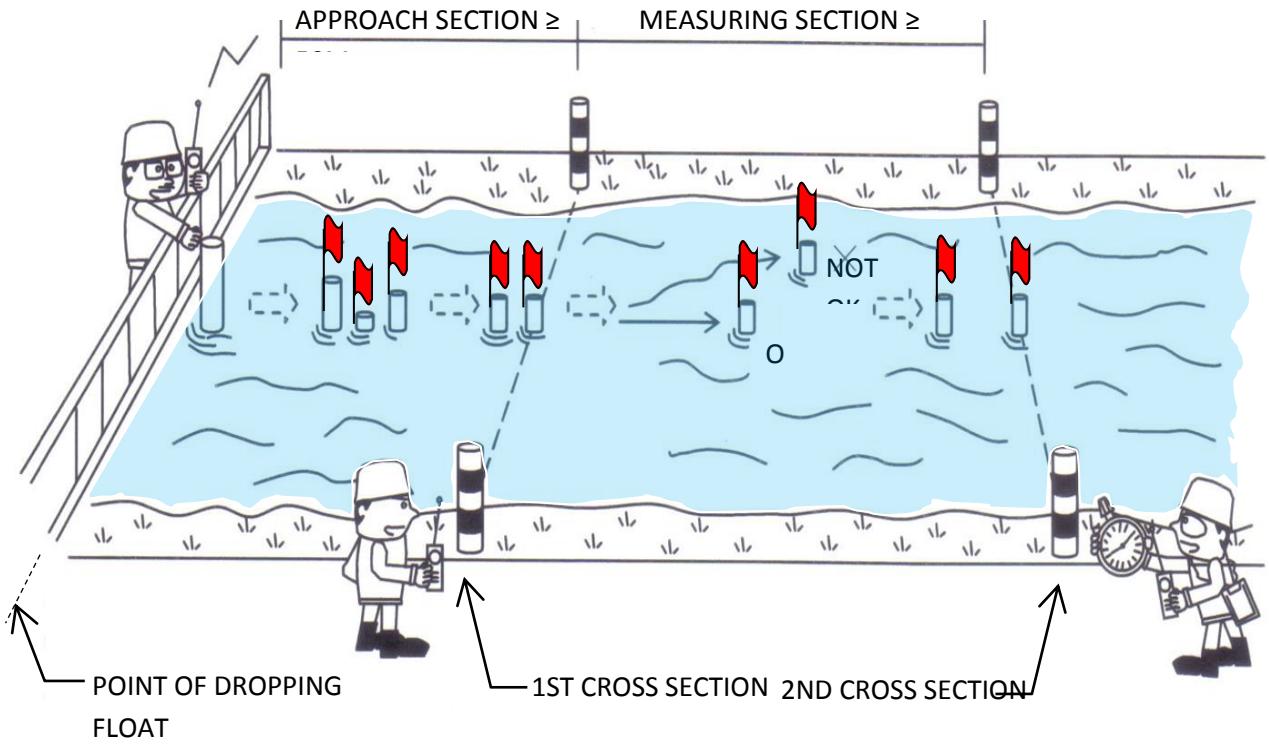
Figure 3.



4.3 Float Gauging

The Float method was also carried out at the top of bridge where the channel geometry of the flow is perpendicular to bridge width position. The vertical width was divided from the total width and marked accordingly. The bamboo was designed as a floater to represent surface water velocity measurement in time. Along the river reach downstream of the bridge the first check section at30m and further 50m is second check section. The floater was dropped from its vertical width correspond to its velocity streamline. The first check marker has to callout start or raise up the flag and simultaneously press his stopwatch to indicate that it has reach him then to the second marker is reached and time is recorded respectively. Three of the floats that were dropped did not emerge and was recorded with no measurement. All measurement was recorded in a notebook.

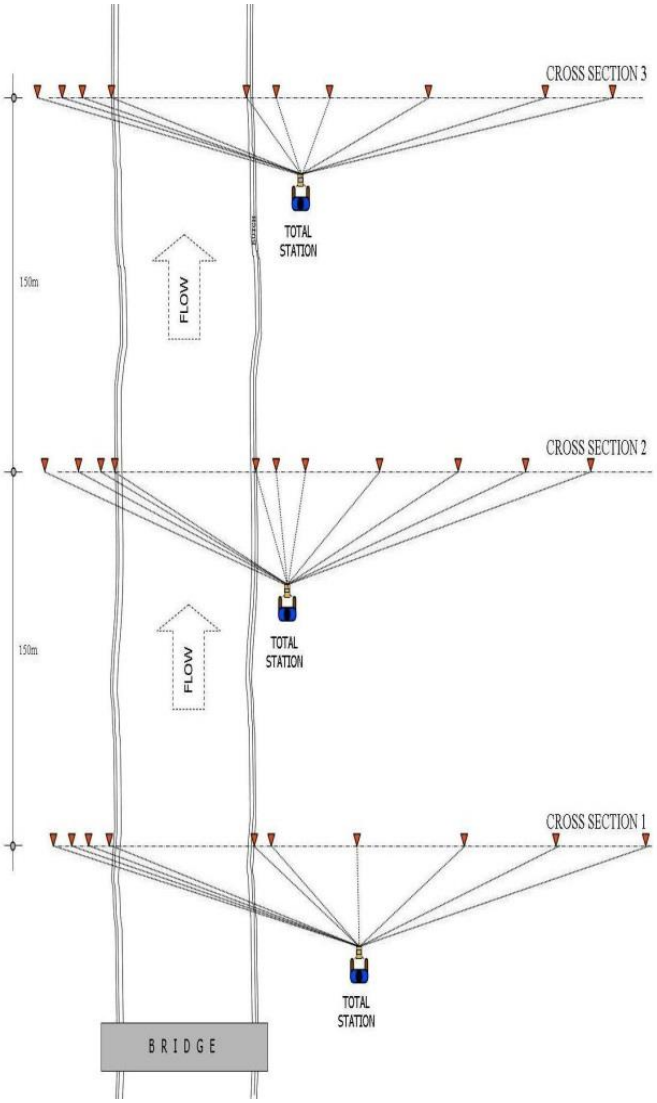
Figure 4.



4.4 Slope-Area

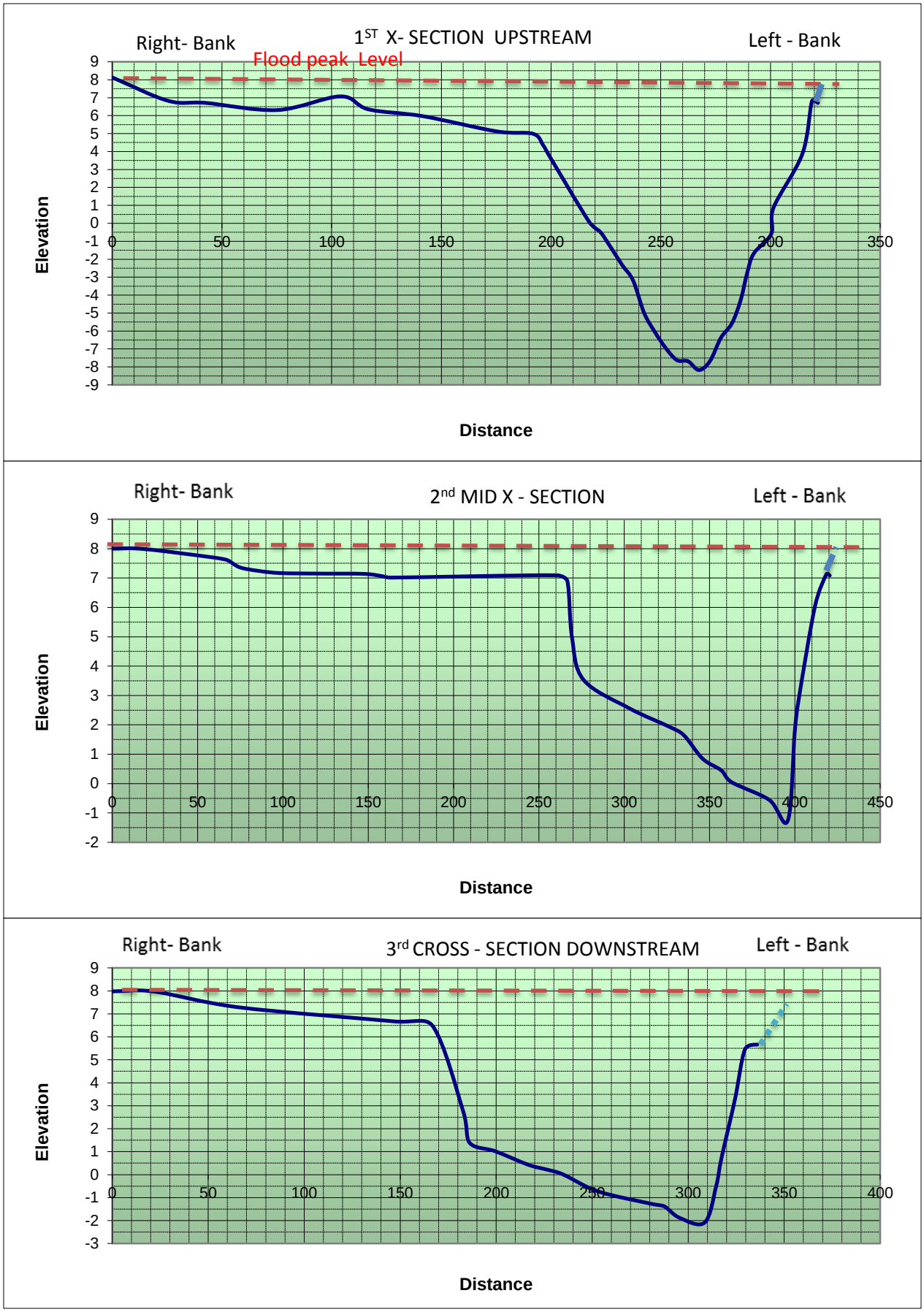
The slope-Area method is an indirect method of obtaining peak discharge of flood event. By carrying out this method a survey instrument total station was used to conduct a river-cross section survey. The survey started at setting up the instrument at old water level recorder where the station BM was established. The BM (9.11msl) was the starting reference point of survey that was carried out and transferred to the right bank .The survey purpose was to obtain surface water slope or in other word energy gradient line and three cross-sectional areas from upstream and downstream. The river cross-section was divided in 100m apart from the initial flood mark elevation right bank and left bank. In the river; sounding depth was taken to obtain surface water and river bed depth. Before conducting sounding depth the tagline was tied from both side of the river bank to guide the measurement activity perpendicular to the flow but unfortunately was not tightly knotted where the width was not well represented as expected.

Figure 5.



Total Station Survey Instrument

4.5 RIVER CROSS - SECTION



5.0 Computation

5.1 ADCP DOPPLER

The river water contains a lot of suspended substance such as animal and plankton or suspended sand. ADCP emits the supersonic wave into the water for direction, degree from vertical angle and measure the reflected wave changes from the suspended substance or the riverbed. The frequency of the measure waves changes because wave substance in the water is moving. By counting the data from pair of remitting system, backward, 3 dimension current velocity distributions (current velocity profile) in the flow section is worked out.The current velocity profile is also used to integrate vertical flow direction and current velocity composition to river cross section and it will calculate the flow discharge.

5.2 Bridge Gauging

Discharge method is an A×V method. The discharge through the cross – section is the wet cross section area multiplied by the average stream flow velocity. The mean velocity by measuring the velocity at point by counting the number of revolutions current metre during a short time period of 60secs. The relation between the rotation n of the propeller and the stream flow velocity v is obtained from the calibration graph of the propeller and is equal to :

$$V = \infty \times \beta . N$$

V = velocity of a current at a point

∞ β = constants, indicated in a certificate provided by the current metre manufacturer

5.3 Float Gauging

The 3 section marked by pegs are surveyed, and an average cross-section is calculated. The (V) is calculated by dividing the distance (in metres) by the time (in seconds) it has taken for the float to

travel the measured distance. Velocity is multiplied by the factor (0.85) to give the mean velocity of the vertical. This correction is necessary because the float is travelling on the surface of the water and the velocity of the water at the surface is faster than the bottom (bed). Multiplying the area of the section will give the discharge through that section.

5.4 Slope – Area Method **(** Using Manning formulae)

The computation used is based on hydraulic formulas for uniform steady flow :

$$Q = \frac{A * S^{1/2} * R^{2/3}}{n}$$

where

Q = total discharge

A = Cross – section Area

V = Mean Velocity in cross – section

n = Roughness coefficients

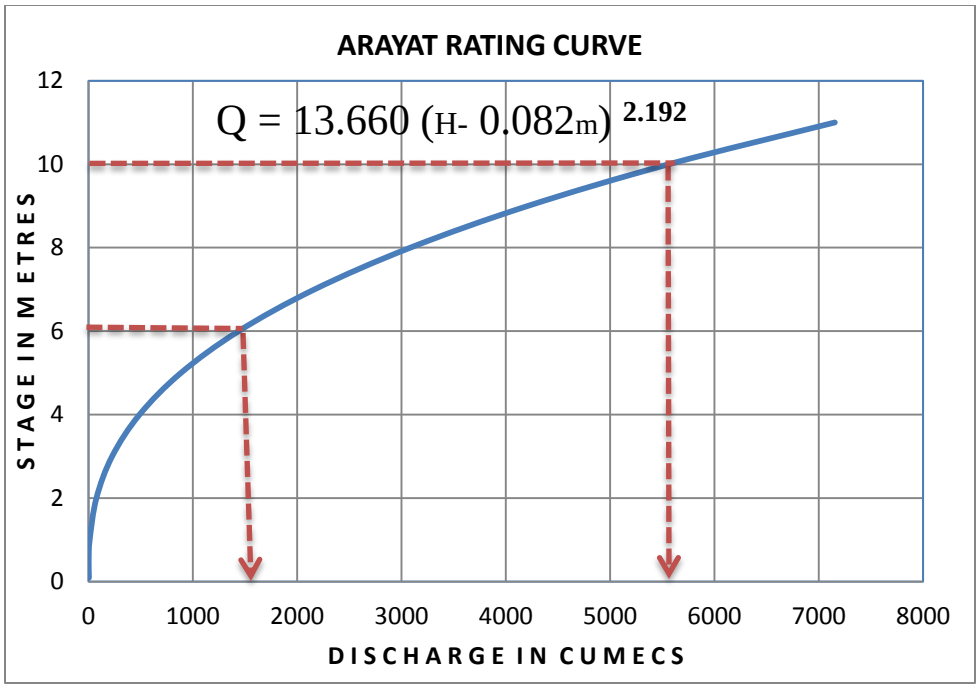
R = Hydraulic radius

S = Slope of water surface

6.0 Result

Table 1.

Measurement Method	**Date of measurement**	**Stage (m)**	**Discharge (m^3/sec)**
ADCP	17.10.2013	5.4	473.0
Current meter	18.10.2013	4.7	350.0
Float	21.01.2013	3.2	269.0
Slope- area	22.10.2013	8.2	3579.0



H	Q
0.082	0
0.1	4
0.5	1.391
1.0	10.918
2.0	75.212
3.0	225.737
4.0	488.488
5.0	885.897
6.0	1438.571
7.0	2165.348
8.0	3083.93
9.0	4211.06
10.0	5563.69
11.0	7154.101

CALCULATED IN LOGARITHM

7.0 Conclusion and Recommendation

- The practical exercise was a very good experience on how the high discharge method carried out after a flood event or medium flow measurement to obtain its discharge.
- The geometry or shape of the river channel is not a good representative of straight uniform reach of the river characteristic for slope – area method.
- The tagline and boat to be align perpendicular to the flow of the river during measurement
- Measured discharge result could be at its reasonable limits of how it was conducted and was adjusted.
- Standard gauging card shall be provided to fill all measurement and noted remark for computation rather than notebook
- Survey level book also should be used rather than note book
- Propose Installation of cable way is appropriate at further upstream site where flood water level is confine to its channel and no tributary inflow along this reach downstream to the existing telemetric water level recorder station.

FIELD VISITS:

8.1 La Mesa Watershed and Eco-Park

Staff reading the staff -gauge Spillway overflowing Dam Reservoir

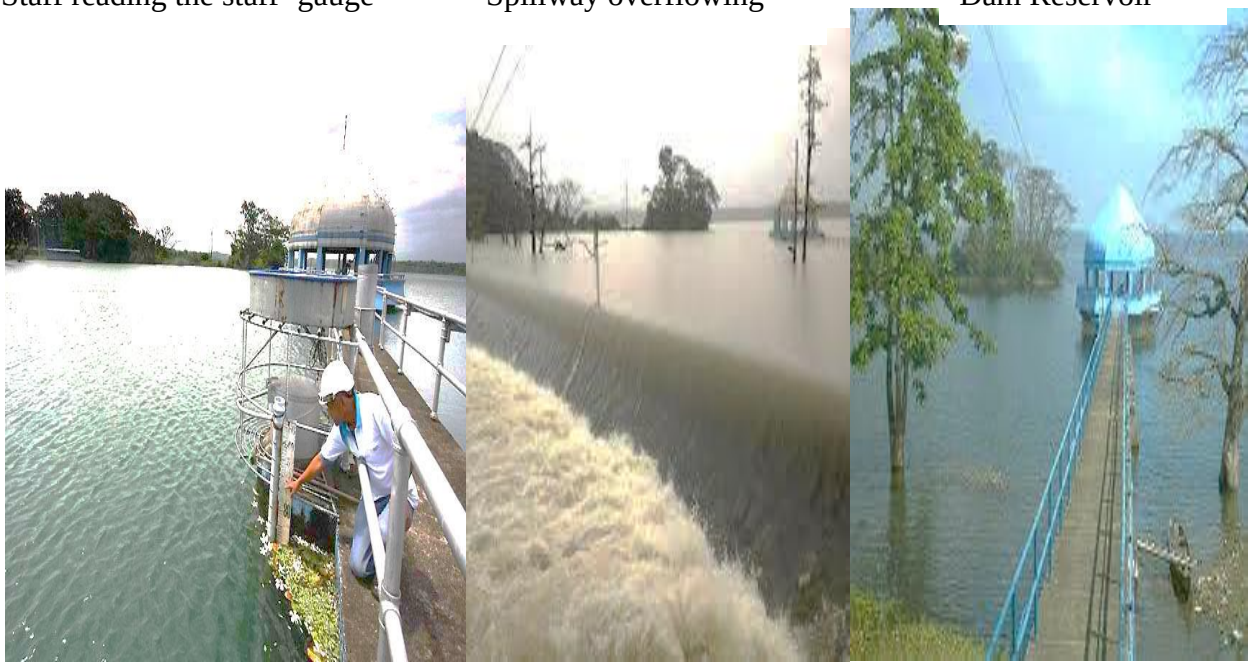


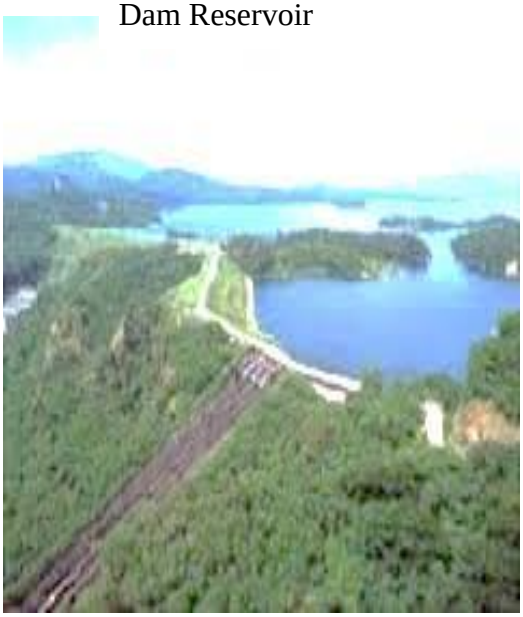
Figure 6.

The **La Mesa Watershed and Eco-Park** consists of the **La Mesa Dam** and an ecological nature reserve site in Quezon City that was commissioned in 1929. It is part of the Angat-Ipo-La Mesa water system, which supplies most of the water supply of Metro Manila. The La Mesa Dam is an earth dams whose reservoir capacity of 50.5 million cubic meters and the catchment area of 27 km^2. The dam forms a spillway purposely as a device for catchment excessive water outflow.

The water collected in the reservoir is treated on-site by the Maynilad Water Services, and at the Balara Treatment Plant further south by the Manila Water. Both water companies are private concessionaires awarded by the Metropolitan Waterworks and Sewage System, the government agency in charge of water supply. It is a vital link to the water requirements of 12 million residents of Metro Manila considering that 1.5 million liters of water pass through this reservoir every day. It is also the last forest of its size in the metropolis.

8.2 Pantabangan Multipurpose Dam

Dam Reservoir



Flood gate

Figure 7.

Pantabangan Dam is an earth-fill embankment dam on the Pampanga River_located in Pantabangan in Nueva Ecija province of the Philippines. The multi-purpose dam provides water for irrigation and hydroelectric power generation while its reservoir, Pantabangan Lake, affords flood control. The reservoir is considered one of the largest in Southeast Asia and also one of the cleanest in the Philippines. Construction on the dam began in 1971 and it was complete in 1977.

In May 1969, the Congress of the Philippines authorized the development of the Pampanga Basin with Republic Act No. 5499. In October of that year, detailed studies of the Pantabangan site were carried out and lasted two years. The dam went into operation in February 1977 and was completed later in May. Approximately 1,300 people were relocated from the dam's reservoir zone.

The dam is a 107 m (351 ft) tall and 1,615 m (5,299 ft) long embankment-type with 9,174,658 m^3 of homogeneous earth-fill and an impervious core. The crest of the dam is 12 m wide while the widest part of its base is 535 m. The dam's crest sits at an elevation of 232 m and is composed of

three sections: the main dam, a saddle dam, and an auxiliary dam located with the spillway. The spillway is a chute-type controlled by three radial gates but equipped with an overflow section. The design discharge of the spillway is 4,200 m^3/s. The dam's reservoir has a gross capacity of 2,996,000,000 m^3 and 2,083,000,000 m^3 of that volume is active (or useful) for irrigation and power. The dam sits at the head of a 853 km^2 catchment area and its reservoir has a surface area of 69.62 km^2 and elevation of 230 m when at its maximum level. The reservoir's life is estimated at 107 years due to silt from denudation. The dam was design to withstand an intensity 10 earthquake.

The power house is located at the base of the main dam and contains two 50 MW turbine-generators for an installed capacity of 100 MW. Each turbine receives water via a 6 m diameter penstock. When the water is discharged, it is released into a 250 m long tailrace channel where it re-enters the river.

8.3 ANGAT DAM FLOOD FORECASTING AND WARNING SYSTEM

Piloted by the Government in 1973, this dam is 50 kilometers upstream from the Bustos Dam. It has coordinates of 14°57'25"N 120°57'15"E serving nearby cities like Real, Quezon, Rodriguez (Montalban), Rizal, Antipolo City, Rizal.

Angat Dam is a concrete water reservoir embankment/hydroelectric dam that supplies water the Metro Manila area. It was a part of the Angat-Ipo-La Mesa water system. The reservoir supplies more or less 90 percent of raw water requirements for Metro Manila through the facilities of the Metropolitan Waterworks and Sewerage System and it irrigates about 28,000 hectares of farmland in the provinces of Bulacan and Pampanga which are their present main priority.

Angat dam covers the area of 10,540sq.km. And have a normal high water level of 210 meters and a critical high level of 219m.

It has three gates opening a total of 1.5 meters to gradually release water that had accumulated

due to continues rains during typhoons. Prior to the actual opening of gates public warning is discriminated 3-4 hours before.

Angat dam supplies potable water and energy to Metro Manila and nearby areas. Surrounded by lush greens, this place is also ideal for fishing, boating and hunting.

Angat Dam is being controlled by the National Power Corporation (NPC) Flood Forecasting and Warning System. Angat dam has a customized flood model designed by JICA.

It has a hydro-electric power plant that has a capacity of 256MW. But due to the present demand of water in metro manila area and the irrigation requirements of farmlands in Bulacan and Pampanga, only partial power is generated by the said power plant.

The dam vicinity is monitored by 4 rain gauges & 1 water level gauge strategically installed with hourly recording thru telemetry. It discharges water in 60 cu.m. per second.

The water from Angat to La Mesa Dam is for domestic use in Metro Manila. Meanwhile, water going to Bustos Dam is for NIA for their irrigation network.

8.4 CALUMPIT MDRRMC

Figure 8.

Calumpit is a first class urban municipality in the Province of Bulacan, Philippines. According to the 2010 census, it has a population of 101,068 people. Fifty-four (54) kilometers north of Manila, the Municipality of Calumpit bounded on the north and west by Apalit and Macabebe, Pampanga, respectively; southwest, southeast and east by Hagonoy, Malolos, and Pulilan, Bulacan respectively.The climate of Calumpit is practically similar with that of the rest of the other municipalities in the province of Bulacan. It is characterized by two (2) distinct seasons namely; the rainy and the dry. The rainy seasons starts from May to around November, while the dry season is from December to April. The average annual rainfall is 255.3 millimeters (10.05 in) with the month of August having the highest month average rainfall is about 304 millimeters (12.0 in). The annual number of rainy days is 175 days.

Since the location of Calumpit is lower than the other nearby municipalities it usually experiences flooding every time there is continues rainfall for several days over the area. The flooding usually results to damage of life, properties, infrastructures and agricultural crops.

Because flooding has been a perennial problem on that area, the local government designed a means to reduce disasters risk by creating a flood preparedness program within their locality. They create a monitoring center to keep track of the four major dams within their area of concern. The center acquires data from PAGASA website, Project NOAH, MMDA, Google Maps, DSWD, GMA7; documenting events like flooding in the area into their database every 6 hours including High and Low tides; and coordinating with other nearby LGU whenever the need arises.

Besides from monitoring and gathering data, they develop warning and response capabilities against flooding by creating rescue teams geared with various life-saving equipment. These teams are ready to react anytime there is an incoming disaster that will pass by their area.

These risk reduction practices of the said local government unit is nearly perfected and have been effective, thus, they were awarded as one of the outstanding LGU on risk reduction management.

8.5 CONG DADONG DAM IN ARAYAT, PAMPANGA

Flood gate

Irrigation diversion

Figure 9.

The P3.4-billion Cong Dadong Dam here, designed to irrigate 10,270 hectares of farms in seven eastern towns, feeds only some 3,500 ha despite a slight surplus amid the long dry spell in Luzon.

The dam is also servicing a fraction of its service area because some canals had been damaged, a number of farms had been converted to commercial uses and the maps used to estimate the farmlands were old and did not reflect actual land use by the time the project resumed in 1996.

Its critical level is 7 meters but the water level has never fallen to that point. The dam operates year round, dispersing water through a network of canals supposed to be 31.8-km long.

Because water was enough, the dam has occasionally fed 200 ha of rice land in Barangay Sta. Isabel in Cabiao, Nueva Ecija. The potential irrigable area on the dam's Nueva Ecija side is some 3,000 ha. The dam should benefit thousands of farmers in that area.

Appendix

Telemetric Water level Recorder reached by flood water

Aratyat River during high water turbidity

Debris after Flood can be seen

Old Water Level Recorder