TECHNICAL REPORT

on

Fieldwork River Cross Sectioning

@ Arayat Station Pampanga River

Submitted by:

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HTC Trainee 2013-2014

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1. Acknowledgement

This fieldwork activity would not be possible without the help and guidance of Sir Hilton Hernando & Sir Toots from PRFFWC and Sir Jun Paat Jr. & Sir Roy Badilla and Manong Rey from HMD who assisted in the proper conduct of the four discharge measurements also to my groupmates at group 2 team relax lead by Boss Leo D. Ortega for doing our daily task with full cooperation of every member and of course the training staff headed by Mam Encar, Mam Jo & Bro. Louie.

2. Introduction

The concept of the amount of water flowing in a body of water is closely related to streamflow. Streamflow, or *discharge,* is the volume of water that moves over a designated point over a fixed period of time. It is often expressed in cubic meters per second (m3/sec) or *cumecs.* Streamflow greatly influences the character of a stream. On the other hand, the concept of the river's depth relates the term "stage". Stream stage (also called *gage height*) is the height of the water above an established altitude where the stage is zero (0). This zero level is arbitrary, but is often close to the streambed.

Lately our country especially in central luzon has suffered massive devastation caused by intense rains and flooding made by Typhoon Santi. The heavy and massive amounts of rainfall induced flooding and flooded the nearby areas. Many of the barangays in Pampanga were flooded with some of which are from the town of Arayat.

River cross-sections, & other data from rain gauge and water level stations are importance in order to efficiently simulate flooding events when there are impending weather systems that may threaten the river basin thereby inflicting destructive effects to human lives and properties.

3. Background

As part of the hydrologist training for the Discharge Measurement component of the Stream Gauging Course, my fieldwork report entitled:

River Cross Sectioning @ Arayat Station Pampanga River

This study was selected and designed on the basis of the following factors:

- **Practical application of discharge measurement/stream gauging;**
- **Availability of instruments/equipment which minimizes fieldwork costs.**

4. Objectives

The fieldwork conducted is guided to fully understand and conduct an actual discharge measurement/stream gauging to implement the five indirect and direct methods of discharge measurement in the Arayat station of the Pampanga River.

a.) to investigate the behaviour of the flooding event in the Arayat Station of Pampanga River; and

b.) Compare and contrast the five discharge measurement methods such as:

- **Method 1 (Float Method)**
- **Method 2 (Slope-Area)**
- **Method 3 (Acoustic Doppler Current Profiler)**
- **Method 4 (Current Meter) – using Boat Method**
- **Method 5 (Rope Weight)**

c.) Compilation and Manipulation of data gathered to compute for the discharge measurement and to arrive at a rating curve and rating curve equation

5. Site Description: San Agustin Bridge Arayat, Pampanga

A large portion of Mount Arayat is located within this municipality.

Pampanga river in this town had been the target area of study of a two-week field work done by the Hydrolgist training class from October 17-22, 2013. It has its banks which are mostly covered with mud and grasses, the water generally flows at a slow movement.

The river is associated with a Bridge named San Agustin Bridge. As the reference landmark taking into consideration the existence of the old benchmark. Along with it is the Arayat RR & WL station, it is unmanned telemetered station located before the bridge.

Figure 1. A view of the upstream of Pampanga River in Arayat

6. Methodology

During the ten-day fieldwork, four methods of discharge measurement were done in the downstream portion of the San Agustin Bridge in Arayat, Pampanga. And one on the bridge (Rope Weight Method) performed by other one group only. Of the four methods, some were direct measurements such as the float, ADCP and current meter methods while slope area method is an indirect measurement. Details of each method were summarized in the following sections below.

a. Float Method

The float method is generally applied for floods which discharge observation by current meter and all other techniques is impractical to use. As the name of the method implies, floats are thrown down into the river and their travelling time in a certain cross section of the river is measured thus, the average velocity in the section can be estimated. This method is the easiest, most practical and cost-effective method for discharge measurements during high flow.

Floats are thrown from bridges but there are emergency cases when they are thrown from the river bank. Float materials used for this study are improvised using bamboo sections of about 1-meter length, filled with 3/4 –full sand with a flag marker for visibility. Travelling time of the float was determined using a stopwatch.

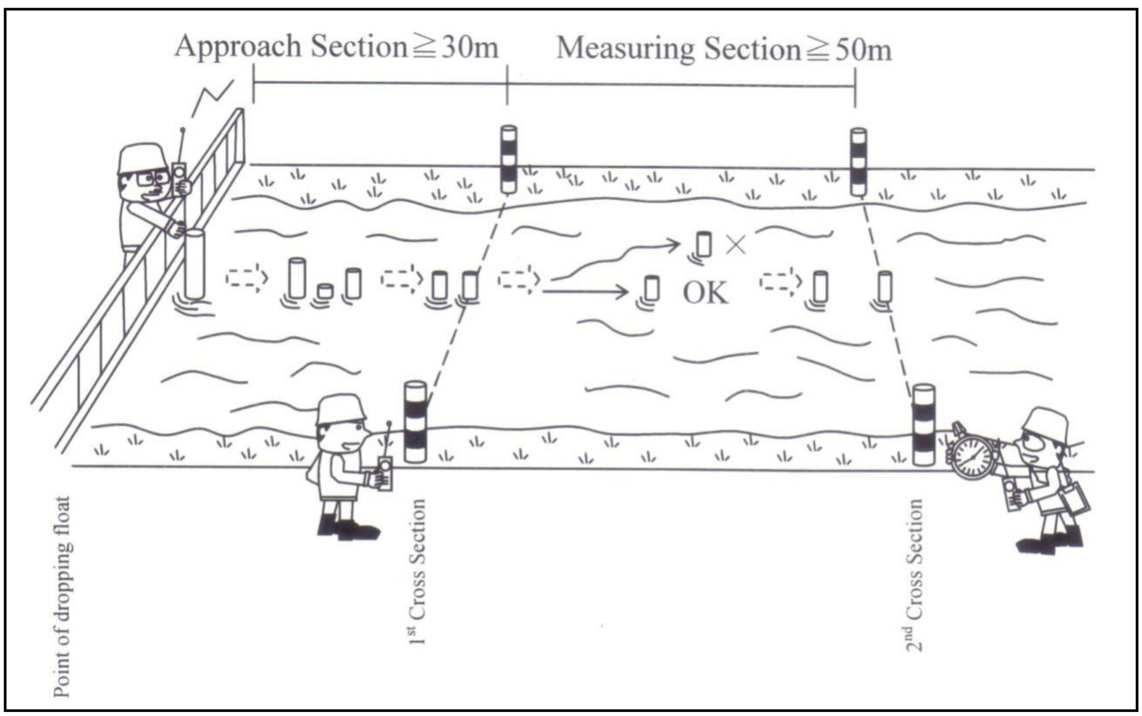


Figure 2. Discharge measurement by float method.

A requirement for this method is a straight section of the river with enough length consisting of approach section and measurement section. The approach section is from dropping point to the first cross section which requires at least 30-meter distance in order to enable a float to maintain its draft. The measurement section is from the first cross section to the second cross section in order to measure the travelling time of a float which requires at least 50 meters. However, in practice, the distance is determined by the maximum velocity multiplied by 10-15 seconds. In Japan, distances ranging from 50 to 100 meters are popular. Too long section causes error in measurement due to variation of stage for long travelling time.

Since discharge observation by float is conducted during high floods, it is difficult to measure water depth simultaneously thus, only water level is measured during discharge observation by float and cross section survey is conducted to estimate discharge area soon after the flood.

In the duration of the fieldwork activity, the two cross sections were measured by boat method using an echo sounder to record water depth and a range-finder to determine the distance of every vertical reckoned from the water edge. Water levels upon the start of observation and at the end were noted to be used to estimate the discharge area of each cross-section using the equation $Q_i = V_i \times A_i$.

b. Slope-Area Method

The slope-area method consists of using the slope of the water surface in a uniform reach of channel and the average cross-sectional area of that reach to give a rate of discharge. The discharge may be computed from the Manning formula:

$$Q = (1.486/n)\ A\ R_h^{2/3} S^{1/2}$$

where:

Q = discharge (m^3/s)

A = mean area of the channel cross section (m^2)

R_h = mean hydraulic radius of the channel (m)

σ = energy slope of the flow

n = a roughness factor depending on the character of the channel lining

A fairly straight reach of the channel should be chosen with length of equal or greater than 75 times the mean water depth and is a contracting area. If the reach is free of rapids, abrupt falls, or sudden contractions or expansions, then the water surface slope is the same as the energy slope.

Figure 3. Fairly straight river reach

The slope, σ, or the fall may be determined by dividing the difference in the water surface elevations at the two ends of the reach represented by the high water marks in cross sections 1 and 3 by the total length of the reach. A value of greater than or equal to 0.15 or greater than or equal to the velocity head should be attained.

The hydraulic radius, R_h, is defined as the area of the cross section divided by its wetted perimeter. Where the channel or canal is of regular cross section, and the depths at the ends of the course are equal, the area and the wetted perimeter will be constant through-out the course. In irregular channels, the area and the wetted perimeter at several cross sections will be required, and a mean value will be used in computing the hydraulic radius.

The factor, *n*, depends on the character of the channel. It may vary from 0.010, where conditions approaching the ideal are maintained, to 0.060, where the channel is strewn with stones and debris or is about one-third full of vegetation.

Because the proper selection of the roughness factor, *n*, for many streams is difficult and is, at best, an estimate, the discharge determined by the slope-area method is only approximate. Care must be taken to determine the slope and areas simultaneously if the water levels are changing.

Using the total station, the benchmark (BM) in the old station at the left bank upstream of the Pampanga River was used. The known elevation of 9.114 meters was used to start with the measurements. In this study, a total of 36 Tie Points and 5 BM Backsights were measured taking off from the known elevation in the benchmark to the three cross sections for this method. The following equations were used to compute for the elevations of each TP and the Height of the Instrument. Several readings taken from the total station used were the Vertical Distance (VD), Horizontal Distance (HD) and Horizontal Angle (HA).

$$HI = BM + \text{Height of Prism Rod} - BS$$

$$\text{Unknown Elevation} = HI + FS - \text{Height of Prism Rod}$$

where: **HI = height of Instrument**
BM = Benchmark Elevation
BS = Back Sight (VD)
FS = Fore Sight (VD)

For easy computations, an excel suite provided by the PRFFWC for automatic discharge computation by slope-area method was provided.

c. Acoustic Doppler Current Profiler Method

In recent years, advances in technology have allowed the USGS to make discharge measurements by use of an Acoustic Doppler Current Profiler (ADCP). An ADCP uses the principles of the Doppler Effect to measure the velocity of water. The Doppler Effect is the phenomenon we experience when passed by a car or train that is sounding its horn. As the car or train passes, the sound of the horn seems to drop in frequency.

The ADCP uses the Doppler Effect to determine water velocity by sending a sound pulse into the water and measuring the change in frequency of that sound pulse reflected back to the ADCP by sediment or other particulates being transported in the water. The change in frequency, or Doppler Shift, that is measured by the ADCP is translated into water velocity. The sound is transmitted into the water from a transducer to the bottom of the river and receives return signals throughout the entire depth. The ADCP also uses acoustics to measure water depth by measuring the travel time of a pulse of sound to reach the river bottom at back to the ADCP.

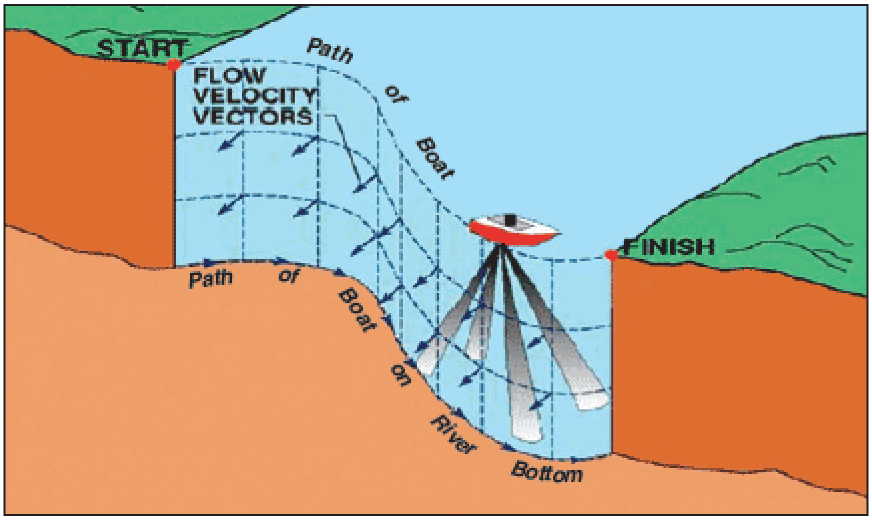


Figure 4. The ADCP Principle of discharge measurement

To make a discharge measurement, the ADCP is mounted onto a boat or into a small watercraft with its acoustic beams directed into the water from the water surface. The ADCP is then guided across the surface of the river to obtain measurements of velocity and depth across the channel. The river-bottom tracking capability of the ADCP acoustic beams or a Global Positioning System (GPS) is used to track the progress of the ADCP across the channel and provide channel-width measurements. Using the depth and width measurements for calculating the area and the velocity measurements, the discharge is computed by the ADCP using discharge = area x velocity, similar to the conventional current-meter method. Acoustic velocity meters have also been developed for making wading measurements.

The World Meteorological Organization (WMO) guide to stream gauging using ADCP suggests four transects to be measured at certain distances. For this study, a total of eight transects were measured at varying distances estimated from each transect.

d. Current Meter Method

The most common method used by the USGS for measuring discharge is the mechanical current-meter method. In this method, the stream channel cross section is divided into numerous vertical subsections. In each subsection, the area is obtained by measuring the width and depth of the subsection, and the water velocity is determined using a current meter. The discharge in each subsection is computed by multiplying the subsection area by the measured velocity. The total discharge is then computed by summing the discharge of each subsection.

Numerous types of equipment and methods are used by USGS personnel to make current-meter measurements because of the wide range of stream conditions throughout the United States. Subsection width is generally measured using a cable, steel tape, or similar piece of equipment. Subsection depth is measured using a wading rod, if conditions permit, or by suspending a sounding weight from a calibrated cable and reel system off a bridge, cableway, or boat or through a hole drilled in ice.

Figure 5. Current meter method by boat

For this study, current meter measurements were taken using the boat method. The Price AA current meter was used with a sounding reel loaded in the boat. Since the water level is significantly low compared from the high flow during the first day of fieldwork, a one point method was used – which is 0.6 from the water surface. Several verticals were measured guided with a tagline to ensure a relatively straight cross section. The calibration equation to be used will be: $V = 0.702N + 0.013$

e. Rating Curve from Rope Weight Method

If a measurement of the flow is made by the current-meter method on different occasions when the river is flowing at different depths, these measurements can be used to draw a graph of amount of flow against depth of flow. The depth of flow of a stream or river is called stage, and when a curve has been obtained for discharge against stage, the gauging station is described as being rated. Subsequent estimates of flow can be obtained by measuring the stage at a permanent gauging post, and reading off the flow from the rating curve. If the cross-section of the stream changes through erosion or deposition, a new rating curve has to be drawn up. To plot the rating curve, it is necessary to take measurements at many different stages of flow, including infrequently occurring flood flows. Clearly this can take a long time, particularly if access to the site is difficult, so it is preferable to use some type of weir or flume which does not need to be individually calibrated, and these are discussed in later sections.

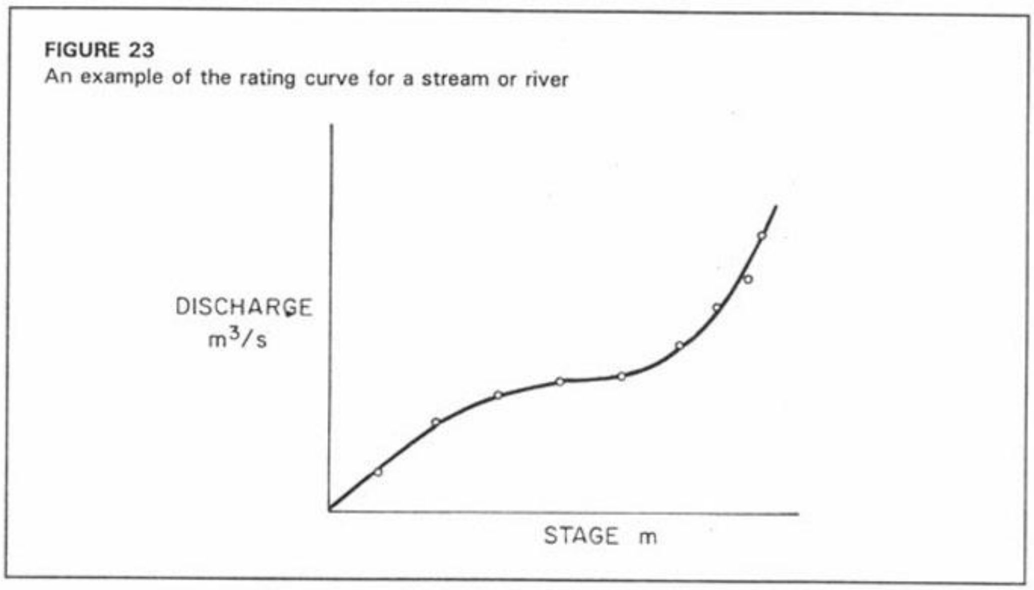


FIGURE 23
An example of the rating curve for a stream or river

Figure 6. Rating curve

6.1) Results and Discussion

Results of the study from the four different discharge measurement methods were summarized in the following tables below.

Table 1. Summary of measurements for the Float Method.

Station	Time (s)	Distance (m)	Velocity (m/s)	Cross Section 1			Cross Section 2		
				HD (m)	Depth (m)	Q (cms)	HD (m)	Depth (m)	Q (cms)
0				0.0			0.0		
1	129	100	0.775	61.0	4.3	136.67	63.0	4.9	159.53
2	106	100	0.943	82.0	6.4	102.64	84.0	6.0	127.36
3	75	100	1.333	95.0	9.2	202.40	108.0	7.0	182.00
4	100	100	1.000	115.0	11.6	208.80	123.0	7.6	117.80
5	125	100	0.800	131.0	7.2	112.32	139.0	6.9	126.96
6				154.0			169.0		
Total						762.83			713.65
Average						738.24			

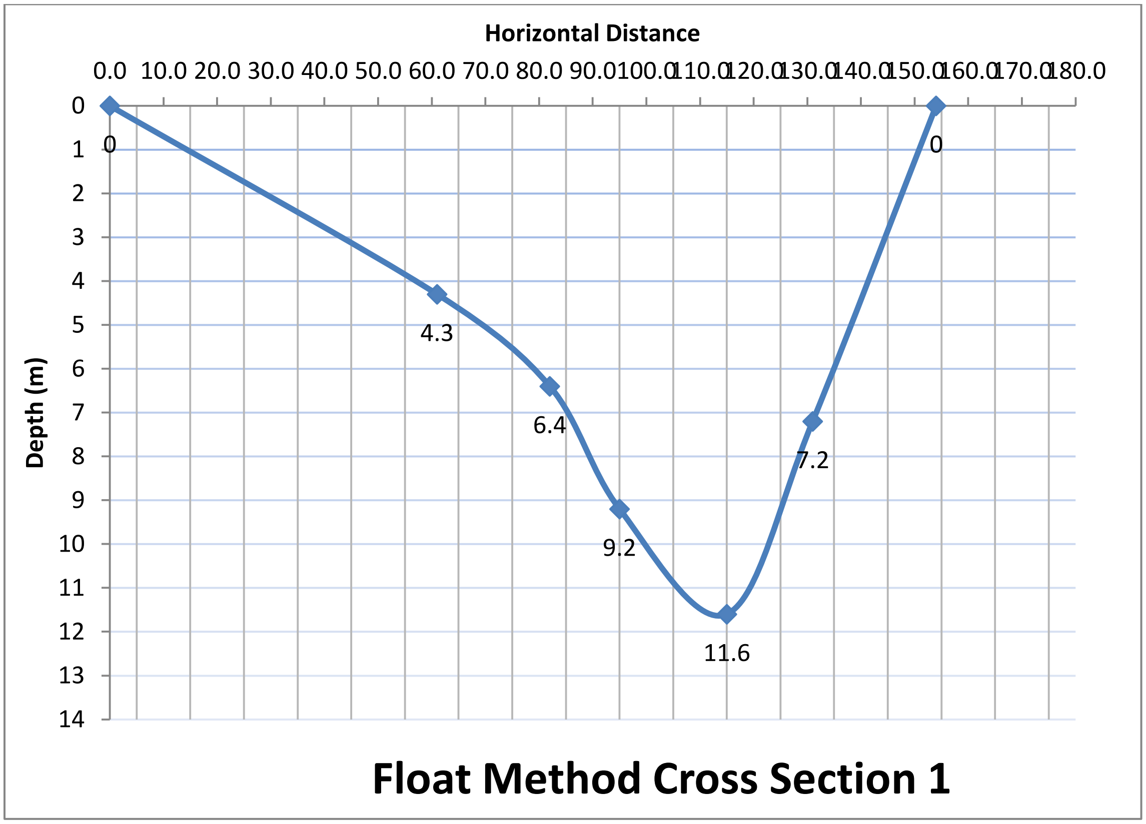


Figure 7. Float Cross Section 1 Profile

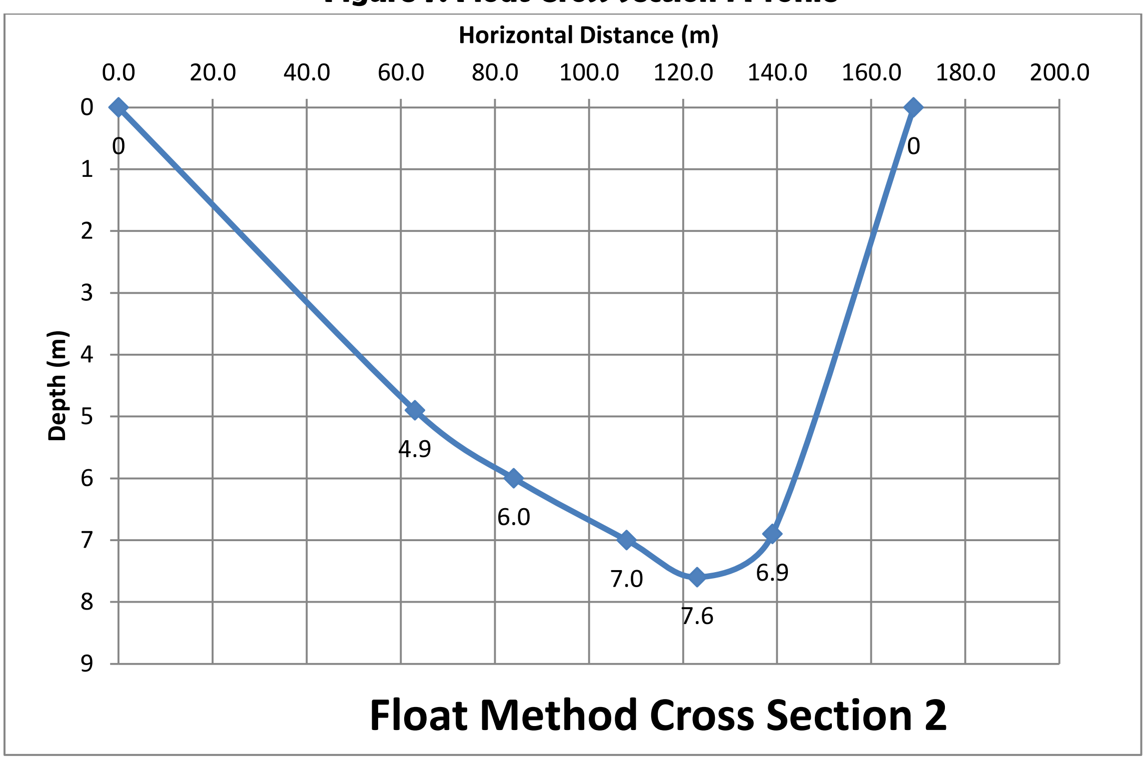


Figure 8. Float Cross Section 2 Profile

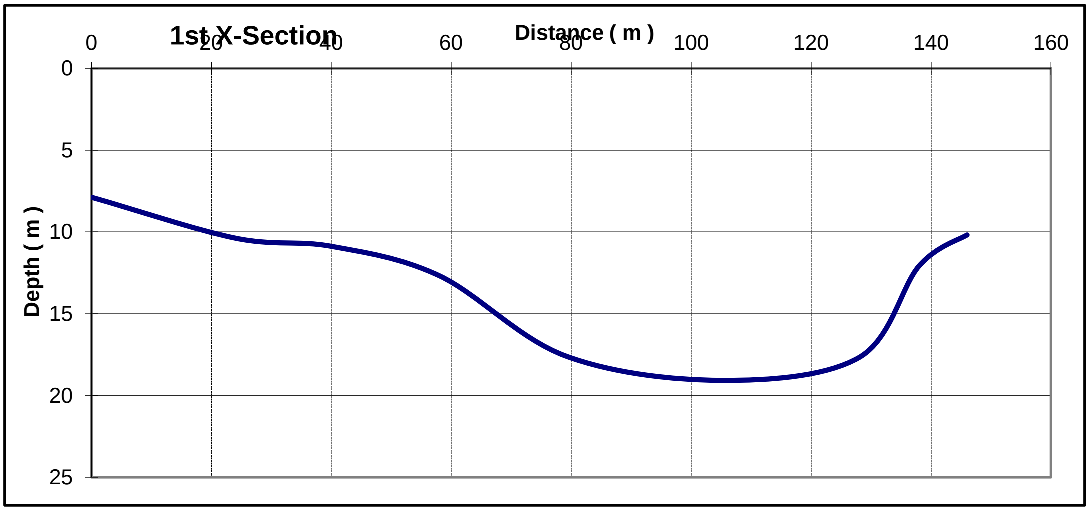
Table 2. Summary of measurements for the Slope-Area Method.

Station	VD (m)	HA (deg-min-sec)	HD (m)	Elevation (m)	Remarks
BS1	0.776	24° 34' 00"	8.642	9.538	
TP1	-0.792	225° 45' 20"	209.487	7.546	
BS2	-0.586	119° 20' 20"	37.278	9.332	
TP2	0.142	233° 09' 20"	104.74	8.274	HWM1 RB
TP3	-0.526	248° 45' 20"	35.468	7.606	
TP4	0.326	247° 59' 00"	11.93	8.458	
TP5	0.197	107° 14' 00"	19.707	8.329	
TP6	-0.889	84° 18' 40"	50.677	7.243	
BS3	0.68	293° 30' 90"	7.821	8.066	
TP8	-1.735	78° 04' 20"	103.399	5.131	
TP9	-3.018	77° 58' 00"	109.198	3.848	RB WE1
TP10	0.713	79° 50' 40"	284.873	7.579	HWM1 LB
TP7	-1.018	82° 34' 00"	77.728	5.848	
TP11	0.906	79° 51' 20"	212.274	7.772	
TP12	-0.743	80° 06' 40"	201.579	6.123	
TP13	-3.057	80° 22' 40"	199.509	3.809	LB WE1
BS4	0.263	350° 48' 00"	108.521	8.483	
TP14	-1.12	80° 14' 20"	96.287	3.763	RB WE2
TP15	-0.996	69° 56' 00"	93.386	6.287	
TP16	-3.421	72° 10' 20"	243.28	3.862	LB WE2
TP17	1.092	72° 37' 20"	250.296	8.375	
TP18	-0.746	70° 34' 40"	87.386	6.537	
TP19	0.539	73° 21' 00"	302.738	7.822	HWM2 LB
TP20	-0.663	69° 50' 40"	67.002	6.62	
TP21	0.083	61° 13' 00"	26.601	7.366	
TP22	-0.041	20° 11' 40"	8.162	7.242	
TP23	1.039	290° 51' 20"	16.994	8.322	
TP24	0.973	255° 05' 20"	38.451	8.256	HWM2 RB
BS5	0	351° 28' 20"	277.511	8.746	
TP25	-0.867	91° 02' 00"	100.313	4.279	RB WE3
TP26	-3.41	91° 21' 40"	249.356	4.136	LB WE3
TP27	-1.507	90° 42' 00"	97.097	6.039	
TP28	0.788	87° 36' 20"	290.393	7.534	HWM3 LB
TP29	-1.098	91° 01' 20"	257.446	6.448	
TP30	-0.845	92° 00' 00"	93.696	6.701	
TP31	-0.379	100° 18' 20"	53.608	7.167	
TP32	0.1	122° 52' 40"	9.815	7.646	
TP33	-0.018	238° 39' 40"	15.247	7.528	
TP34	0.94	256° 58' 40"	19.332	8.486	
TP35	0.96	267° 08' 40"	45.271	8.506	
TP36	0.683	267° 33' 20"	94.086	8.229	HWM3 RB

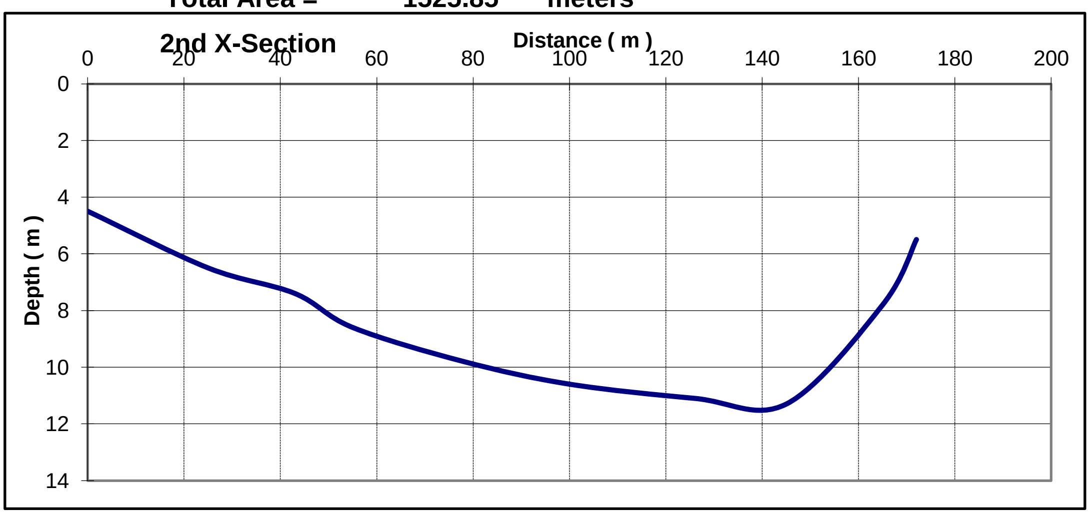
Total discharge= 2389.70 cumecs

Station: *Arayat* **Date:** *10/18/2013*

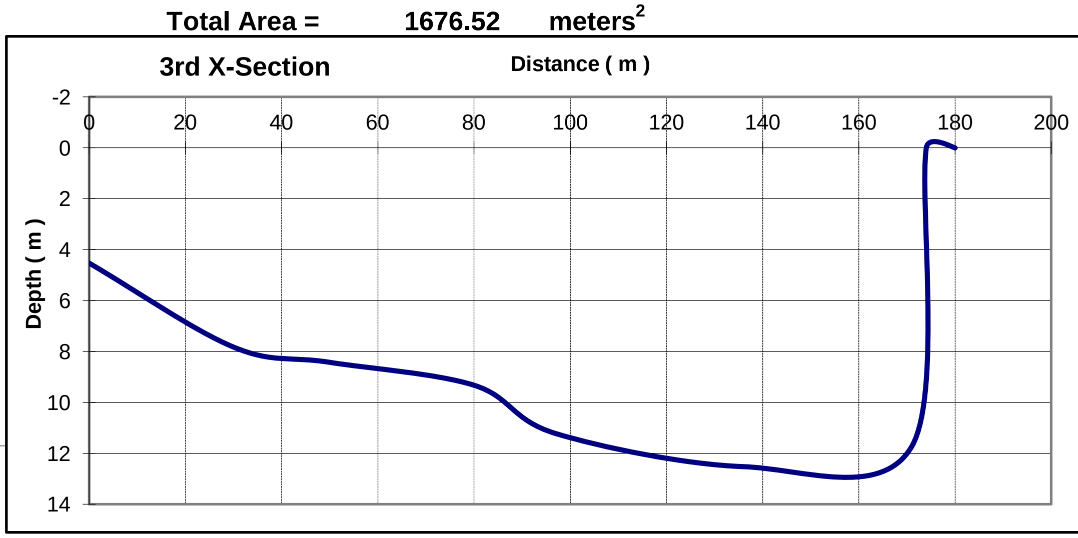
River: *Pampanga River* **Total area=2056** **Gage Ht.** **0.00** **meters**



Total Area = **1525.85** **meters^2**



Total Area = **1676.52** **meters^2**



Republic of the Philippines
Department of Science and Technology
PHILIPPINE ATMOSPHERIC, GEOPHYSICAL AND ASTRONOMICAL SERVICES ADMINISTRATION (PAGASA)
Pampanga River Flood Forecasting and Warning Center (PRFFC)
Agham Road, Diliman, Quezon City

FFB, PAGASA

Slope-Area Summary Sheet (3-Section)

Station:	*Arayat*	River:	*Pampanga River*
Flood Date:	*13-Oct-13*	Drainage Area:	
Gauge Height:		Meas. #:	

6/6/97

X - Section Properties:

			Highwater Marks										
X-Sect.	Width	Area	Left Bank	Right Bank	Average Water Sfc.	d_m (mean depth)	n	r	K	K^3/A^2	α	F	State of Flow
1	146.00	2056.71	7.579	8.274	7.9265	14.087	0.03	13.84	398751.9	1.5E+10	1	0.099	tranquil
2	172.00	1525.85	7.822	8.256	8.039	8.871	0.03	8.83	218797.6	4.5E+09	1	0.168	tranquil
3	180.00	1676.52	7.534	8.229	7.8815	9.314	0.03	9.24	247827.2	5.4E+09	1	0.149	tranquil

note: Assume no sub-divided sections, hence α is always 1!!

Reach Properties:

Reach	Length	Δh Fall	k	reach condition	K_U/K_D	K_U/K_D Condition	Ave. A	Q by formula	Ave V
1-2	100	-0.1125	0	contracting	1.822469	poor	1791.280	x	x
2-3	200	0.1575	0.5	expanding	0.882863	good	1601.182	9334.831	5.830
1-2-3	300	0.045	0	contracting	1.608991	poor	1753.026	**2389.701**	1.363

Discharge Computation:(comparison)

		h_v							
Reach	Assumed Q	U/S	D/S	Δh_v	h_f	$S=h_f/L$	$S^{1/2}$	K_w	**Computed Q**
1-2	x	0.068878	0.125144	-0.05627	-0.16877	-0.00169	x	295374.2	x
2-3	9334.831	0.125144	0.103661	0.021483	0.168241	0.000841	0.029004	232860.5	6753.786

Rem:

n - roughness coefficient
K - conveyance
K_w - wtd. conveyance (Geometric mean of K of 2 sections).
F - Froude no. (indicates the state of flow).
α - velocity head coefficient
r - hydraulic radius
k - coefficient for differences in velocity heads between 2 sections.
h_v - velocity head
h_f - energy loss due to boundary friction in the reach.
S - friction slope

$Q_{1\text{-}2\text{-}3}$ = 2389.70 **cumecs**

Discharge

Table 3. Summary of measurements for the ADCP.

Transect	Discharge (Q in cms)
1	292.871
2	292.668
3	304.15
4	334.503
5	250.691
6	238.568
7	296.384
8	301.213
Average	288.881

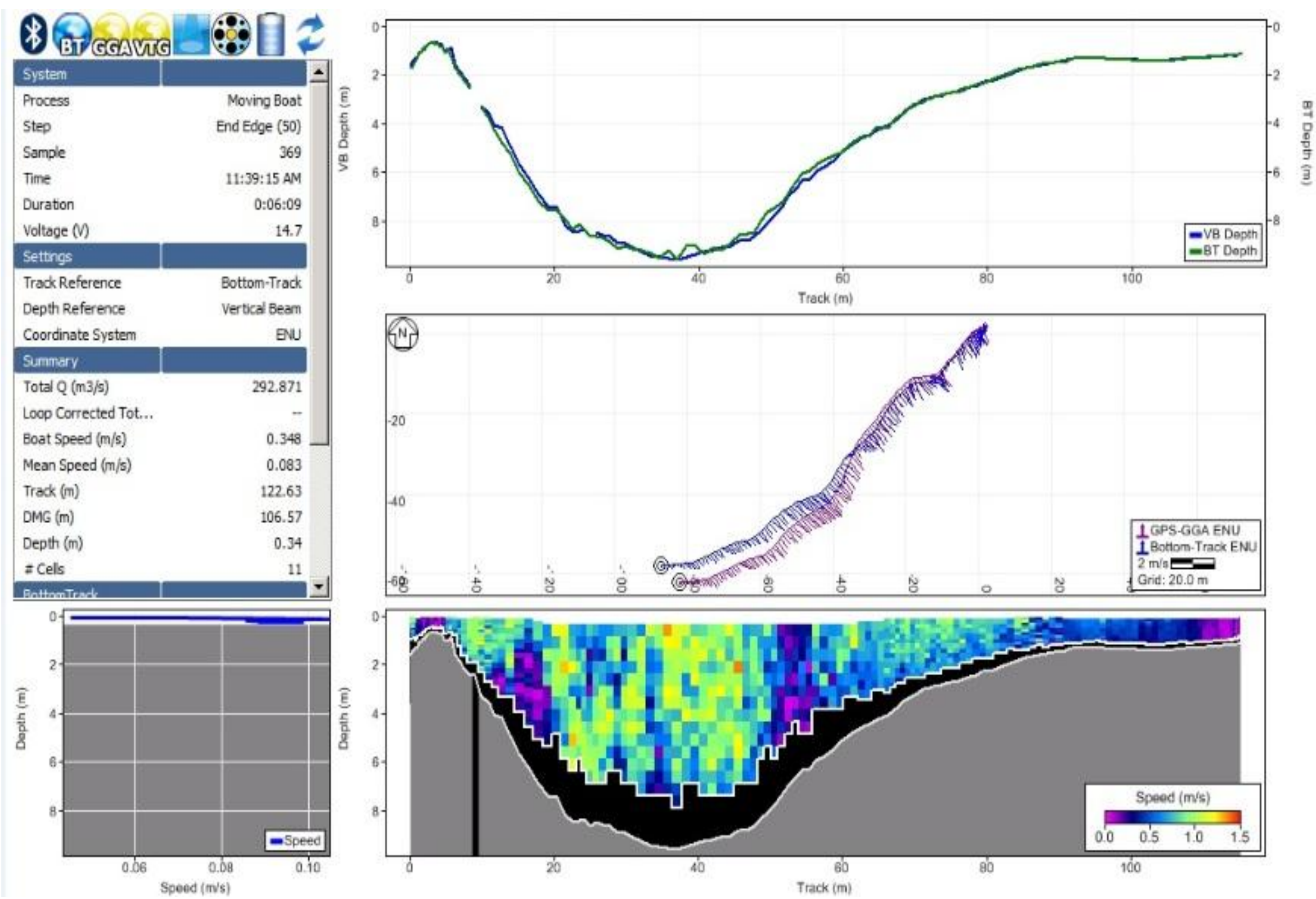


Figure 9: ADCP Transects

ADCP method by boat

Table 4. Summary of measurements for the current meter method.

St ation	Distance from Left Water Edge (m)	Water Surface Depth (m)	0.6 Depth (m)	Velocity	
				No. of Revolutions	Time (sec)
1	1	NA	NA	Unable	60
2	6	1	0.4	Unable	60
3	9	2.1	0.84	Unable	60
4	12	3.17	1.268	Unable	60
5	16	4.7	1.88	1	60
6	21	6	2.4	6	61
7	26	6.8	2.72	10	61
8	31	8.1	3.24	10	61
9	36	8.6	3.44	13	62
10	41	8.11	3.244	8	63
11	46	8.05	3.22	5	65
12	51	7.4	2.96	9	75
13	56	6.5	2.6	5	30
14	61	5.42	2.168	1	45
15	66	3.62	1.448	7	66
16	71	2.75	1.1	Unable	60
17	76	1.8	0.72	Unable	75
18	81	0.9	0.36	NA	NA
19	86	0.35	0.14	NA	NA
20	98.3	NA	NA	NA	NA

Rating Curve from Rope Weight Method

Rating Curve Development for . . . . ***Pampanga River***

Measuring Station: ***Arayat***
Drainage Area:
River:
Location:
Elev. S.G."0" rdg.= ***0.082*** **meters**

Meas. #	Day	Month	Year	S.G.(m)	Q(m^3/sec)	Remarks
				15.320	6846.291	
				14.918	6473.362	
				13.918	5581.845	
				12.918	4745.562	
				11.918	3965.539	
				10.918	3240.859	
				9.918	2577.586	
				8.918	1976.518	
				7.918	1616.029	
				6.918	1471.252	
				5.918	1266.117	
				4.918	1018.181	
				3.918	782.183	
				2.918	576.024	
				1.918	405.261	
				0.918	268.817	
				0.418	209.401	
				-1.082	132.877	
				-2.082	85.635	
				-3.082	45.374	

$$Q = 0.026\,[H - (-10.10)]^{3.851}$$

The Rating Curve Equation !!!

Assumed Ho = -10.10 meters

S.G. elev. (H)	H-Ho	Log H-Ho (X)	Log Q (Y)	X^2	XY
15.402	25.502	1.407	3.835	1.978	5.395
15.000	25.100	1.400	3.811	1.959	5.334
14.000	24.100	1.382	3.747	1.910	5.178
13.000	23.100	1.364	3.676	1.859	5.013
12.000	22.100	1.344	3.598	1.807	4.838
11.000	21.100	1.324	3.511	1.754	4.649
10.000	20.100	1.303	3.411	1.698	4.445
9.000	19.100	1.281	3.296	1.641	4.222
8.000	18.100	1.258	3.208	1.582	4.035
7.000	17.100	1.233	3.168	1.520	3.906
6.000	16.100	1.207	3.102	1.456	3.744
5.000	15.100	1.179	3.008	1.390	3.546
4.000	14.100	1.149	2.893	1.321	3.325
3.000	13.100	1.117	2.760	1.248	3.084
2.000	12.100	1.083	2.608	1.172	2.824
1.000	11.100	1.045	2.429	1.093	2.540
0.500	10.600	1.025	2.321	1.051	2.380
-1.000	9.100	0.959	2.123	0.920	2.036
-2.000	8.100	0.908	1.933	0.825	1.756
-3.000	7.100	0.851	1.657	0.725	1.410

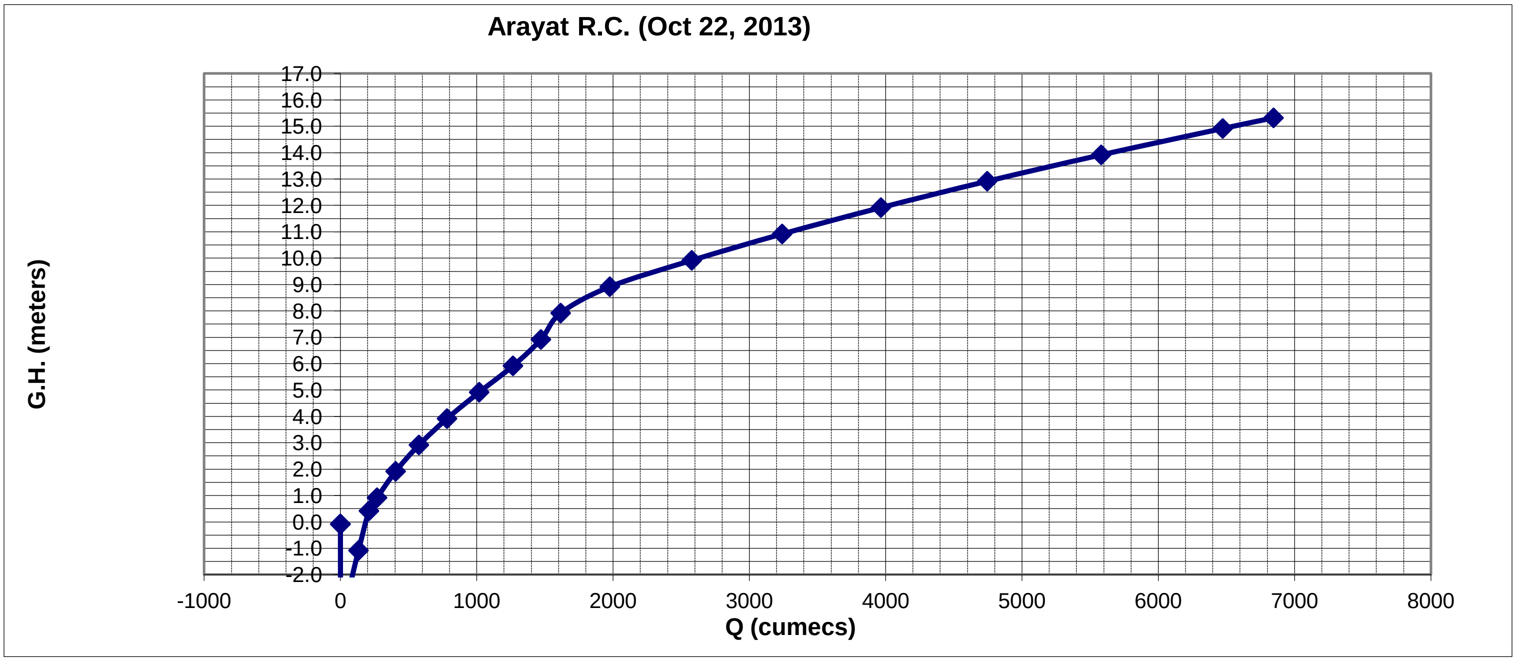
n =	20.000
S(X) =	23.820
S(Y) =	60.097
S(X^2) =	28.911
S(XY)=	73.661
X_{bar} =	1.191
Y_{bar} =	3.005
$(S(X))^2$=	567.390
b^ =	3.851
a^ =	-1.581
a = $10^{a\wedge}$ =	0.026
b = b^ =	3.851

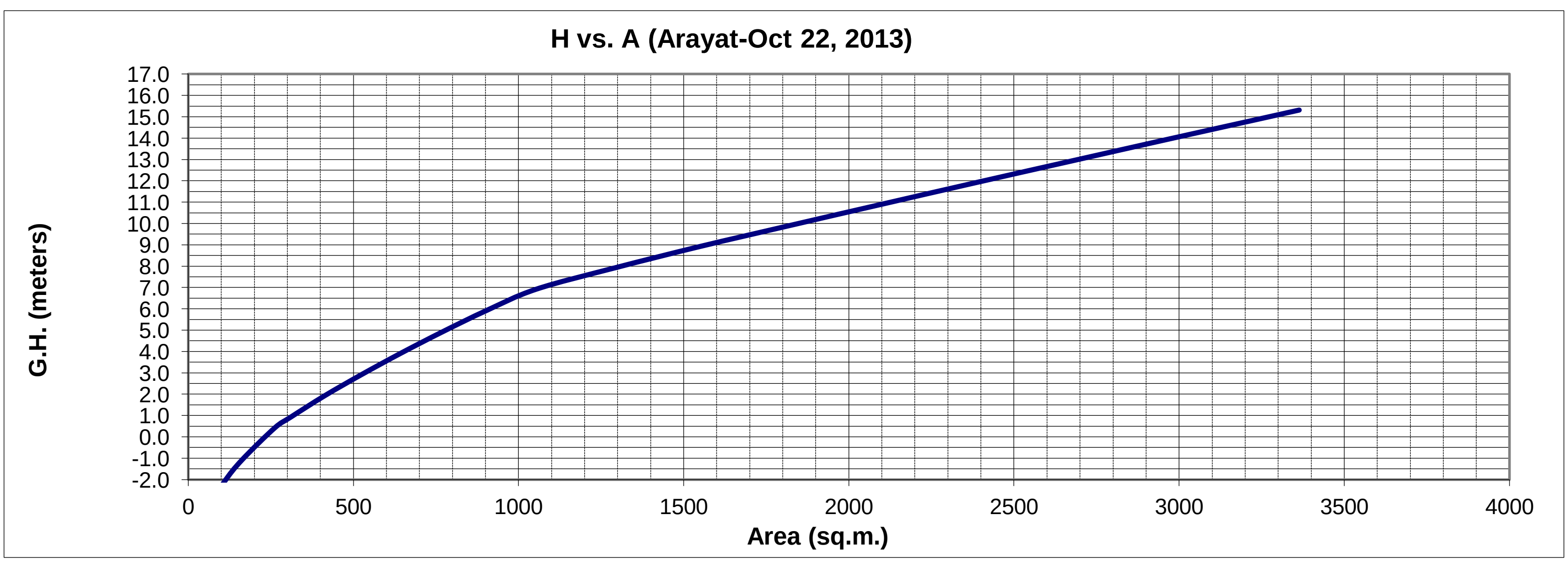
Ho Determination - Elevation of zero of flow (by Chi Square)

H (Xobs.)	Q (Yobs.)	Ycomp.	Ycomp.-Yobs.	$\boldsymbol{X^2}$= $(Y_c-Y_o)^2/Y_c$
15.402	6846.291	6839.036	-7.255	0.008
15.000	6473.362	6433.130	-40.232	0.252
14.000	5581.845	5500.850	-80.995	1.193
13.000	4745.562	4672.566	-72.996	1.140
12.000	3965.539	3940.433	-25.106	0.160
11.000	3240.859	3296.893	56.035	0.952
10.000	2577.586	2734.672	157.085	9.023
9.000	1976.518	2246.782	270.264	32.510
8.000	1616.029	1826.527	210.498	24.259
7.000	1471.252	1467.501	-3.750	0.010
6.000	1266.117	1163.595	-102.522	9.033
5.000	1018.181	908.994	-109.187	13.115
4.000	782.183	698.183	-84.000	10.106

SX^2 =	110.5742
when Ho =	-10.10

3.000	576.024	525.950	-50.074	4.767
2.000	405.261	387.387	-17.873	0.825
1.000	268.817	277.898	9.081	0.297
0.500	209.401	232.703	23.303	2.334
-1.000	132.877	129.310	-3.567	0.098
-2.000	85.635	82.594	-3.041	0.112
-3.000	45.374	49.725	4.351	0.381





7. Summary and Conclusions

Indirect and direct methods of discharge measurement have their limitations and strengths depending on the practical use of each during flood and non-flood seasons. For the float method, it is the most practical and most effective method for peak discharge determination when all other methods are impossible to be performed.

On the other hand, the slope – area method, a tedious method provides good information on the discharge of the streams given accurate instruments.

Meanwhile, the ADCP has proven to be beneficial to stream gauging in several ways. The use of ADCPs has reduced the time it takes to make a discharge measurement. The ADCP allows discharge measurements to be made in some flooding conditions that were not previously possible. Lastly, the ADCP provides a detailed profile of water velocity and direction for the majority of a cross section instead of just at point locations with a mechanical current meter; this improves the discharge measurement accuracy.

In the case of current meter method it is the most conventional method of the methods done, can be very useful both in high flows or in low flows, whether it done on boat, bridge or just by wading.

The Rating Curve equation derived from the data of other group who performed the rope weight method is

$$Q = 0.026\,[H - (-10.10)]^{3.851}$$

8. Other Places Visited

a.) La Mesa Watershed

Is consists of the La Mesa Dam and an ecological nature reserve site in Quezon City commissioned in 1929 in the Philippines. 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 dam whose reservoir can hold up to 50.5 million cubic meters and occupying an area of 27 square kilometers.

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 Sewerage 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 everyday. It is the last forest in metropolitan manila.

b. Angat Dam

Angat Dam is a concrete water reservoir embankment hydroelectric dam that supplies the Manila Metropolitan area water. It was a part of the Angat-Ipo-La Mesa water system. The reservoir supplies about 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. The primary purposes of it are for domestic use, flood control and power generation.

c. 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.

d. Cong Dadong Dam

concrete gravity irrigation dam roughly about 2.5 kilometers upstream of the San Agustin Bridge in Arayat Pampanga, registered peak gauge reading of around 9.80 meters at its reservoir side during Habagat 2013. The Dam is being regulated to an elevation of 8.70 meters . The Dam is an overflow type dam and is also meant to direct water for irrigation purposes to seven towns within Pampanga

b.) Calumpit Bulacan MDRMMO

Authority that is responsible for the disaster management, response & rescue in Calumpit. Since the town is a flood loving people they are always doing their task on how to protect the people & community by monitoring the weather & flood forecast. So that they can advise & give warning to the public based on the flood status or water level data from related agency like PRFFWC.

9. References

PRFFWC Annual Reports (2010-2012) via the www.prffwc.webs.com

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PRB flood-aug2013 maring-SW pdf

WMO Stream Gauging pdf