ARAYAT FLOOD SURVEY MEASUREMENTS

FIELD REPORT

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I. Introduction:

Recently a flood occur on some part of the Pampanga during the onslaught of Typhoon Santi, particularly near the river banks, ripping off establishments, toppling trees and pylons, and took several casualties along as reported. Through these incidents, data gathering and studies were conducted on some part of the Pampanga River specifically at Arayat, Pampanga. A field visit, along with the 4 groups of hydrologist trainees, has conducted assessments through the aftermath of the said typhoon.

II. Objectives:

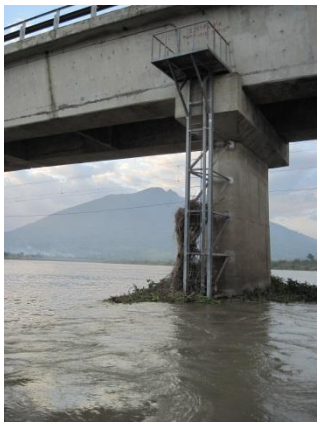
The goal for this activity is for the teams, hydrologist trainee, to gather specific data, information, and measurements using stream gauging techniques. The approached needed were to use direct method, and indirect methods. It was to be conducted at 4 days' time. Through this approaches, cross sectional measurements and river discharge were to obtain and project the maximum discharge of water from the highest flood mark. Through this, a cross check will be done comparing from the previous data gathering if significant changes of the river profile were to be considered, from the river bed to its banks, after the river over topped the banks and inundates some portion of the residential areas.

III. Site Description:

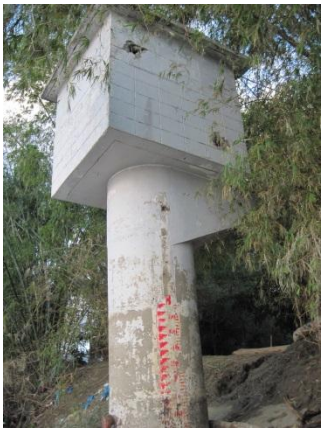
Our site of interest was a portion of Pampanga River basin, within the Municipality of Arayat at San Agustin Bridge, Pampanga which were located approximately 17.64 Km North East from the city of San Fernando, Pampanga and approximate situated from the map at 15° 9'59.24"N, 120°47'1.71"E.

At the site, a telemetry water level station is located at the edge of bridge, right bank downstream of the river, elevated at from the highest historical flood level and approximately 218 meters from the staff gauge and water level sensor. And an old water level station, stilling well, was situated at the left bank upstream of the bridge.

Telemetered Water Level Station



Staff Gauge and Water Level Sensor



Old Water Level Station

The telemetered staff gauge is graded with 0-12 meters from mean sea level. 4.5 meters water level was measured at the first day of our site survey.

By visual inspection, we concluded that the river is at its critical level with debris floating. Also flood traces are still visible taking it as our flood marks.

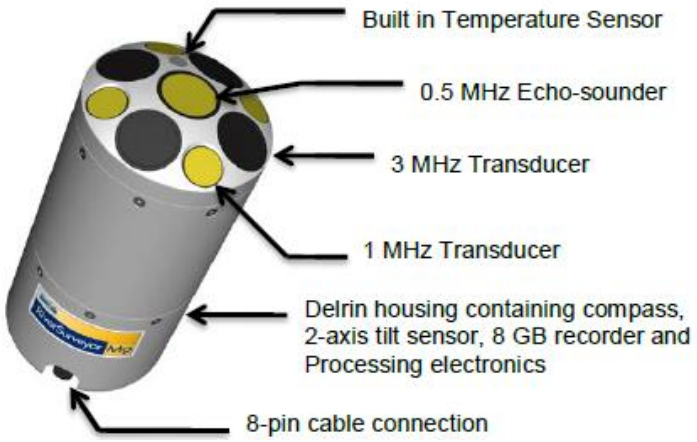
Flow of Water

Flood Marks

IV. Methods of Measurements:

A. Day 1: Using Acoustic Doppler Current Profiler (ADCP)

The ADCP is a robust and highly accurate system specifically designed to measure river discharge, 3-Dimensional water currents, depths, and bathymetry from a moving or stationary vessel in both shallow and deep channels.



SonTek RiverSurveyor M9 Acoustic Doppler Profiler (ADP)

a) PROCEDURES:

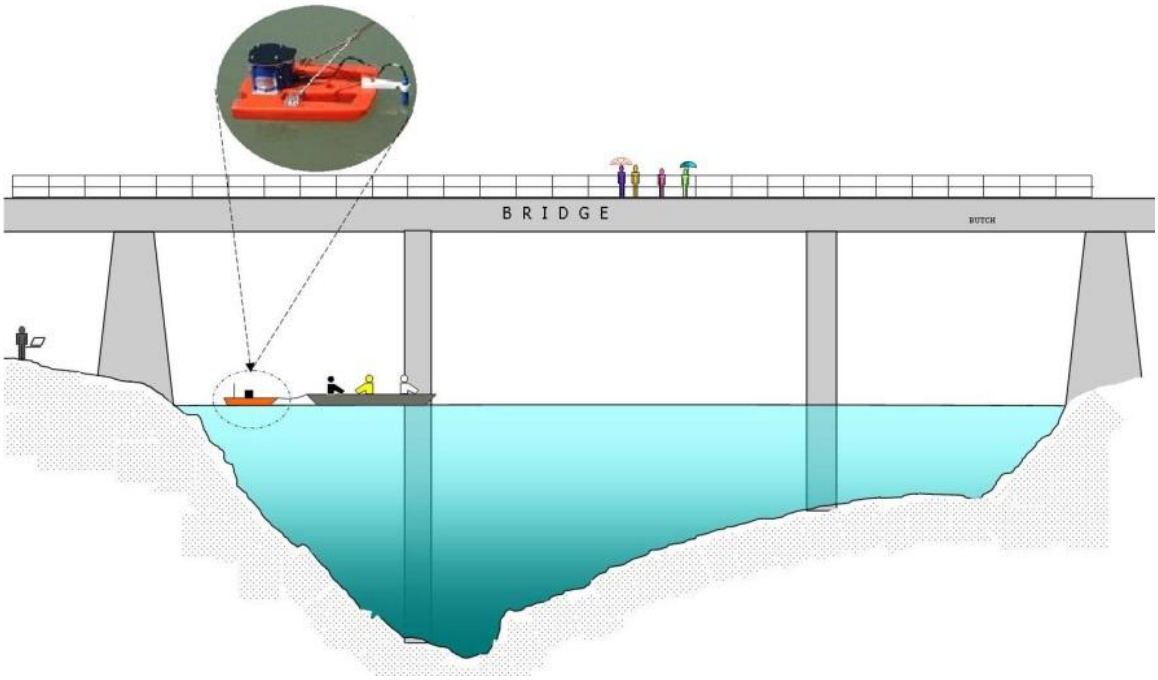
a. Assembled the Hydro board
b. Mounted of the ADCP components and accessories on the hydro board
c. Attached wire connections
d. Connected RTK (Real Time Kinematics) Base Station Components to PC and switched all power to on.
e. Opened software application that came with the hardware(RiverSurveyor Live)
f. Checked and tested connectivity from Base station to ADCP
g. Compass calibration
h. Place ADCP on the water, obtain the shore edge estimate and stage height
i. Input data requirements: stage height and shore edges
j. Begin data recording and transects
k. Save data and evaluate

Assembly and Test Connectivity

System Calibration

Shore Edge Measurements

Transecting



b) RESULTS:

Discharge Measurement Summary

Date Measured: Thursday, October 17, 2013

Site Information		Measurement Information	
Site Name	Arayat Stn	Party	HTC - Grp 4
Station Number	001	Boat/Motor	1
Location	Arayat Pampanga	Meas. Number	1

System Information		System Setup		Units	
System Type	RS-M9	Transducer Depth (m)	0.00	Distance	m
Serial Number	3860	Salinity (ppt)	0.0	Velocity	m/s
Firmware Version	3.00	Magnetic Declination (deg)	0.0	Area	m2
Software Version	3.7			Discharge	m3/s
				Temperature	degC

Discharge Calculation Settings				Discharge Results	
Track Reference	Bottom-Track	Left Method	Sloped Bank	Width (m)	130.596
Depth Reference	Vertical Beam	Right Method	Sloped Bank	Area (m2)	703.897
Coordinate System	ENU	Top Fit Type	Power Fit	Mean Speed (m/s)	0.672
		Bottom Fit Type	Power Fit	Total Q (m3/s)	473.139
				Maximum Measured Depth	11.086
				Maximum Measured Speed	1.876

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
2	L	1:40:59 PM	0:12:41	29.0	170.35	129.00	130.596	703.897	0.224	0.672	-0.02	0.00	25.95	365.10	82.12	473.139	--	77.2
			Mean	29.0	170.35	129.00	130.596	703.897	0.224	0.672	-0.02	0.00	25.95	365.10	82.12	473.139	0.000	77.2
			Std Dev	0.0	0.00	0.00	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.0
			COV	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Exposure Time: 0:12:41

Tr2=20131017134059.riv;

Comments

Tr2=20131017134059.riv - Fair weather;

Compass Calibration

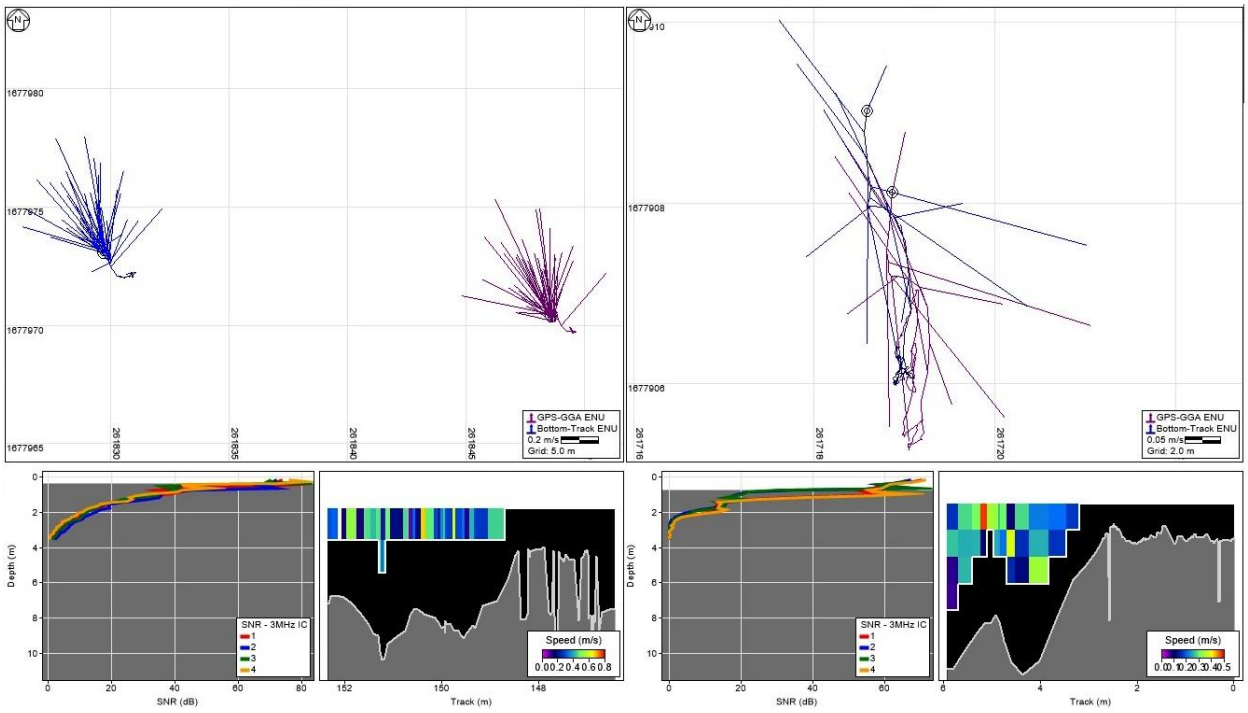
Passed Calibration
Calibration duration = 66 seconds
M7.00 = Magnetic influence is acceptable
Q9 = Magnetic field is uniform
H9 = Complete horizontal rotation
V9 = High pitch/roll
Recommendation(s):
Avoid any changes to the instrument setup or its orientation to the magnetic influences detected during the compass calibration.
Measurements should be made in locations with similar magnetic influences as the location of the compass calibration.

System Test

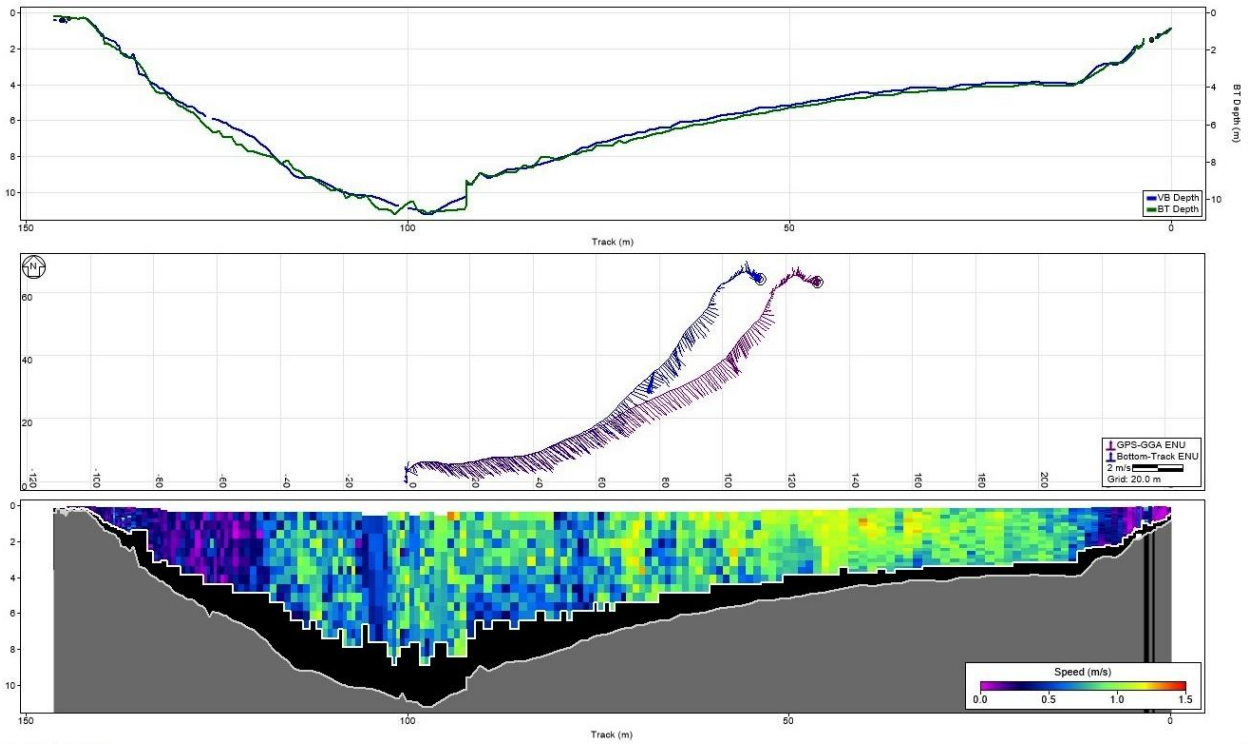
System Test: PASS

Parameters and settings marked with a * are not constant for all files.

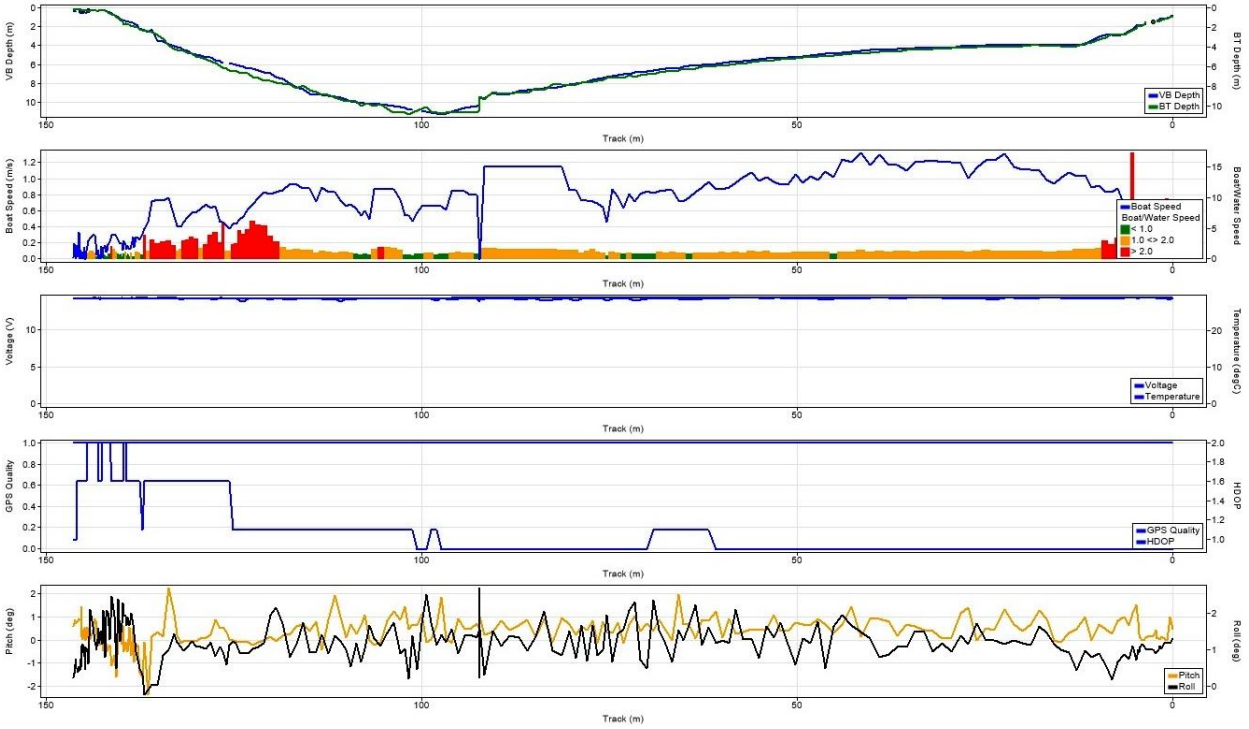
Report generated using SonTek RiverSurveyor Live v3.7



Shore Edges



ADCP Profile

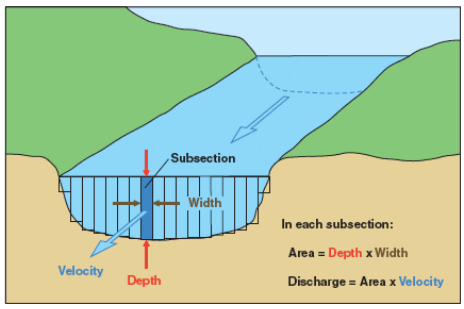


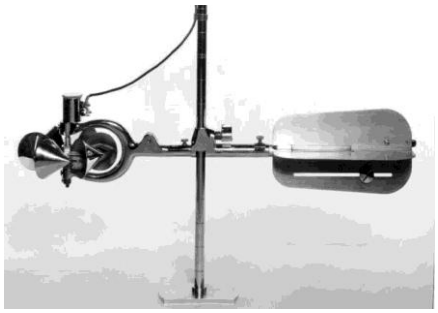
ADCP Time Series

B. Day 2: Using Current Meter On The Bridge

In this method, the stream channel cross section is divided into numerous 17 vertical subsections with 5 meters each. 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 current meter use was the price type AA current meter, 15 pounds of Columbus weight , and with a sounding reel of 20 meters long. Calibration and revolution test were conducted before the procedures were carried out.



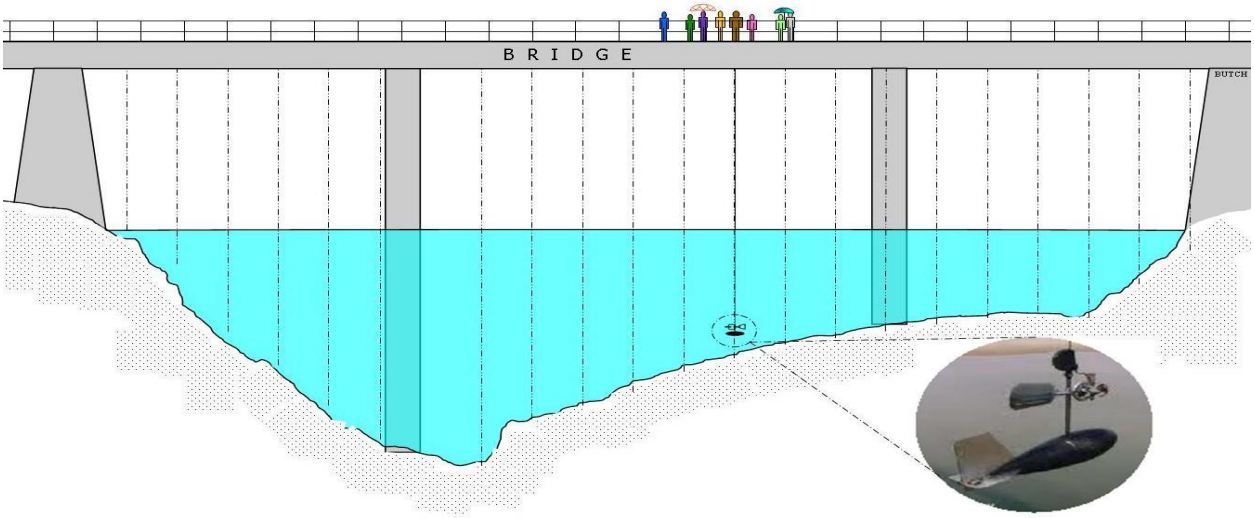


Measurement started from water edge left bank, taking the depth from water surface to riverbed and applying 2 point (0.2, 0.8) velocity profile method. If a strong current flow which may drag length of the line out of the reel, the depth may not be perpendicular from the point of drop. The “dryline” or “wetline” correction is relevant.

Procedure:

a. Winch out the first station of gauging
b. Lower the meter assembly until it touches the water surface. Set depth counter to zero. Record the measured depth.
c. Lower further the current meter assembly until it touches the bed.
d. Read the depth counter. This gives the depth of water at that point. Record the measured depth.
e. Points of depth were calculated for current reading (0.2 and 0.8).
f. Rise – Lift the meter assembly until the C-type weights are on the surface of the water.
g. Zero the depth counter. Lower your instrument to the calculated depth referencing from the calculated depth.
h. Hooked up the counter to the cableway terminal and record the revolution per minute (60 secs) from the meter.
i. Displaced the depth of the current assembly to the next depth required (0.2, 0.8) and repeat the “h” procedure.
j. Repeated all procedure to all stations needed to complete the transections of the river.

k. Read the staff gauge at the beginning, mid through, and at the end of the measurements.
l. Consolidated and reviewed all data obtained and set corrections for discharge measurements.



Transection of the River

Assembly of the Portable Carriage that supports the reel, cable, and meter assembly

Positioning the Portable carriage

Connecting and testing the Beep Counter

Results:

$V = \infty \times {}_{\beta}. n$

V = velocity of a current at a point

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

Calculations and correction were carried out by the Excel Sweep for Current Meter Discharge Measurement.

Discharge Measurement (Current Meter) for :																
				Arayat					River:	***Pampanga***						PRFFC
DM #:	2		Date:	October 18, 2013			Team:			Group 4						FFB
Gage Height:	Start:	4.68	End:	4.57	Inst. # :		Price AA			Wx:	fair					PAGASA
Observation Time:	Start:	10:55	End:	3:00	Calibration Eqtn.: V =	0.702	N+	0.013	note: just input negative value							htlr/ 97
		Vertical dist. to water surface (m) =		11.00					for latter if eqtn. is minus.							
Total Area (m^2) =			**466.24**		**Ave. Gage Height =**		**4.63**		**Sectional Width (m) =**							**120.0**
Total Q (m^3/s) =			**350.04**		**Ave. Vel. (m/s) =**		**0.751**									

Dist. from		Depth	Vert.	Angle	Observation Depth						Velocity				Remarks
Initial	Width	(ep for pier)	Angle	Corrected	0.2		0.6		0.8		at point	Mean (0.2,0.6 & 0.8) or	Area	Q	Excellent, Good
point	(mts.)	(mts.)	4^0-36^0	Depth	Rev.	Time	Rev.	Time	Rev.	Time	for 0.6 only	(0.2 & 0.8)	(m^2)	(cumecs)	Fair, Poor
0				0											**Welb**
5	5	2.3		2.300	60	62			60	65	x	0.677	11.50	7.78	
10	5	4.11	8	3.989	90	64			75	62	x	0.931	19.95	18.57	
15	5	4.56	10	4.368	95	65			80	65	x	0.958	21.84	20.92	
20	5	8.18	5	8.129	95	63			30	64	x	0.707	40.65	28.73	ripples
25	3	9.72	19	8.881	85	62			75	60	x	0.933	26.64	24.86	
26	1.15	EP													pier
27.3	2	EP													
30	6.35	9.63	4	9.597	90	60			50	62	x	0.823	60.94	50.13	
40	7.5	8.1	5	8.049	85	64			60	65	x	0.803	60.37	48.49	
45	5	6.72	5	6.671	85	65			60	63	x	0.806	33.35	26.89	
50	5	5.2		5.200	85	62			70	62	x	0.891	26.00	23.15	
55	5	5.25		5.250	85	64			65	62	x	0.847	26.25	22.24	
60	5	5.05		5.050	80	61			60	64	x	0.802	25.25	20.26	
65	5	4.45		4.450	80	61			60	62	x	0.813	22.25	18.09	
70	5	4		4.000	60	63			65	64	x	0.704	20.00	14.08	
75	5	2.55		2.550	55	63			50	61	x	0.607	12.75	7.74	
80	22.5	2.6		2.600	30	66			25	64	x	0.310	58.50	18.11	
120	x			x							x	x	x	x	**Werb**
	x			x							x	x	x	x	
	x			x							x	x	x	x	water lily
	x			x							x	x	x	x	pier
	x			x							x	x	x	x	turbulent
	x			x							x	x	x	x	pier
	x			x							x	x	x	x	
	x			x							x	x	x	x	
	x			x							x	x	x	x	shallow
											Total Area =		**466.24**		
Rem:											**Total Discharge =**			**350.04**	
											Ave. Velocity =			**0.751**	

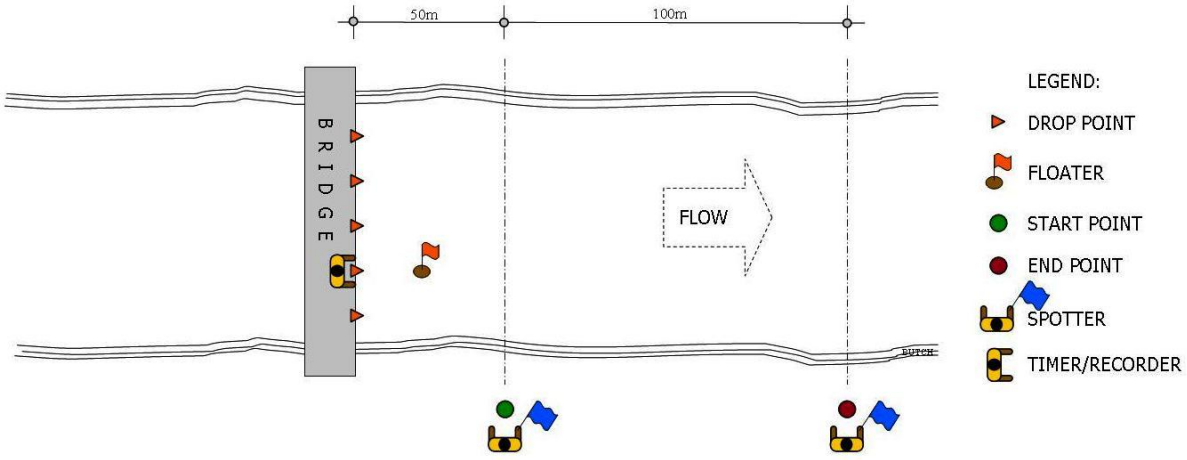
C. Day 3: Float Method

This method is inexpensive and simple for measuring surface velocity. Average velocity is obtained using a correction factor. The basic idea is to measure the time that it takes the object to float a specified distance downstream.

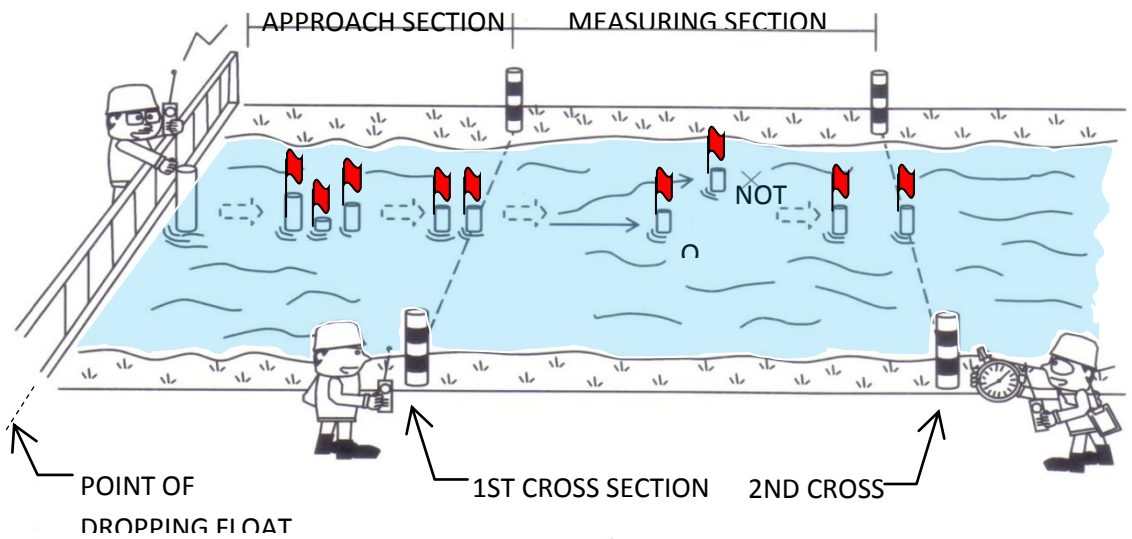
Our procedures were carried out on the top on the bridge, dropping the floating device at the downstream part. As for our visible buoyant objects, we used 10 cut section of a bamboo with haft sand-filed for vertical float, and a small flag attached for better visibility on the river. Two sets of bamboo were used on each drop lanes. And for constant flow reparation, a 50 meter distance is established from the drop points, which the bridge, to the first mark.

Procedures:

a. Establish 5 drop points for float lanes, and initial distance from the drop points to the starting point (50 meters).
b. Marked the start and end points of reach which is 100 meter from start to end of the reach.
c. A condition is set that the travel time should exceed 20 seconds.
d. The object were dropped into the stream our upstream marker.
e. Timers begun when the object crosses the first marker and stopped when it crosses the second marker.
f. The procedures were repeated 2 times and the average is used in further calculations.



g. For measuring the stream's width and depth across the two markers, echo sounder and range finder were used. Considering that the measurements were at a straight path, displacement corrections were irrelevant.
h. Consolidated the data acquired and imply adjustments and minor corrections to compute discharges.



Results:

								wl	time			
	Time	Staff gage	as of	stage 1	stage	Distance	end of activi	3.07	3:00pm			
Start	11:30	3.16	11:00 AM			100						
End	12:05	3.12	12:00 nn			100						
Average	6:05											
										Divided Area		
Measuring Line		Time of Drop		Traveling Time (secs)	Ave traveling T (1st trial + 2nd trial)/2	Velocity of Float	Correction Coefficient	Corrected velocity	Section 1	Section 2	Average Area	Divided Q
No. 1	1st trial	11:30		186	186	0.537634409	0.85	0.456989247	27.75	27.33	27.54	12.58548387
	2nd trial	failed		0								
No. 2	1st trial	failed		0	123	0.81300813	0.85	0.691056911	105.9	62.025	83.9625	58.02286585
	2nd trial	11:44		123								
No. 3	1st trial	11:47		118	127	0.787401575	0.85	0.669291339	229.65	113.5	171.575	114.8336614
	2nd trial	11:51		136								
No. 4	1st trial	11:55		120	128	0.78125	0.85	0.6640625	338.7	144.7	241.7	160.5039063
	2nd trial	11:58		136								
No. 5	1st trial	12:02		140	140	0.714285714	0.85	0.607142857	338.05	146.9	242.475	147.2169643
	2nd trial	failed		0								
										Total Q		**493.16**

Buoyant Objects

Tag Line Establisment

D. Day 4: Slope Area Method

This method is an indirect approach to measure discharge of a river. Its eventually good for estimating flood peaks which cannot otherwise be measured.

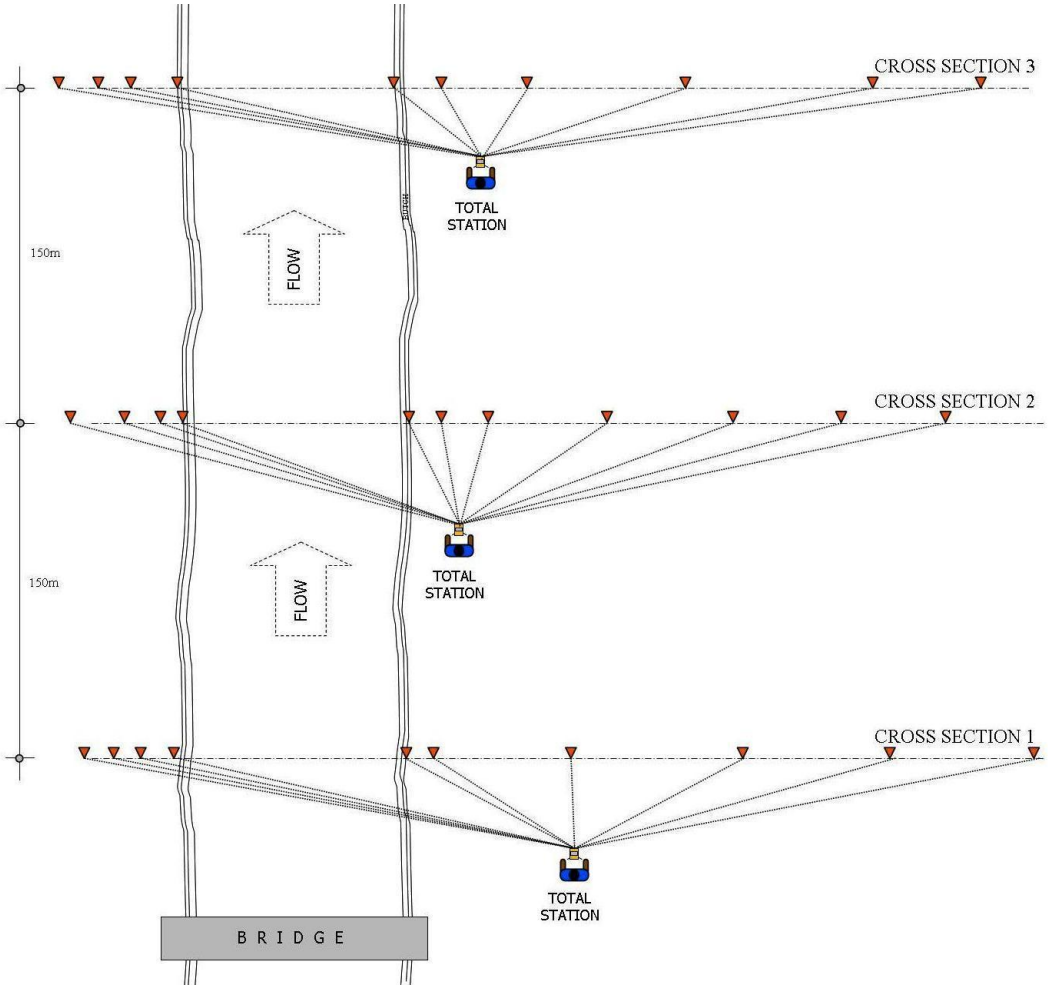
The slope-area method consists of using the slope of the water surface in a uniform reach of channel and the average cross-sectional area of that reach to give a rate of discharge. The discharge may be computed from the Manning formula.

Inspections and observations were implicated to the sight. Flood marks and debris were located and categorized. And based from information acquired, friction coefficients were set.

But before procedures were carried out, the river cross-section was divided in 3 sections with a 150 meter of distance from the initial section with flood mark elevation from right bank to left bank. For the water elevation and distance, a diferrent approached were used with the aid of the tag line perpendicular to the flow.

Procedures:

a. All measurements of distance are on unit meter and calibration to north is always observed at the surveying instrument, total Station, every turning point.
b. Bench mark (9.11asml) was located and transferred to a location that can be easily foresighted from the area of interest.
c. At the first cross section, we measured the horizontal distance and elevation of stations, referencing from the turning point of the bench marked traversing to the points where the water meets the shore or the water edges, traversing from right bank to left bank, while disregarding the points along the river surface.
d. A tag line was established for the vertical and horizontal measurement on water surface.
e. For the river surface station measurements, an echo sounder was used to obtain river bed depth and a range finder to obtain distance from the water edge to the points of measurements.
f. Repeated steps b, c and e at all the vertical lines across the width of the stream.
g. Consolidated the acquired data and apply additional inputs or corrections if necessary.



Traversed Sections of Stations

Results:

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

Q = total discharge

n = Roughness coefficients

A = Cross – section Area

R = Hydraulic radius

V = Mean Velocity in cross – section

S = Slope of water surface

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

Slope-Area Cross-Section Computation							
Station:					Survey Date:		
River:					Gage Ht.=	9.11	meters
Cross-Section number ONE (1)							hth/ 97
Station	Distance	Elevation	Water Sfc. elev.	Depth	Mean Depth	Area	Wetted Perimeter
0		8.129	8.129	0			
25.509	25.509	6.825	8.129	1.304	0.652	16.63187	25.54231
42.67	17.161	6.709	8.129	1.42	1.362	23.37328	17.16139
75.27	32.6	6.31	8.129	1.819	1.6195	52.7957	32.60244
104.001	28.731	7.073	8.129	1.056	1.4375	41.30081	28.74113
116.728	12.727	6.352	8.129	1.777	1.4165	18.0278	12.74741
141.631	24.903	5.969	8.129	2.16	1.9685	49.02156	24.90595
175.413	33.782	5.12	8.129	3.009	2.5845	87.30958	33.79267
191.773	16.36	4.991	8.129	3.138	3.0735	50.28246	16.36051
196.461	4.688	4.343	8.129	3.786	3.462	16.22986	4.732573
200.129	3.668	3.569	8.129	4.56	4.173	15.30656	3.748773
217.429	17.3	0.0745	8.129	8.0545	6.30725	109.1154	17.64941
222.429	5	-0.4755	8.129	8.6045	8.3295	41.6475	5.030159
227.429	5	-1.3755	8.129	9.5045	9.0545	45.2725	5.080354
232.429	5	-2.3255	8.129	10.4545	9.9795	49.8975	5.08945
237.429	5	-3.1955	8.129	11.3245	10.8895	54.4475	5.075126
242.429	5	-4.9955	8.129	13.1245	12.2245	61.1225	5.314132
247.429	5	-6.0755	8.129	14.2045	13.6645	68.3225	5.11531
252.429	5	-6.9755	8.129	15.1045	14.6545	73.2725	5.080354
257.429	5	-7.6255	8.129	15.7545	15.4295	77.1475	5.042073
262.429	5	-7.6855	8.129	15.8145	15.7845	78.9225	5.00036
267.429	5	-8.1755	8.129	16.3045	16.0595	80.2975	5.023953
272.429	5	-7.6755	8.129	15.8045	16.0545	80.2725	5.024938
277.429	5	-6.3755	8.129	14.5045	15.1545	75.7725	5.166237
282.429	5	-5.5755	8.129	13.7045	14.1045	70.5225	5.063596
286.429	4	-4.2755	8.129	12.4045	13.0545	52.218	4.205948
289.429	3	-2.7455	8.129	10.8745	11.6395	34.9185	3.367625
292.429	3	-1.6755	8.129	9.8045	10.3395	31.0185	3.185106
300.429	8	-0.5755	8.129	8.7045	9.2545	74.036	8.075271
301.429	1	0.88	8.129	7.249	7.97675	7.97675	1.765922
314.571	13.142	3.877	8.129	4.252	5.7505	75.57307	13.4794
318.913	4.342	6.808	8.129	1.321	2.7865	12.09898	5.238676
321.651	2.738	6.713	8.129	1.416	1.3685	3.746953	2.739648
Total Width =		321.65	meters	Hydraulic Radius(r) =		4.99	meters
Total Area =		1627.90	meters^2	Mean Section Depth =		5.061073	meters
Wetted Perimeter(P) =		326.148	meters				

1st Cross Section

Slope-Area Cross-Section Computation							
Station:	*0*			Survey Date:	*0*		
River:	*0*			Gage ht.=	***9.11***	meters	
Cross-Section number TWO (2)							hth/ 97
Station	**Distance**	**Elevation**	**Water Sfc. elev.**	**Depth**	**Mean Depth**	**Area**	**Wetted Perimeter**
0		8.001	8.001	0			
18.2	18.2	7.99	8.001	0.011	0.0055	0.1001	18.2
58.972	40.772	7.701	8.001	0.3	0.1555	6.340046	40.77302
67.263	8.291	7.612	8.001	0.389	0.3445	2.85625	8.291478
74.655	7.392	7.365	8.001	0.636	0.5125	3.7884	7.396126
85.681	11.026	7.243	8.001	0.758	0.697	7.685122	11.02667
98.611	12.93	7.168	8.001	0.833	0.7955	10.28582	12.93022
120.597	21.986	7.151	8.001	0.85	0.8415	18.50122	21.98601
147.577	26.98	7.141	8.001	0.86	0.855	23.0679	26.98
158.263	10.686	7.063	8.001	0.938	0.899	9.606714	10.68628
163.171	4.908	7.014	8.001	0.987	0.9625	4.72395	4.908245
260.233	97.062	7.093	8.001	0.908	0.9475	91.96624	97.06203
266.634	6.401	6.909	8.001	1.092	1	6.401	6.403644
269.411	2.777	4.979	8.001	3.022	2.057	5.712289	3.381809
276.167	6.756	3.533	8.001	4.468	3.745	25.30122	6.909012
302.942	26.775	2.566	8.001	5.435	4.9515	132.5764	26.79246
325.942	23	1.949	8.001	6.052	5.7435	132.1005	23.00827
334.942	9	1.649	8.001	6.352	6.202	55.818	9.004999
345.942	11	0.849	8.001	7.152	6.752	74.272	11.02905
356.942	11	0.449	8.001	7.552	7.352	80.872	11.00727
362.942	6	0.049	8.001	7.952	7.752	46.512	6.013319
384.942	22	-0.551	8.001	8.552	8.252	181.544	22.00818
395.942	11	-1.251	8.001	9.252	8.902	97.922	11.02225
399.942	4	1.749	8.001	6.252	7.752	31.008	5
402.442	2.5	2.932	8.001	5.069	5.6605	14.15125	2.765771
411.878	9.436	6.056	8.001	1.945	3.507	33.09205	9.939692
418.479	6.601	7.127	8.001	0.874	1.4095	9.304109	6.687319
420.497	2.018	7.086	8.001	0.915	0.8945	1.805101	2.018416
Total Width =		**420.50**	**meters**	**Hydraulic Radius(r) =**		**2.62**	**meters**
Total Area =		**1107.31**	**meters^2**	**Mean Section Depth =**		**2.633345**	**meters**
Wetted Perimeter(P) =		**423.232**	**meters**				

2nd Cross Section

Slope-Area Cross-Section Computation							
Station:	*0*			Survey Date:		*0.00*	
River:	*0*			Gage ht.=		*9.11*	meters
Cross-Section number THREE (3)							hth/ 97
Station	**Distance**	**Elevation**	**Water Sfc. elev.**	**Depth**	**Mean Depth**	**Area**	**Wetted Perimeter**
0		7.979	7.979	0			
21.521	21.521	7.976	7.979	0.003	0.0015	0.032282	21.521
66.242	44.721	7.283	7.979	0.696	0.3495	15.62999	44.72637
146.794	80.552	6.674	7.979	1.305	1.0005	80.59228	80.5543
166.819	20.025	6.482	7.979	1.497	1.401	28.05503	20.02592
182.931	16.112	2.722	7.979	5.257	3.377	54.41022	16.54491
186.095	3.164	1.393	7.979	6.586	5.9215	18.73563	3.431783
199.628	13.533	1.016	7.979	6.963	6.7745	91.67931	13.53825
216.628	17	0.4335	7.979	7.5455	7.25425	123.3223	17.00998
226.628	10	0.216	7.979	7.763	7.65425	76.5425	10.00237
234.628	8	0.016	7.979	7.963	7.863	62.904	8.0025
248.628	14	-0.584	7.979	8.563	8.263	115.682	14.01285
259.628	11	-0.884	7.979	8.863	8.713	95.843	11.00409
281.628	22	-1.284	7.979	9.263	9.063	199.386	22.00364
287.628	6	-1.384	7.979	9.363	9.313	55.878	6.000833
295.628	8	-1.884	7.979	9.863	9.613	76.904	8.01561
308.628	13	-2.084	7.979	10.063	9.963	129.519	13.00154
314.628	6	-0.484	7.979	8.463	9.263	55.578	6.20967
317.318	2.69	0.711	7.979	7.268	7.8655	21.1582	2.943489
324.345	7.027	3.269	7.979	4.71	5.989	42.0847	7.478108
329.542	5.197	5.446	7.979	2.533	3.6215	18.82094	5.634549
335.94	6.398	5.667	7.979	2.312	2.4225	15.49916	6.401816
Total Width =		**335.94**	**meters**	**Hydraulic Radius(r) =**		**4.08**	**meters**
Total Area =		**1378.26**	**meters^2**	**Mean Section Depth =**		**4.102686**	**meters**
Wetted Perimeter(P) =		**338.064**	**meters**				

3rd Cross Section

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*
Flood Date:	*22-Oct-13*	Drainage Area:	*6,487*
Gauge Height:	*8.78*	Meas. #:	*4*

X - Section Properties:

X-Sect.	Width	Area	Highwater Marks: Left Bank	Highwater Marks: Right Bank	Average Water Sfc.	d_m (mean depth)	n	r	K	K^3/A^2	α	F	State of Flow
1	321.65	1627.90	6.713	8.129	7.421	5.061	0.035	4.99	136572.1	9.6E+08	1	0.312	tranquil
2	420.50	1107.31	6.086	8.001	7.0435	2.633	0.035	2.62	60263.82	1.8E+08	1	0.636	tranquil
3	335.94	1378.26	5.667	7.979	6.823	4.103	0.035	4.08	100968.1	5.4E+08	1	0.410	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	150	0.3775	0	contracting	2.266236	poor	1367.606	3049.902	2.230
2-3	150	0.2205	0.5	expanding	0.59686	poor	1242.785	3572.588	2.875
1-2-3	300	0.598	0	contracting	1.352626	good	1371.156	**3579.188**	2.610

Discharge Computation:(comparison)

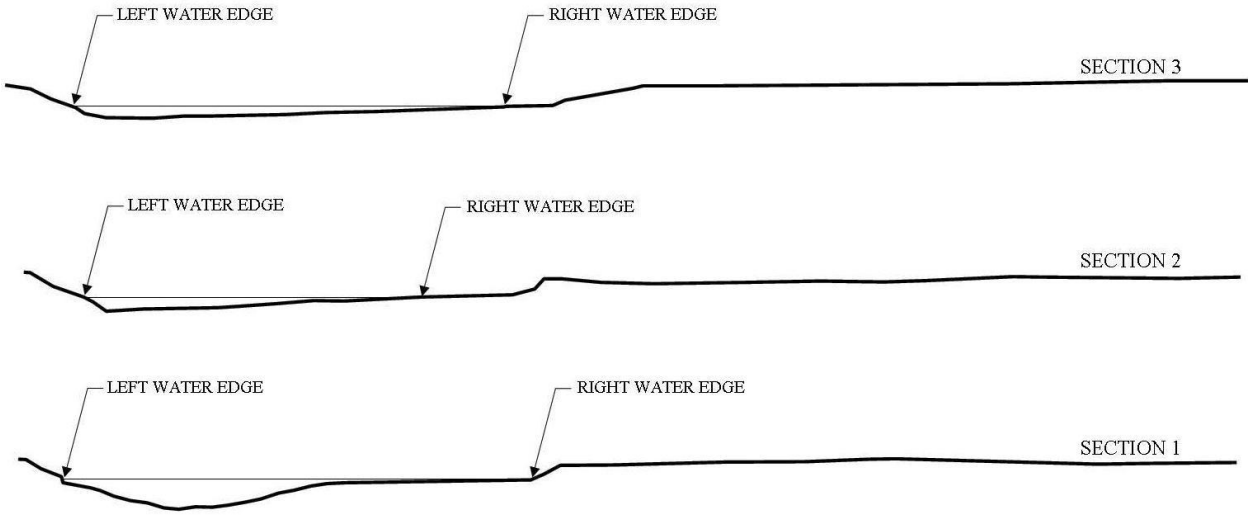
Reach	Assumed Q	h_v U/S	h_v D/S	Δh_v	h_f	$S=h_f/L$	$S^{1/2}$	K_w	**Computed Q**
1-2	3049.902	0.2466368	0.533055	-0.28642	0.091082	0.000607	0.024642	90721.3	2235.531
2-3	3572.588	0.5330545	0.344075	0.18898	0.31499	0.0021	0.045825	78004.64	3574.564

Rem:

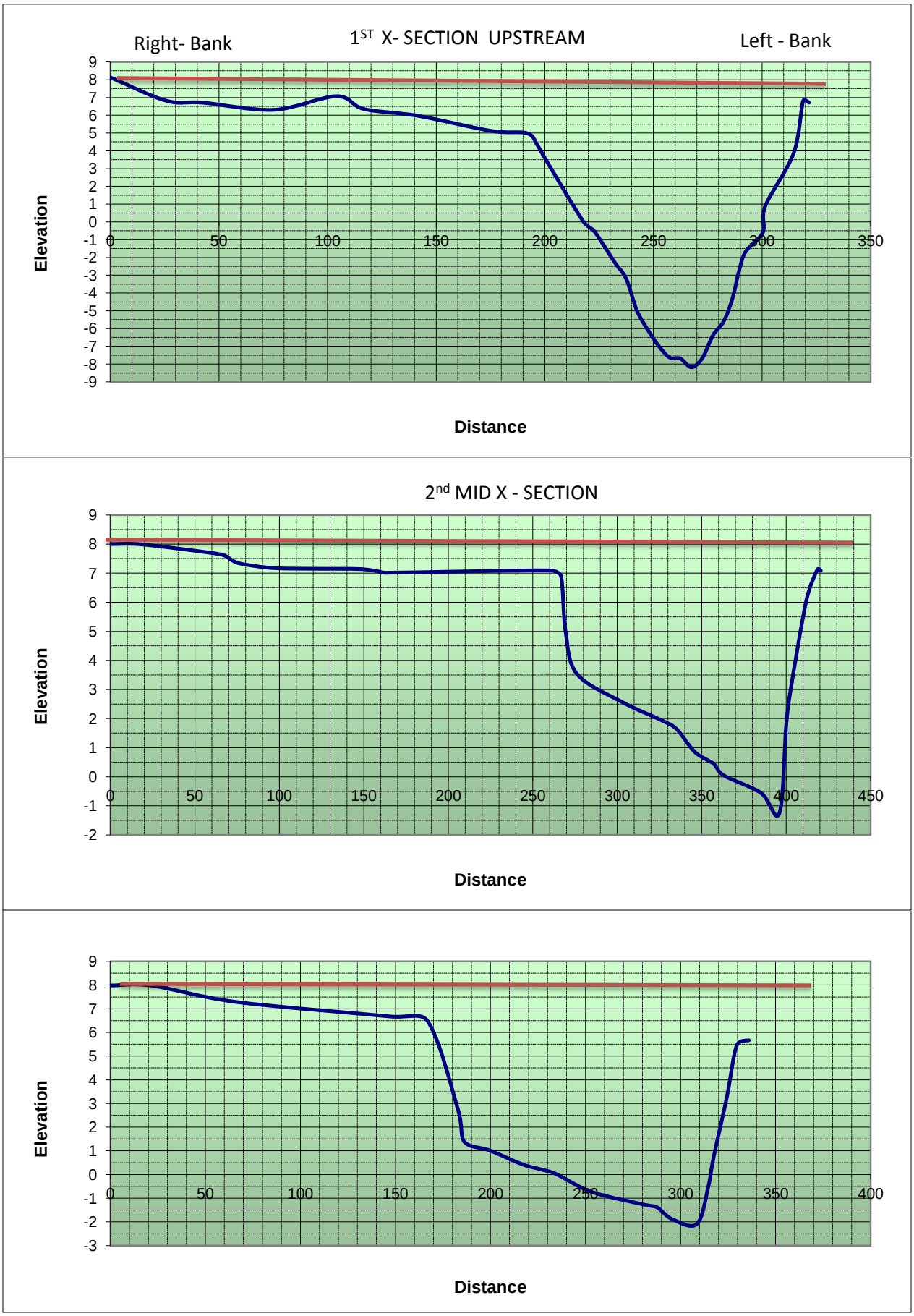
n - roughness coefficient
K - conveyance
K_w - wtd. conveyance (Geometric mean of K of 2 sections).
F - Froude no.(indicates the state of flow).
α - velocity head coefficient
r - hydraulic radius
k - coefficient for differences in velocity heads betw een 2 sections.
h_v - velocity head
h_f - energy loss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

Q_{1-2-3} = **3579.19** cumecs
Discharge

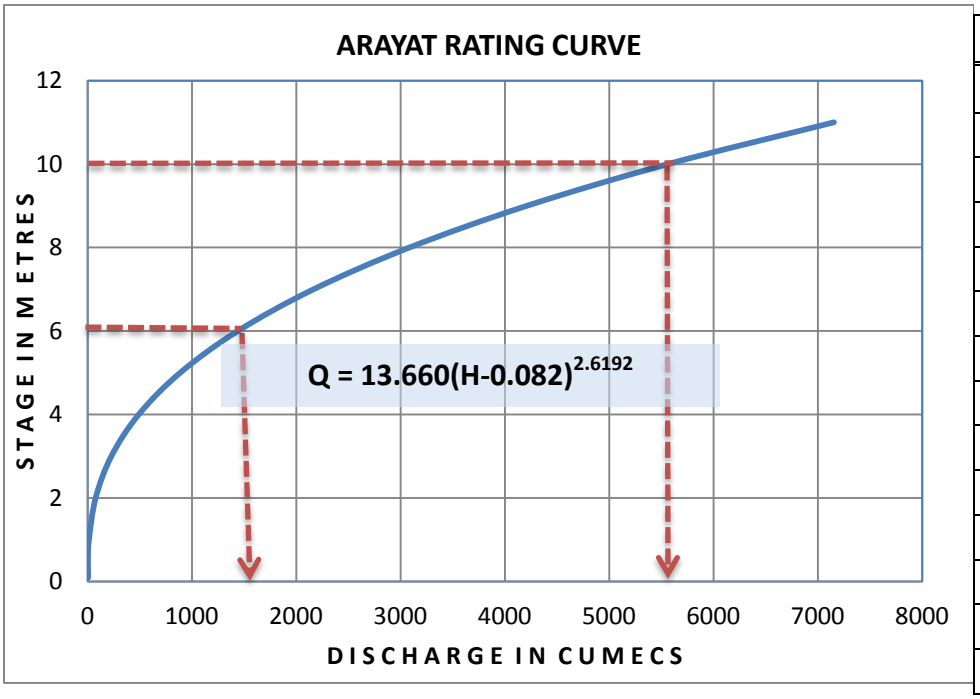
Profile of the Cross sections



Summary of Discharge


Right- Bank
1ST X- SECTION UPSTREAM
Left - Bank
Elevation
Distance
2nd MID X - SECTION
Elevation
Distance
Elevation
Distance

Rating Curve:



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

V. River Flow Summary:

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	493
Slope- area	22.10.2013	8.2	3579

VI. Conclusion/Recommendations:

- All approach for discharge measurements were carried out smoothly and responsively. It s very invigorating in the sense that we only have limited time at hand. Class discussions and interpretations were very much implied for this field works.
- It was a challenging sites and a practical one since criteria and conditions were not imposed based from books, abrupt decision making and judgment call were also practiced.
- Impressions on how to measure high discharges and medium flow measurement were much proficient and practical.
- 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, if possible, must be perpendicular to the flow of the river.
- Discharge results were at reasonable limits, since there were limitations from conducting the procedures.
- There is a big exception for the float discharged measurements, were the results are still questionable. And for this reasons, float method is best applied during flood situations only.
- Advantages and disadvantages arouse for each methods. Accessibility and lack of proper equipments were one of the major factors.

Gauging card shall be provided to fill all measurement and noted remark for computation

VII. FIELD TRIPS

FIELDWORK Program for HTC2013 (Tentative Sked & Activities)			
October	Time	Activity	Remarks
15	8am-9am	Assembly time	Central office
	9:30am	Leave for La Mesa Dam	
	10:30am	Briefing at La Mesa Dam	(take lunch at site)
	2:00pm	Leave for Pampanga	
	4:00pm	Arrive Pampanga (SACOP)	arrangement of lodgings
16	whole day	Lecture / Briefing / filed orientation	PRFFWC
17	9:00-9:30am	assembly at PRFFWC / leave for Arayat SG site	hire jeep / hire banca at site
		FIELDWORK day 1	(packed lunch / canteen)
18	9:00-9:30am	assembly at PRFFWC / leave for Arayat SG site	hire jeep / hire banca at site
		FIELDWORK day 2	(packed lunch / canteen)
19-20		Site visit - Pantabangan Dam (tentative)	with J.Paat
21	9:00-9:30am	assembly at PRFFWC / leave for Arayat SG site	hire jeep / hire banca at site
		FIELDWORK day 3	(packed lunch / canteen)
22	9:00-9:30am	assembly at PRFFWC / leave for Arayat SG site	hire jeep / hire banca at site
		FIELDWORK day 4	(packed lunch / canteen)
23	9:00am	assembly at PRFFWC / leave for Calumpit, Pampanga	briefing by MDRRMO-Calumpit
	1:00pm	visit Mega Dike and Bacolor Church	(packed lunch / canteen)
24	9:00-9:30am	assembly at PRFFWC / leave for Angat Dam	with J.Paat
	11:00am-2:00pm	Briefing at Angat Dam	(take lunch at site) - prepare packed lunch
	3:00pm	Return back to Central Office	

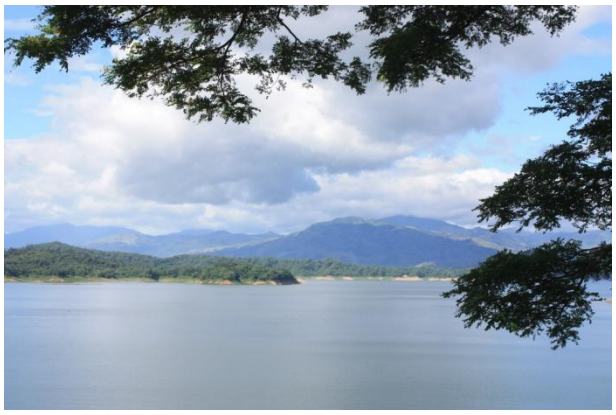
1. La Mesa Dam

The La Mesa Watershed in Quezon City commissioned in 1929. Its is located in Quezon City, Philippines. It is an earth dam whose reservoir can hold up to 50.5 million cubic meters of water and occupying an area of 27 square kilometer. It is a part of the Angat- Ipo- La Mesa Water System.

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.

In terms of water treatment, their pre-treatment plant used copper sulfate to control the presence of algae. Before releasing water for consumption the 1-1.3 turbidity must be met. The treatment process includes Pre- Chlorination, Sedimentation, 2nd Chlorination where biological components are being treated. La Mesa Dam and its treatment plant is a vital link to the water requirements of 12 million residents of Metro Manila considering the 1.5 million of water which pass through their reservoir every day. Their eco- park is also the last forest of its size in the metropolis.

2. Pantabangan Dam



The Pantabangan Dam is a multi-purpose dam which provides water for irrigation and hydroelectric power generation. It is an earth-fill embankment dam on the Pampanga River located at Pantabangan, Nueva Ecija province of the Philippines. The reservoir is considered as one of the largest in the Southeast Asia and one of the cleanest in the Philippines. The Dam's construction began in 1971 and it was completed in 1977.

The dam is a 107 m (351 ft) tall and 1,615 m (5,299 ft) long embankment-type with 12,000,000 cu yd (9,174,658 m^3) of homogeneous earth-fill and an impervious core. The crest of the dam is 12 m (39 ft) wide while the widest part of its base is 535 m (1,755 ft). The dam's crest sits at an elevation of 232 m (761 ft) 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 as well. The design discharge of the spillway is 4,200 m^3/s (148,322 cu ft/s). The dam's reservoir has a gross capacity of 2,996,000,000 m^3 (2,428,897 acre·ft) and 2,083,000,000

m^3(1,688,716 acre·ft) of that volume is active (or useful) for irrigation and power. The dam sits at the head of a 853 km^2 (329 sq mi) catchment area and its reservoir has a surface area of 69.62 km^2 (27 sq mi) and elevation of 230 m (755 ft) when at its maximum level.

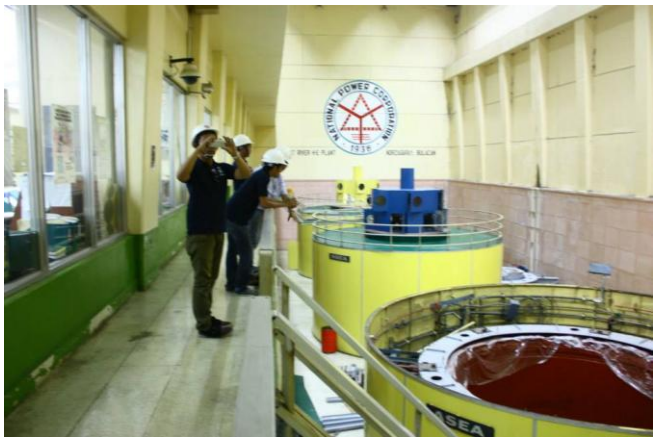
It was established last 1985 by the help of the Japanese. A telemetry staff gauge is attached in the side portion of the dam. CCTV cameras are used as an alternative monitoring device to remotely view the gauge height. Most of the station's facility came from PAGASA. The station gets data from 6 rain gauges located at the upstream of the Pampanga River. A flood warning console used in triggering flood warnings and alarm located in populated areas in the lower portion of the site traversing from the spillways.

3. Cong Dadong Dam

The 3rd dam that the HTC trainees had visited is the Cong Dadong Dam which is near the location where the field work was hold. Since Arayat, Pampanga is an agricultural land; one can easily tell the main function of the Cong Dadong Dam. It's made for irrigation purpose.

Cong Dadong Dam is located at Barangay San Juan Bano, Arayat, Pampanga. Its coordinates is 15°11'2"N 120°46'32". The 3.4 billion Cong Dadong, named after former President Macapagal Arroyo's father, the late President Diosdado "Dadong" Macapagal. The dam diverts water from Pampanga and Rio Chico rivers. Canals leading to farms in Arayat, Sta. Ana, San Luis, Candaba, San Simon and Apalit towns.

4. Angat Dam



Angat Dam is a concrete water reservoir embankment hydroelectric dam that supplies the Manila metropolitan area water. Surrounded by lush greens, this place is also ideal for fishing, boating and hunting.

The project is located at Barangay Tibagan, Bustos, Bulacan, served by the Angat River. The main dam is about 18 meters above sea level.

Among the 2.5-meter high, six-span dam's main features are easily deflatable and inflatable rubber body, resistance to sedimentation, economical and having auto-deflation system.

Angat dam has a normal high water level of 210 meters, according to the Philippine Atmospheric, Geophysical and Astronomical Services Administration (Pagasa).

The dam has its own Flood Forecasting and Warning System for Dam Operations or FFWSDO, piloted by the Philippine government on 1973. On 1978, the dam released its first impounded water. On April 1983, the Angat started its Forecasting and warning system implemented by the National Power Corporation with PAGASA and NIA as cooperating agencies. The system is composed of 4 remote raingauges upstream of the reservoir and 1 water level gauge. It senses data every hour for remote areas. It also simulates rainfall data. The FFWS facilities are the dam office which was built on 1986, repeater microwave station, telemetry stations located in of Agno, Angat, and Caliraya. Warning stations and patrol vehicles.

A so called Forecasting Phase was also introduced. Its main components are flood operation, Dam Discharge Warning governed by NPC and NIA, and the Flood Warning by PAGASA.

The components of Flood Forecasting and Warning Operations are assessment of weather, collecting of hydrological data, data analysis, flood forecasting, consultation with other agencies concerned, preparation and issuance of dam operation flood, and dissemination. The flood model inputs basic data (rainfall from the upstream) and it will be run and simulate. It is a customized model for Angat and the program is a visual basic and excels type which was given last year by the Japanese. It will give idea of possible effects of rainfall intensities at the place. 17 locations have fixed warning stations. The farthest is the place of Tibag and the nearest is the Padling. The office will first activate the warning stations in time of spilling. It will warn all the places that will be affected by the spill.

5. MDRRMO – Calumpit, Bulacan

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, lies 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.

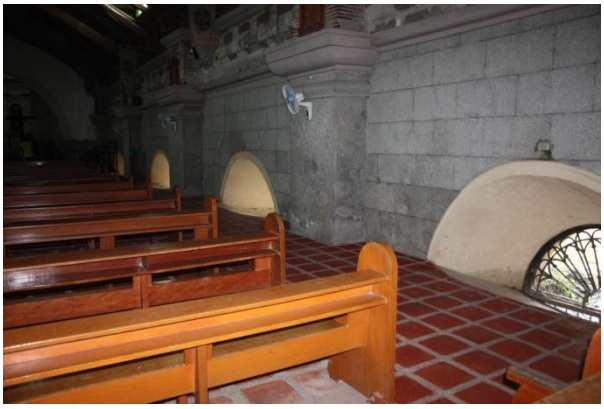
Calumpit is sprawled over an area of 5,625 has. of flat terrain classified accordingly to use as agricultural lands (66.81%), residential (10.42%), industrial (2.48%), commercial, (0.89%) and others was (1.05%).

Calumpit is considered to be a “flood loving community”. When a heavy rainfall pours, Calumpit is easily. Because of this, its National Disaster Risk Reduction and Management or NDRRMC headed by Mr. Jojo Thomas and the Calumpit’s Municipal Admin Mr. Dong Manumbas launched a project which is a system for monitoring and early warning. Since NDRRMC is an agency of the government under the Department of National Defence. It has a great help in terms of security of the municipality.

The monitoring system of Calumpit has a real time advisories and navigation. It is an excel based system. It estimates rainfall in a 3- day period. It accesses its data from the government agencies such as PAGASA, NAMRIA and others. It has a 12- hour rainfall advisory.

The Tropical Disturbance Database of Calumpit is the municipalities’ basis for flooding next year. It is somewhat a simulation system. It is a 90-day capacity. The systems primary goal is acquiring the information in how much is the rainfall in whole Pampanga River Basin. There is also a so called SIYAM-SIYAM or a 9-day rainfall tracking of all the Pampanga River Basin stations which is composed of 18 stations.

6. Bacolor Church



San Guillermo Parish Church is named after San Guillermo, the patron saint of Bacolor, Pampanga, the Philippines, where the church is erected. The church was originally constructed by the Augustinian Friars in 1576.

In 1880, the church was destroyed by an earthquake only to be rebuilt by Fr. Eugenio Alvarez in 1886. On September 3, 1995, lahar flow from the slopes of Mt. Pinatubo which erupted into world notice on June 15, 1991, buried the church at half its 12-m height.

Only half of the original facade of the church can be seen today due to the eruption of Mount Pinatubo in 1991 which half-buried the church. After the volcanic eruption, the town's people painstakingly excavated the altar and the retablo and relocated it under the dome in order for the tall wooden retablo to fit. The retablos niches are filled with centuries- old statues which were saved from destruction of the lahar. The church is already a world famous tourist destination prior to the lahar tragedies and present has remained being so.


Rex Regum et Dominus Dominantium