Arayat, Pampanga River
Discharge Measurement Report
And Field Trips

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I. INTRODUCTION

Flood is defined as a great flowing of water, especially overland not usually submerged. It is an outcome when the precipitation rate is greater than the infiltration capacity. Lives of human beings are in danger because of this natural happening. Man is now finding ways to manage or minimize the effects of flood. One way is by studying the behavior of water above and below the land surfaces, their occurrences, circulation in both time and space or what we called Hydrology.

The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) which means "hope" in tagalog is a Philippine national institution dedicated to provide flood and typhoon warnings, public weather, forecasts and advisories, meteorological, climatological and other specialized information and services primarily for the protection of "life" and property in support of economic productivity and sustainable development. By its vision and mission, PAGASA launched the Hydrologists Training Course (HTC) 2013 which is composed of 32 professional individuals from the 3 main islands of the country, Luzon, Visayas and Mindanao and 2 foreigners from Papua New Guinea and Figi. The 30 aspiring Filipino hydrologists must undergo the course and the trainings associated with it. When they pass the HTC they will be deployed in the different areas in the country.

One of the major subjects in the training course is the Stream Gauging. The subject's goal is to educate the future hydrologists to monitor and test terrestrial bodies of water. Hydrometric measurements of wa3ter surface elevation (stage) and/ or volumetric discharge (flow) are generally taken and observations of data may also be made. Field works and Field trips are also included in the said subject matter.

II. OBJECTIVE

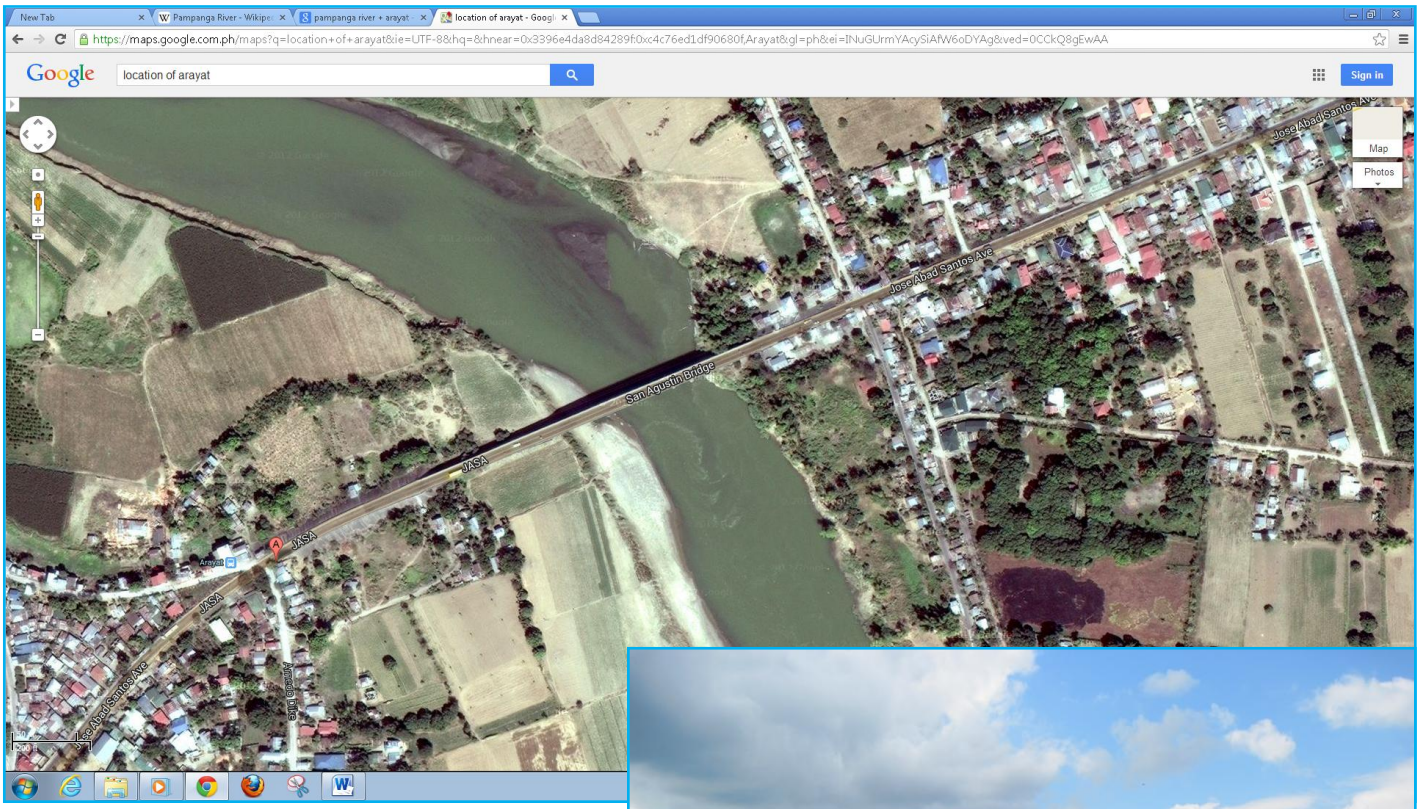
"The only source of knowledge is through experience" according to one great scientist named Albert Einstein. All genuine knowledge originates in direct experience in things than reading printed books, besides writers come up with a good story based on their own experiences.

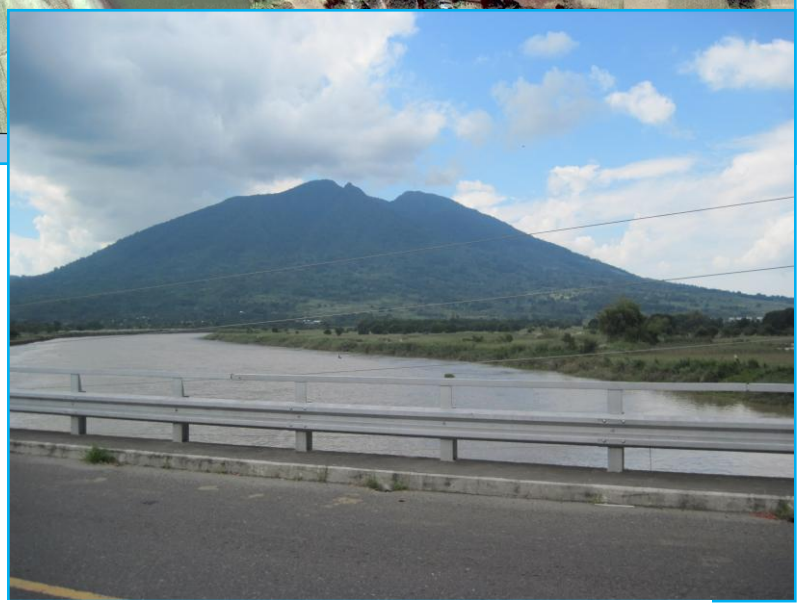
Field work is a way where students or group of individuals see, feel and experience in real life the things that they only read in the books. It is where imagination just by reading books ends.

The objectives of Field Work are:

1. For the HTC trainees to experience the actual measuring of discharge at the Pampanga River which is flowing along the Arayat area. Using the four (4) methods of measuring the discharge. Indirect: Slope Area and Float Methods, Direct: Acoustic Doppler Current Profiler (ADCP) and Price AA Current Meter.
2. To determine the advantages and disadvantages of each discharge measurement.
3. To become familiar with real work of practice.
4. To apply all the theoretical knowledge acquired in the training.
5. To allow oneself to develop sense of professional discipline in the field and gain self-confidence in future works and be a competent hydrologists.

III. SITE DESCRIPTION





The Hydrologists Training Course (HTC) 2013 trainees of the PAG-ASA underwent their field works at **Arayat, Pampanga, Philippines.** Arayat is a first class municipality in the province of Pampanga, Philippines, located at 15°9'59.24"N and 120°47'1.71"E.It is politically subdivided in 30 barangays and is known for its majestic Mt. Arayat. Rio Grande de Pampanga which is now known as Pampanga River is considered as the most important river in the Philippines. The second largest river in the island of Luzon and third in the whole country. It passes the Arayat municipality. A bridge called San Agustin is a bridge which joins two places in Arayat that were separated by the portion of the Pampanga River. This is where the Field works of the HTC trainees was conducted. For the whole duration of the field works the weather was fine. The trainee's number 1 problem is the muddy soil. Since Arayat is an agricultural land and it recently experienced a flood due to the topical typhoon Santi. The flood left traces such as high level flood marks, fragments and silts. Houses are situated near the river but some are already abandoned.

Telemetered Water Level

Staff Guage

A telemetered water level station is located near the side of the bridge where the data is established. A telemetered water level was attached in a staff gauge can be found in the middle pier located downstream. Its height is above the highest historical flood mark recorded in that area. At the first day of the field works the staff gauge was not visible for the reason that it was covered by bushes and water lilies.

In terms of River Channel Geometry, the river reach is hard to identify but by observation, one can notice that the flow distribution of the water surface is not uniformly straight. Near the piers you can see ripples as evidence that the flow is unsteady and it's a typical case in most rivers. The resistance of a channel to the flow of the water is considering being in an unstable state or critical.

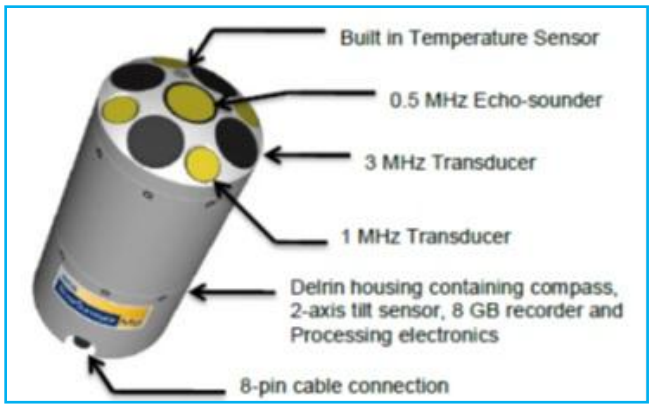
IV. METHODS OF MEASURING RIVER DISCHARGE

Note: Always get the water level measurements of the staff gauge before and after doing each method.

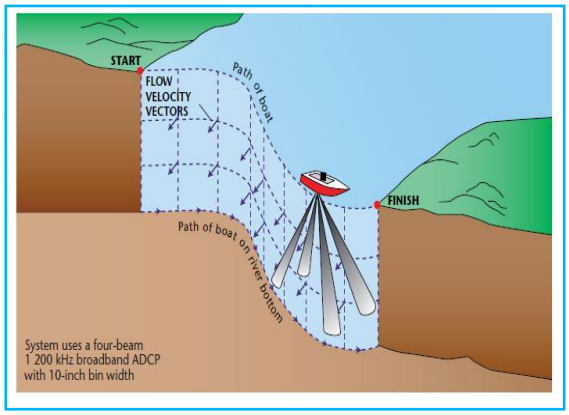
DIRECT METHODS

1.1 First Day: Acoustic Doppler Current Profiler (ADCP)

As a pioneering group in using the ADCP, the first thing that the group did was assembling the said instrument. It is composed of an antenna, data logger, computer interface connection and a base which looks like a "Banka". ADCP measures the Doppler shift of the reflected energy and uses this to compute the velocity of the water relative to the instrument. Before deploying the instrument it must be calibrated first. The yaw, pitch and roll are used when calibrating the equipment. Calibration is quite time consuming if you don't know how to calibrate it properly. The ADCP must transect the distance of the river perpendicular to the flow of the water. According to the World Meteorological Organization (WMO) the minimum transect must be 4. A rope was attached to the device while one of the persons inside the boat is guiding it by tagging the rope. While the device is moving the water velocity, river depth, vessel path and speed is now measured simultaneously to compute discharge by the use of a computer. You can also visualize the contour of the river.



Doppler Current Profiler



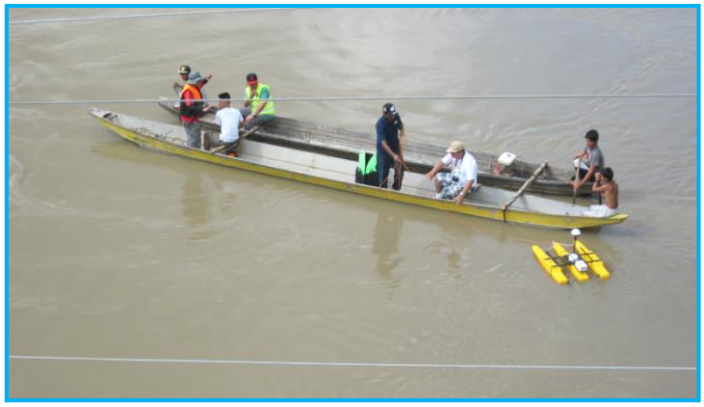
How the ADCP transects a river

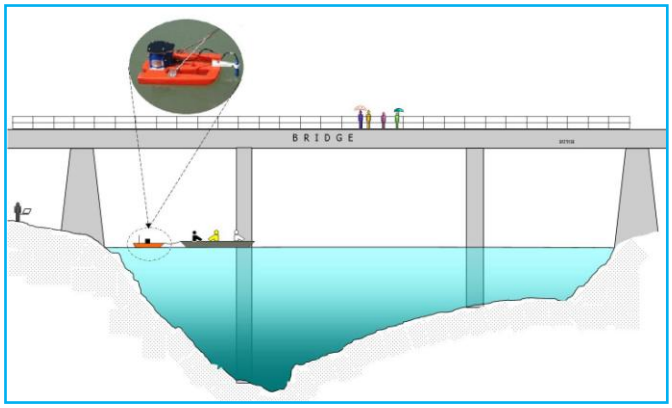
1.2 Output Data and Pictures:

Assembling the ADCP

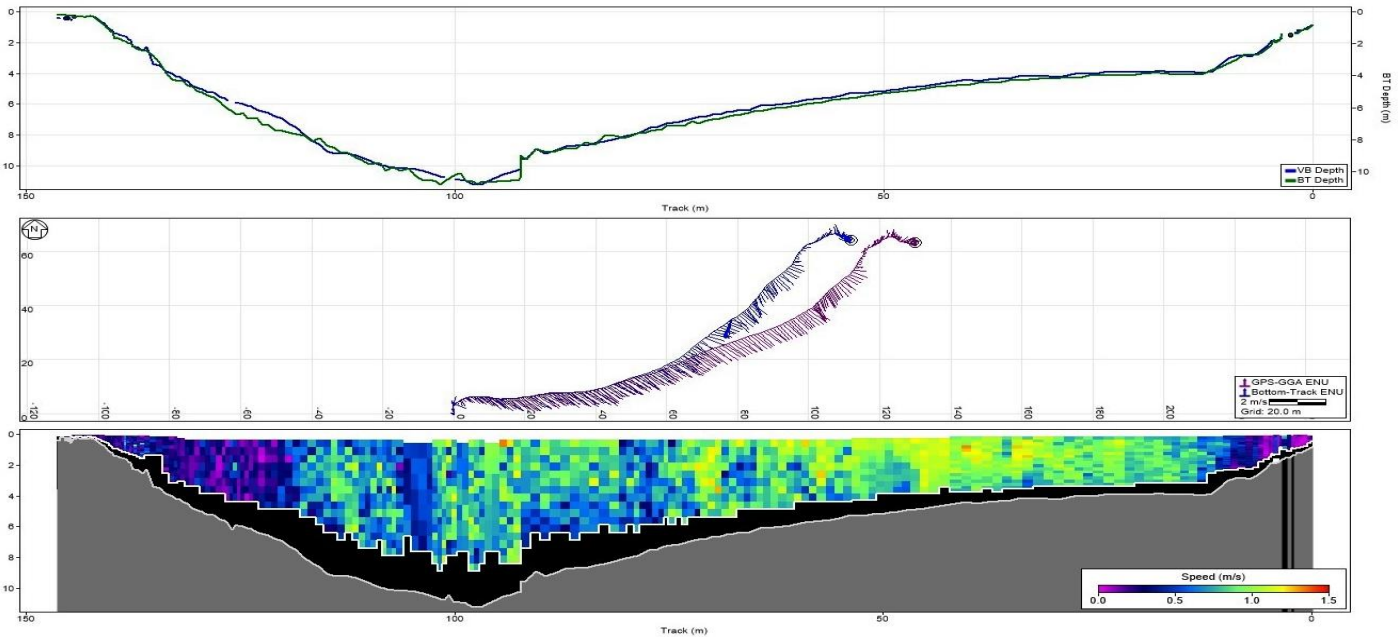
Connectivity Test

System Calibration

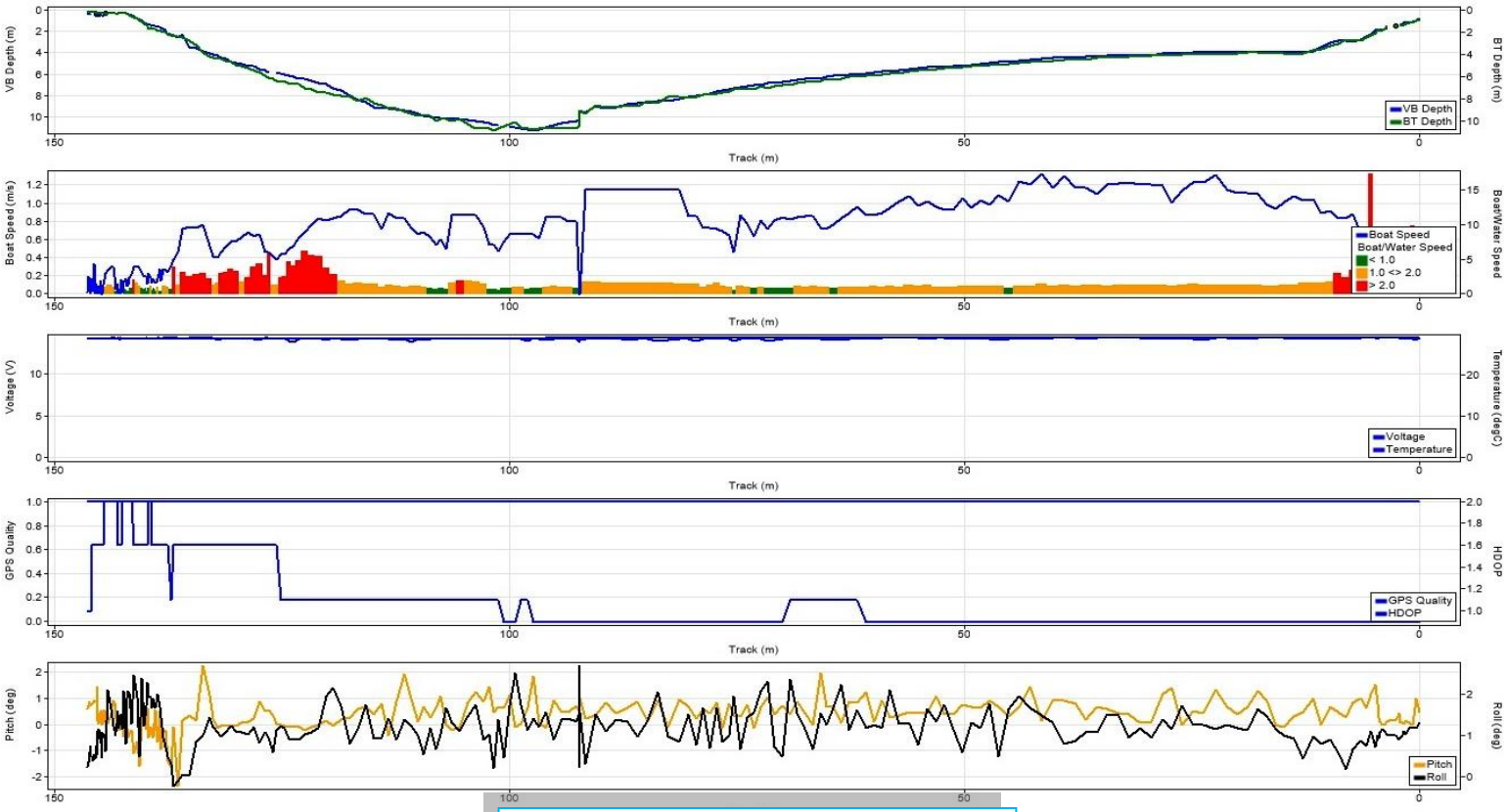




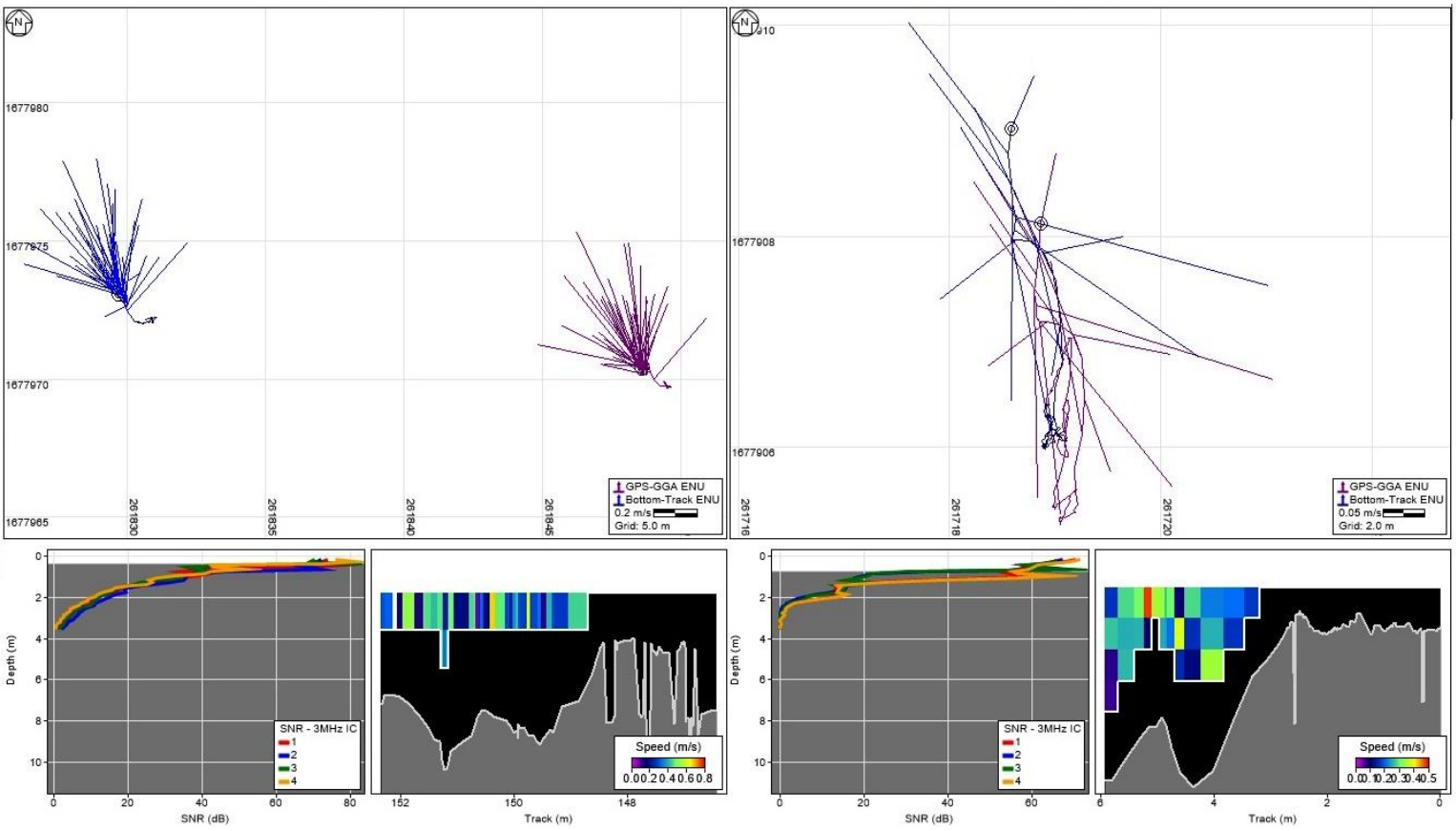
Group IV while transecting a portion of the Pampanga River (Arayat)



River Profile



Time Series


1677980
1677975
1677970
1677965
261630
261635
261640
261645
GPS-GGA ENU
Bottom-Track ENU
0.2 m/s
Grid: 5.0 m
1677910
1677908
1677906
261716
261718
261720
GPS-GGA ENU
Bottom-Track ENU
0.05 m/s
Grid: 2.0 m
Depth (m)
SNR - 3MHz IC
1
2
3
4
SNR (dB)
Speed (m/s)
Track (m)

ADCP edges

Discharge Measurement Summary

Date Measured: Thursday, October 17, 2013

Site Information

Site Name	Arayat Stn
Station Number	001
Location	Arayat Pampanga

Measurement Information

Party	HTC - Grp 4
Boat/Motor	1
Meas. Number	1

System Information

System Type	RS-M9
Serial Number	3860
Firmware Version	3.00
Software Version	3.7

System Setup

Transducer Depth (m)	0.00
Salinity (ppt)	0.0
Magnetic Declination (deg)	0.0

Units

Distance	m
Velocity	m/s
Area	m2
Discharge	m3/s
Temperature	degC

Discharge Calculation Settings

Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (m)	130.596
Area (m2)	703.897
Mean Speed (m/s)	0.672
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

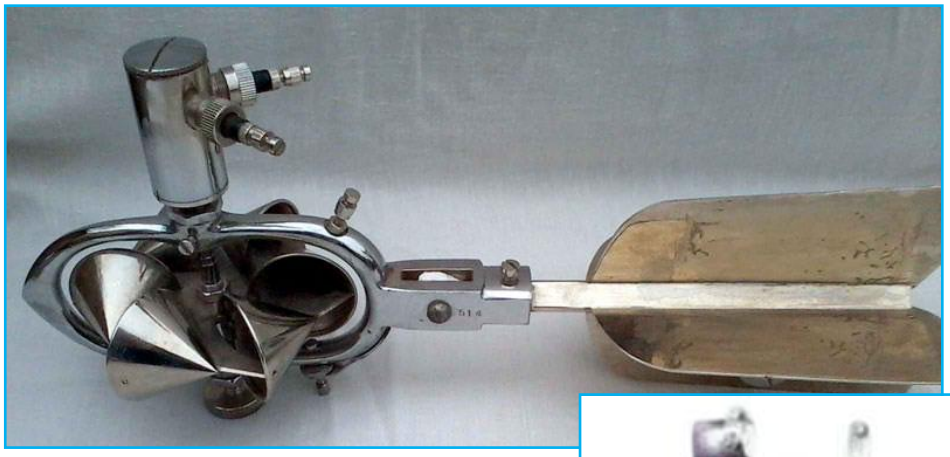
Passed Calibration
Calibration duration = 66 seconds
M7.00 = Magnetic influence is acceptable
Q9 = Magnetic field is uniform
H9 = Complete horizontal rotation
V9 = High pitch/roll
Recommendation(s):
Avoid any changes to the instrument setup or its orientation to the magnetic influences detected during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

System Test

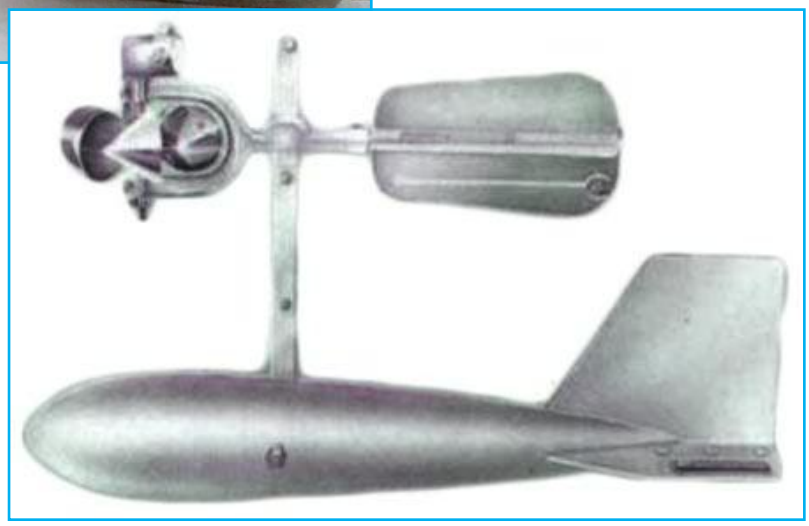
System Test: PASS

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

2.1 Second Day: Price AA Current Meter



Current Meter



Current Meter with weight

Things needed:

1. Current Meter
2. Weight/s
3. Sounding Reel
4. Beeper
5. Stop Watch
6. Measuring Steel Tape
7. Notebook and ballpen/pencil
8. Protractor

Measuring of discharge by current meter was done on the San Agustin Bridge. Current Meter is a precision instrument calibrated to measure the velocity of flowing water. The basic components of the Price AA meter include the shaft and rotor (bucket wheel) assembly, the contact chamber, the yoke and the tailpiece. A six cone-shaped cups mounted on a stainless-steel shaft. These were attached at the sounding reel.

There should be a “spin test” before using the instrument. The rotation of the rotor must take 2 minutes or more before it will stop. In this way one will be able to know if the current meter is functioning well.

The width of the bridge was divided by 5 meters. In every 5 meters the group used two-point (0.8 and 0.2) depth measurements but before measuring the depths on the said two points the current meter must first be placed in the water surface then the scale of the sounding rope will be placed to zero. When placed in flowing water the rotor of the Price current meter turns at a speed proportional to the speed of the water. Then the beeper attached to it will beep when the rotor turns. There are 2 settings in terms of revolution of the rotor. One is 1 revolution per beep and the 5 revolutions per beep. The current meter was set to 5 revolutions per beep at that time. When the rotor is already stable, after 30 seconds one should start the counting of beeps. Then time it using the stop watch. The minimum time of counting the beep is 60 seconds. A dry and wet line should also be considered when suspended angles are observed in the sounding rope. The allowable angle of suspension is 4 degrees. Above 4 degrees one should take note of the angle of suspension. When the angle is high, attaching an additional weight is recommended. These angles will be used during computation of discharge. Also, take note of the distances where piers are located and also when there is a presence of turbulent/s and other things that may affect the rotation of the current meters rotor like water lilies, measuring of velocity in these distances is impossible.

In computation, Mean- section and Mid-section methods are applicable. Take note of velocity equation of the current meter used. V= aN+b; where N= revs/time; a,b= coefficient of instrument. It is a default in every current meter. In two-point method, the average of the two points or the vertical mean velocity is used.

2.2 Output Data and Pictures:

Connecting a current meter to the sounding reel

Actual usage of the Current Meter

Formula: $V = \infty \times \beta . n$

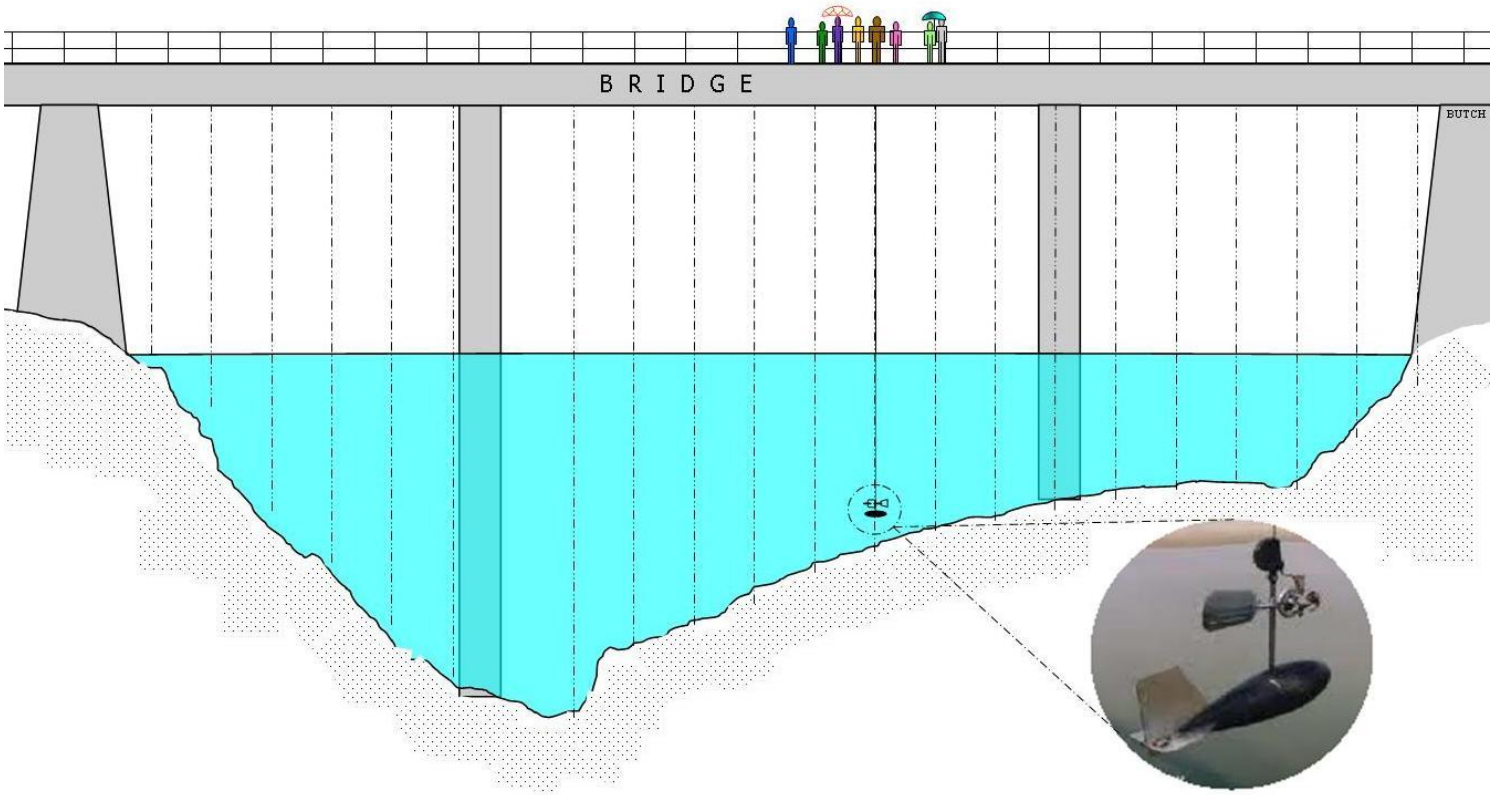
V = velocity of a current at a point

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

Calculations and corrections 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					hth/ 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**		


BRIDGE
BUTCH

INDIRECT METHODS

3.1 Third Day: Float Method

Things needed:

1. Materials that can be use as floaters
2. Stop Watch
3. Range Finder
4. Echo sounder
5. Boat/ Banca

Discharge measurement by float is the most convenient way of measuring discharge during flood times. This is done by throwing floats in a bridge or any particular facility. Before doing this the width of the bridge must be subdivided. And the group used a 21.5 meters division. Along the river banks downstream of the bridge 50 meters from the dropping point was measured, this was considered to be the 1st cross- section and an additional of 100 meters is the 2nd cross-section.

A float was thrown into the river until the float maintains its draft before reaching the 1st section. Measuring the time of travel using stop watch will start at the 1st section and ends at the 2nd section. After all the 10 floats were thrown (2 floats at each division) the next part was measuring the cross- section of the river. An echo sounder was submerged in the water to find its depth while measuring the depth of the water; someone will hold the range finder. This instrument was used to locate the horizontal distance from the banks to the point of the river where the echo sounder was submerged.

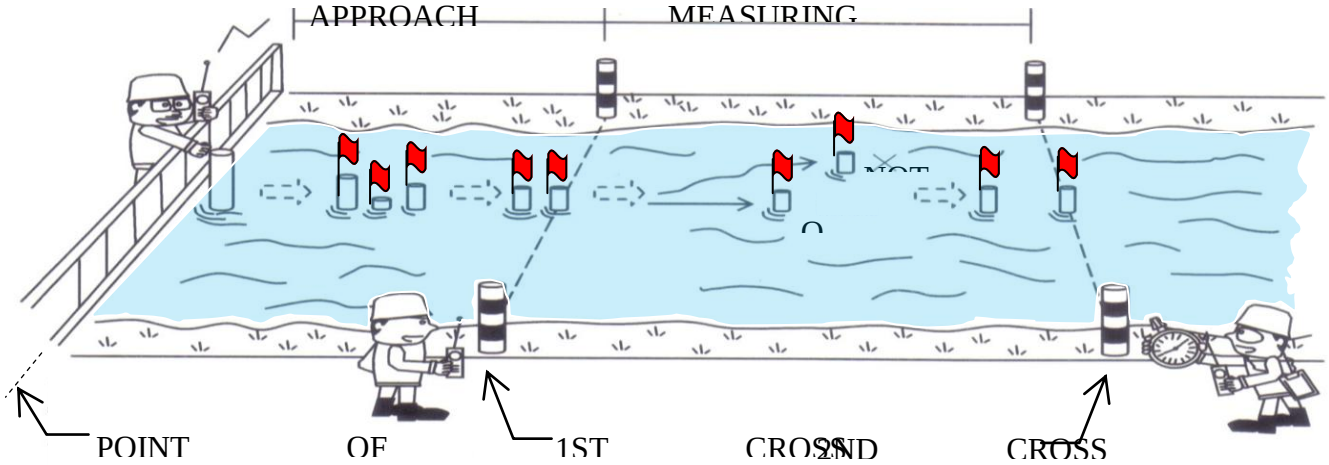
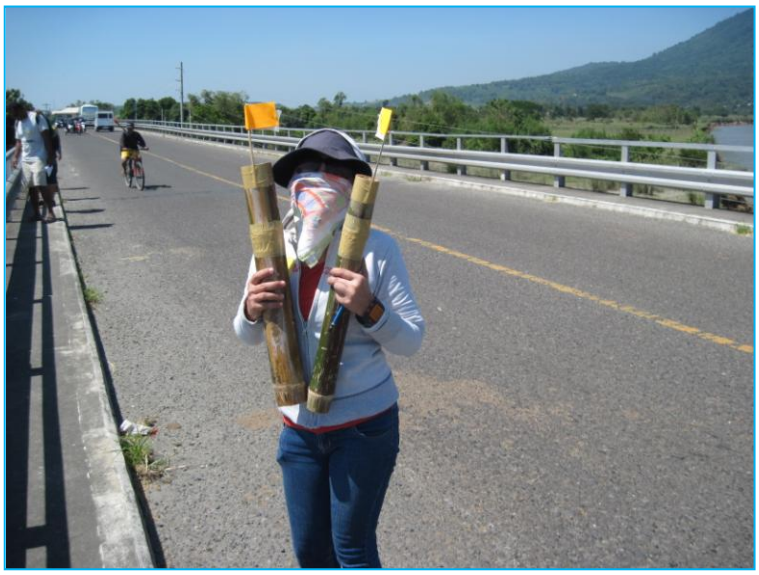


Illustration: **Measuring of Discharge using Float Method**

3.2 Output Data and Pictures:

Measuring the width of the bridge

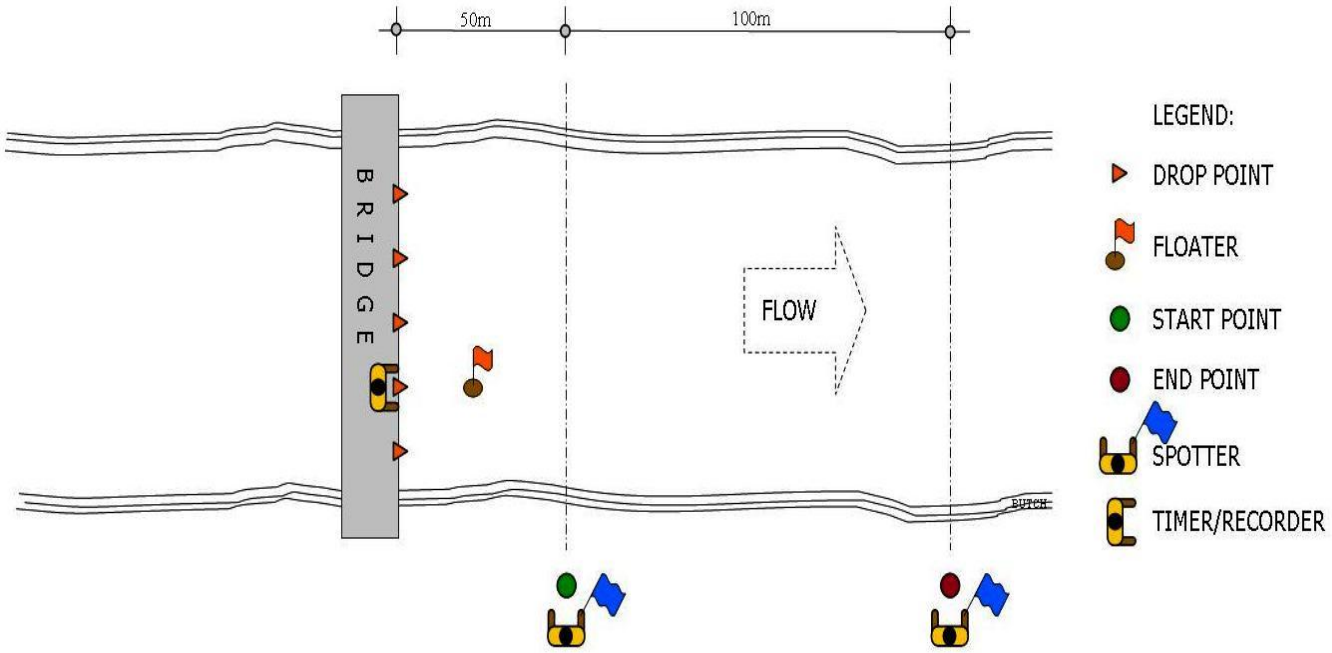


Preparing the floats for the drop

Person holding the Signal Flag

Cross sectioning the river

3.3 Illustration: Float Method



3.4 Float Method Data and Total Discharge:

								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**

4.1 Fourth Day: Slope Area Method

The last method that the group performed was the Slope Area Method. Slope area is a time consuming method but this method is used when no other equipments are available. Through channel characteristics, water surface profiles, and roughness coefficient the slope area of a river can be computed. The selection of suitable reach is probably the important element of a slope area measurement. During the time of measurement, there were still flood marks left by the typhoon Santi. The marks on the clear banks was destroyed or washed to a lower elevation. The group identified first the highest water flood marks caused by the said typhoon.

After identifying the highest flood marks, the group selected the 3 cross sections to be used. Since a minimum of 3 cross sections is recommended in using the slope area method.

Then the group looked for the bench mark (BM). It is located at the left bank and upstream portion of the bridge near the old stilling well of the PAGASA. The BM will be used as a reference in getting the elevation in each point. These elevations will be used in getting the profile of the river, from the highest flood marks on both banks of the river up to the thalweg.

Total station and its prism were the equipments that used by the group in getting the elevation in each point. Keep in mind that before positioning the total station at a certain area it must be oriented in the North. A beep will tell you that the total station locates the prism, and it will automatically give the Horizontal Distance, Horizontal Angle, and the Vertical Distance from the total station up to the person who holds the prism.

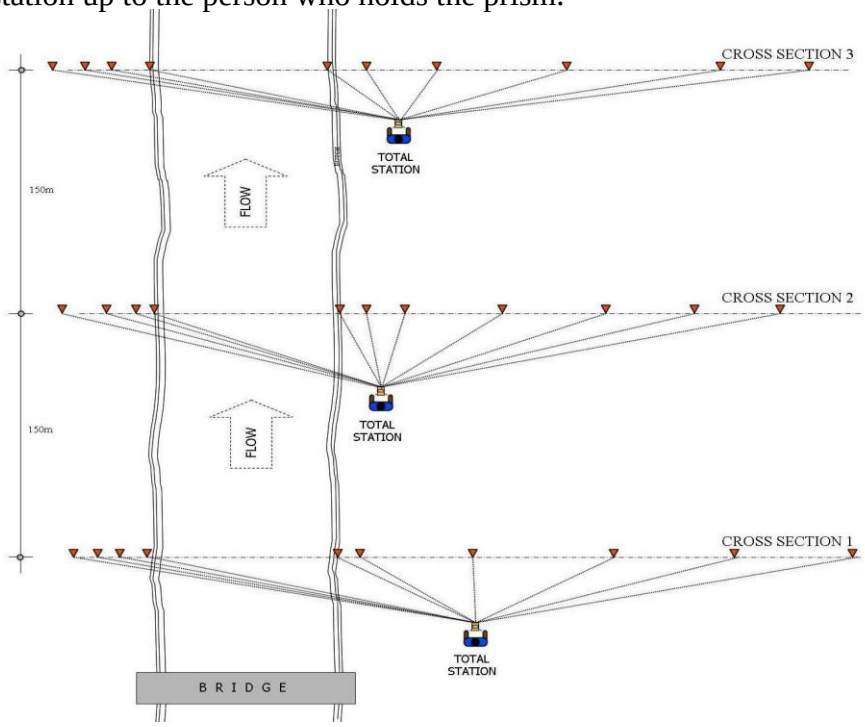


Illustration: **Slope Area Method of Measuring Discharge**

4.2 Output Data and Pictures:

Leveling the Total Station

Prism Holder

Cross Sectioning

4.3 Result:

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 - w td. 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

Computation of Discharge

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

Q = total discharge

A = Cross – section Area
V = Mean Velocity in cross – section

n = Roughness coefficients

R = Hydraulic radius

S = Slope of water surface

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

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**				

First Cross Section

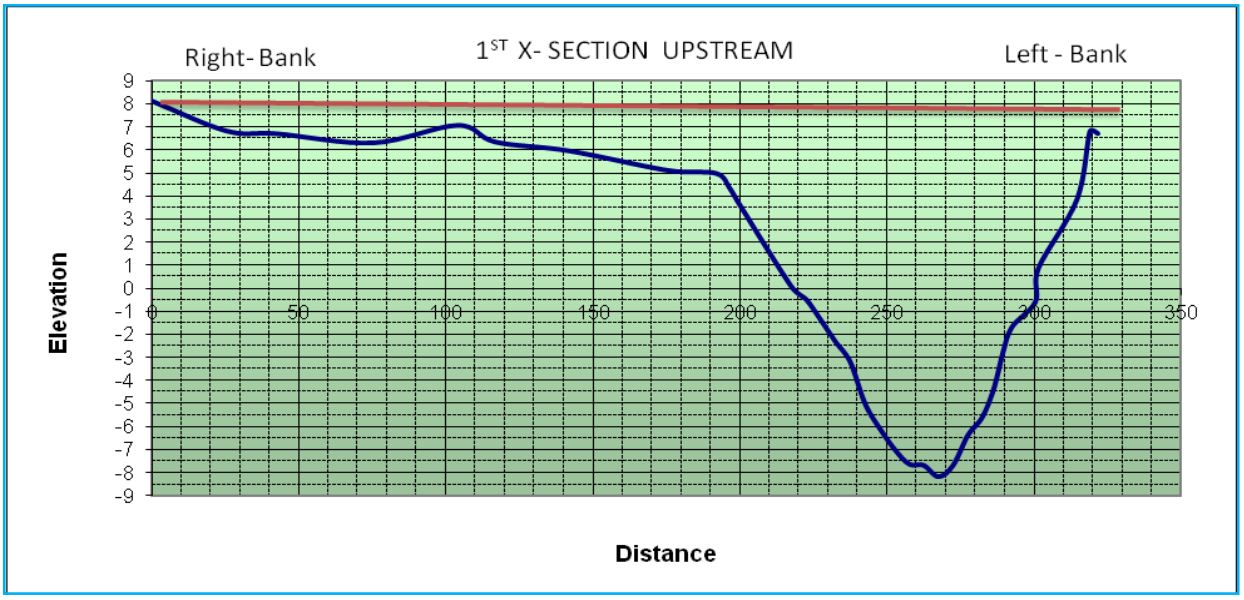
Slope-Area Cross-Section Computation							
Station:	*0*			Survey Date:		*0*	
River:	*0*			Gage ht.=		*9.11*	meters
Cross-Section number TWO (2)							hth/ 97
Station	**Distance**	**Elevation**	**Water Sfc. elev.**	**Depth**	**Mean Depth**	**Area**	**Wetted Perimeter**
0		8.001	8.001	0			
18.2	18.2	7.99	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

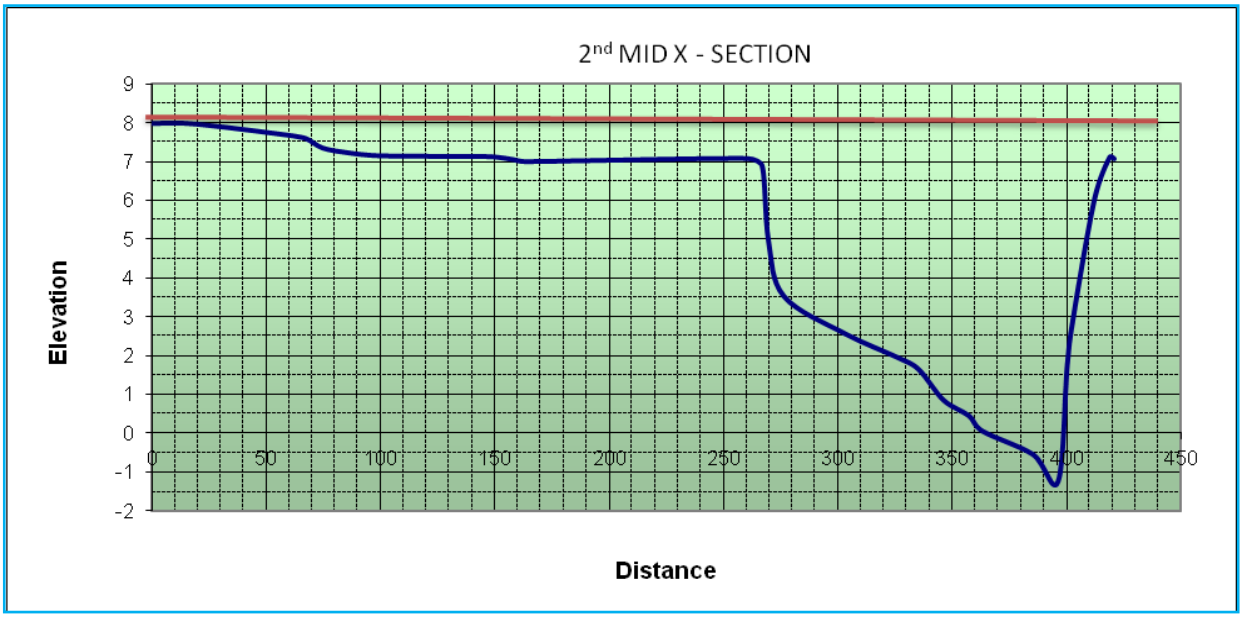
Total Width =	**420.50**	**meters**	**Hydraulic Radius(r) =**	**2.62**	**meters**
Total Area =	**1107.31**	**meters^2**	**Mean Section Depth =**	**2.633345**	**meters**
Wetted Perimeter(P) =	**423.232**	**meters**			

Second Cross Section

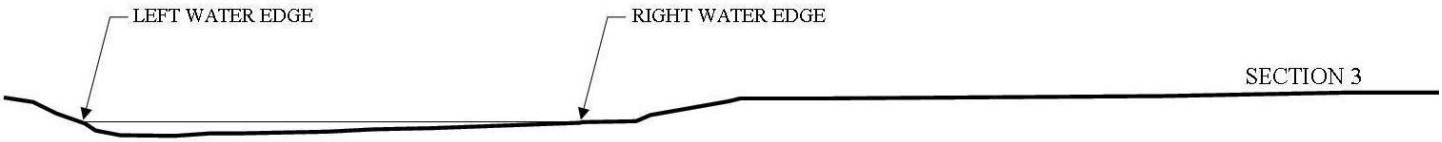
Slope-Area Cross-Section Computation							
Station:	*0*			Survey Date:		*0.00*	
River:	*0*			Gage ht.=		*9.11*	meters
Cross-Section number THREE (3)							hth/ 97
Station	**Distance**	**Elevation**	**Water Sfc. elev.**	**Depth**	**Mean Depth**	**Area**	**Wetted Perimeter**
0		7.979	7.979	0			
21.521	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**				

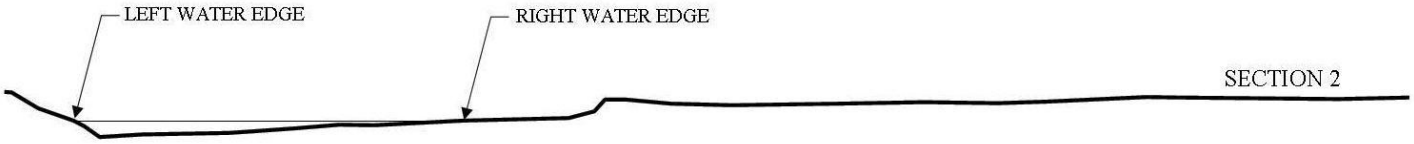
Third Cross Section

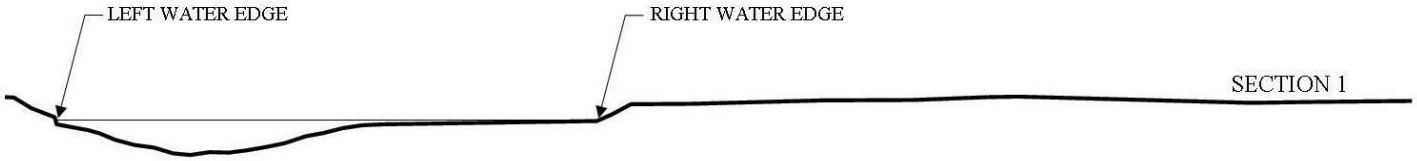


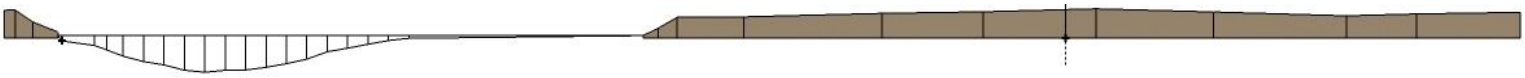


Slopes of the River at 3 Cross Sections (viewed upstream)



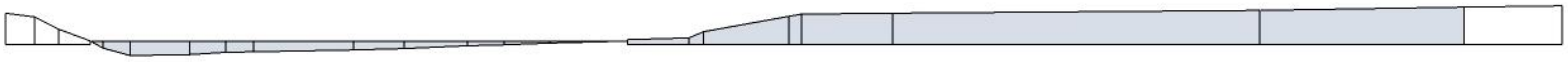






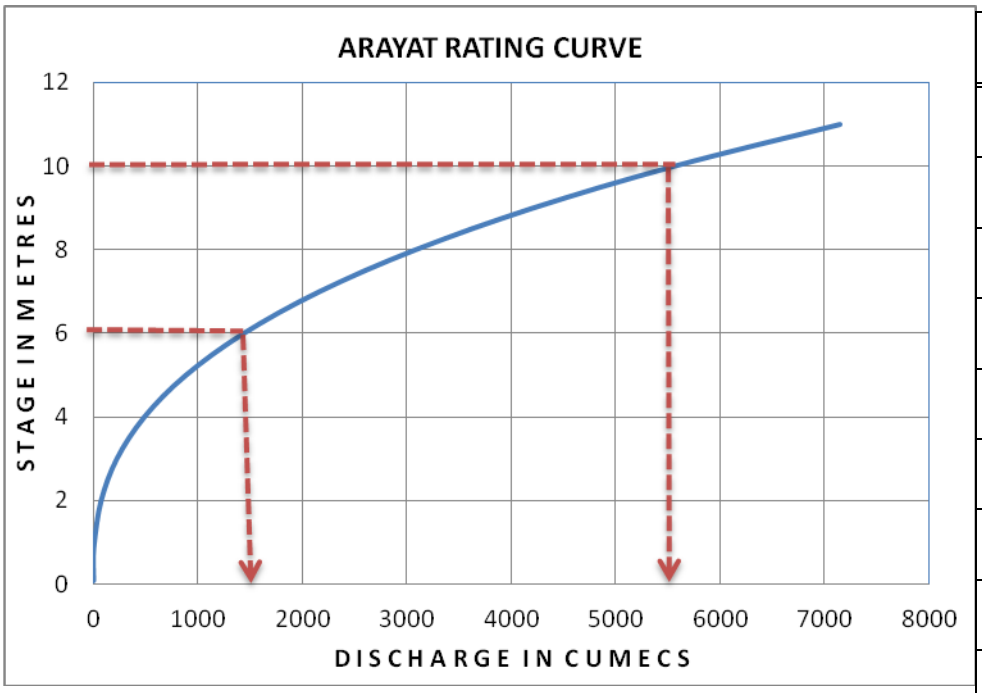
1st Cross Section

2nd Cross Section



3rd Cross Section

Slopes of the River at 3 Cross Sections (viewed downstream)



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

Rating Curve and Equation

Note: Data came from the Group 1

Equation: $13.660\ (H-0.082)^{2.6192}$

V. Output Description:

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

1. ADCP

Above are the results that the group IV got during the measurement of discharge using the ADCP. The Arayat portion of Pampanga River's profile, its time series, ADCP river edges and finally, the discharge measurement summary. In the WMO standards the minimum transects must be 4. Our group transected the river only twice. At the first attempt of transecting a problem occurs. The inputs were not set properly that's why the second profile is presented above.

The Calibration took 60 seconds. The total width of the river from right bank to the left bank is 130.596 meters, area= 703.897 square meter, Mean Speed= 0.672 m/s, total discharge=473.139 cubic meter/sec. The maximum measured speed and depth is also indicated in the above form.

The ADCP will give you automatically the whole profile of the river that is being transected. And you can easily pinpoint what portion of the river is shallow or deep. The colors in the river profile indicate the speed of the ADCP when it was being towed by the banca. It only took us about 30 minutes to finish the said method.

2. Current Meter

The result in the current meter presented above indicates that out of 17 divisions in measuring the depth and velocity of the river only 15 points have results. The group put an EP sign in the table indicating that at this portion there is a pier which is considered as an obstruction. We have no data for that said 2 points. By putting an EP sign the total discharge will decrease. That's why whenever there is a pier in location where you will measure the velocity at a certain depths, by using the excel format given above you must indicate it by putting an EP.

There are still points that we had dropped the current meter but the sounding reel cannot penetrate or touch the river bed because it's quite short. We had tried to use the bigger and longer sounding reel but it is malfunctioning. The group also cannot attach the echo sounder at the sounding reel because the other group was using it.

At point 85m going to 120m, there are no values because the current meter can no longer rotate because of the presence of obstructions like water lilies, pier, turbulent and others are points in the river where it is shallow**. The results in current meter: Area= 466.24 sq.m., Discharge= 350.04 cubic meter/sec, Average Velocity=0.751 m/s.**

3. Float Method

On the third day, the group did the float Method. Here we have observed that the river is getting shallow. Since float method is mainly used in measuring discharge during flood times, the river made it difficult for us to find the points/ location where we will drop the floats.

Out of 10 floats 3 was considered as a failure. One got drown, the other one was stuck and the last one was not seen by the flag holder when it reaches the 2^{nd} station.

Our total discharge using float method is **493.15 cubic meter/s.** It's quite high considering that time when we did the float method the river is shallower compared to the time while we were doing the ADCP and Current meter methods.

4. Slope Area Method

This method is a time consuming method compared to the other methods performed by the group. Even in calculating the discharge, it is a bit complicated. But slope area method is used when there is no other equipments in measuring discharge are available.

By the use of the excel sweep, the formulas need in solving the discharge using slope area is already in and the excel will be the one to calculate it automatically. You just have to put the data needed such as the stations, elevation, and water sfc level. The above tables and graphs are the results of the groups slope area method in measuring the discharge. The results are based on the highest flood marks found that day**. Total width= 321.65m, Total Area= 1,627.90 square m, Wetted Perimeter= 326.148 m, Hydraulic Radius= 4.99 m, and the Mean area depth= 5.061073m.** There are also graph showing the slope and profile of the Pampanga River in the Arayat portion.

The slope of the 3 cross- sections differ from each other specially the first section. The data were taken from the group. They used the current meter in computing the area and discharge for the said section. The two other cross sections of the river, our group used the range finder in getting the distance at a certain point and an echo sounder in getting the depth.

A rating curve is also shown above. This rating curve came from the data of the Group I. We used their data because their group is the only group that used the total station and the prism in getting the slope area of the river. By the use of Manning's Coefficient the discharge was being computed.

VI. FIELD TRIPS

A. Itinerary:

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	

B. Places:

1. La Mesa Dam

2. Pantabangan Dam

3. Cong Da Dong Dam

4. Municipality of Calumpit, Bulacan

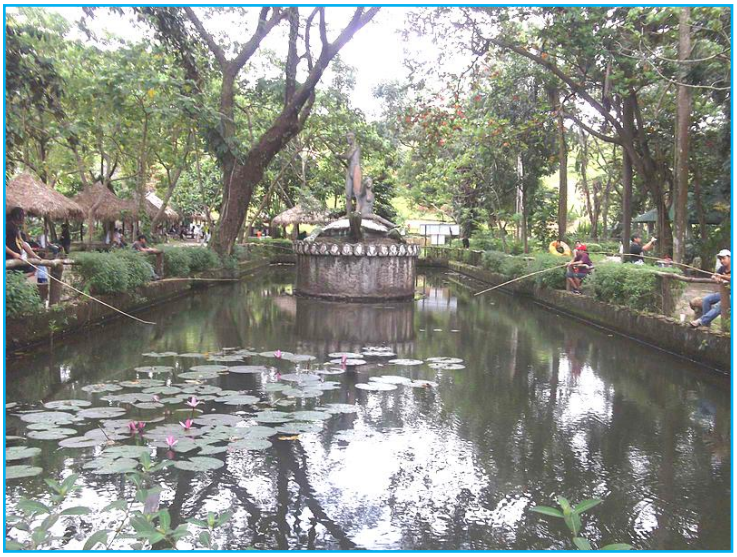
5. Mega Dike and Bacolor Church (San Guillermo Parish)

6. Angat Dam

7. Pampanga River Flood Forecasting and Warning Center (PRFFWC)

C. Overview:

1. La Mesa Dam



La Mesa Eco park

La Mesa Dam is the first dam that was visited by the HTC trainees. There the trainees had found out about the dams importance not only for human beings but also for the nature in general.

La Mesa Dam 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. Why Angat- Ipo- La Mesa? Most of the water in the Dam came from the Angat Lake which passed through the Angat Dam. And about 5-

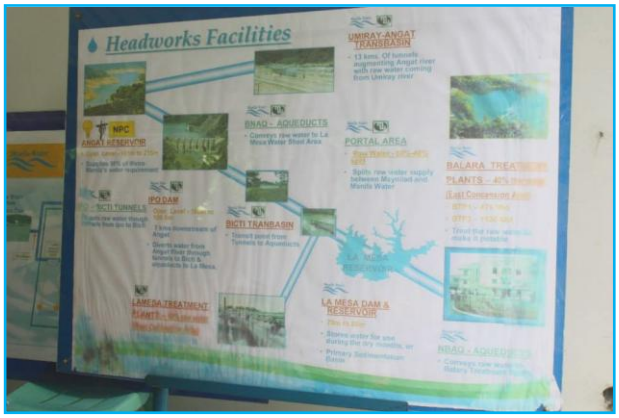
7 km, a dam named Ipo was situated. It is a diversion dam. This Ipo dam is so useful since if there's no diversion there will be no supply of water for Manila.

La Mesa Dam's primary purpose is for Domestic. It is built for impounding purpose only. It has no spill gates. It only means that whenever the amount of water exceeds the maximum volume that the dam can hold it will spill naturally. The highest water level of the dam is 80.150 meters. Its outflow is 80.151 meters. According to the speaker, the lowest water level was recorded during the El Nino of year 2010 which is 68.6 meters.

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. Turbidity is the ability of light to pass through a substance and this parameter is important when treating water for domestic utilization. The treatment process includes Pre- Chlorination, Sedimentation, second chlorination where biological components are being treated, filtration which uses silica sand, Post Chlorination, and lastly pumping of water or the treated water.

While on the site, we have seen the PAGASA rainfall station. Its rain gauge is a tipping bucket type which is powered by a solar panel and it is connected into a console system with an SD memory card where data are stored. The equipment is a daily, hourly recorder and it resets every 8 in the morning. Its antenna is a Yagi Uda type.

PAGASA Console System



La Mesa Headworks Facilities

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

Spillway

The Pantabangan Dam was the 2nd dam that the trainees had seen during the HTC field trip. The path going there is not that easy. It is located in an elevated place that's why the group had a difficulty in reaching the said 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. Its reservoir, Pantabangan lake helps flood control. 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 First and largest project made in the Philippines.Since its primary purpose is irrigation, it is under the supervision of National Irrigation Administration, one of the agency of the Philippine Government, a contract under the Hydro Resources Contractor Council (HRCC).

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 areaand 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. 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 Francis turbine-generators for an installed capacity of 100 MW. Each turbine receives water via a 6 m (20 ft) diameter penstock. When the water is discharged, it is released into a 250 m (820 ft) long tailrace channel where it re-enters the river.

The personnel’s job is not only focus in irrigation. The dam has also instrumentation and forecasting. 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. And a discharge measurement was installed in the main plant. 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. 2 are a manual rain gauge. Its office has also a flood warning console used in triggering the flood sirens located in populated areas in the upper portion of Pampanga River.

Pantabangan dam serves an important role in Pampanga. It’s not merely used for irrigation and for hydroelectric , it is also a great help in saving lives of human beings in case calamity such as flood occurs.

3. Cong Dadong Dam

Name inscribed in silver

Dam's Spillway

Water Level Gauge

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"E and near the cities of San Fernando City, Mabalacat City, and Porac, Pampanga.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.

It is a Japanese funded dam under the supervision of Pampanga Delta Development Project (PDDP) - Irrigation Component. The dam services 10, 270 hectares of farmland.

Cong. Dadong's name, each letter inscribed in silver was set in a huge wall toward the spilling gate. It took government engineers and Japanese consultants at least 26 years to complete the project. The dams 4 gates if closed during typhoon would force the water to spill out to low- lying areas of Nueva Ecija. A water level gauge is affixed to the wall its irrigation canal. It is used in monitoring the water height.

4. Municipality of Calumpit, Bulacan

The HTC trainee's fourth stop is the Municipality of Calumpit, which is a first class urban municipality found in Bulacan, Philippines. The name "Calumpit" is named after the hardwood trees named "kalumpit" found growing abundantly in front of St. John the Baptist Church. With a total area of 5, 625 has. of flat terrain. 66.81% is for agriculture lands, 10.42% for residential, 2.48% for industrial, 0.89% commercial and 1.05% others. It occupied around 2.06% of the total area of Bulacan.

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 late May and ends around November, the dry season is from December to April. The average annual rainfall is 255.3 millimetres (10.05 in) with the month of August having the highest month average rainfall is about 304 millimetres (12.0 in). The annual number of rainy days is 175 days.

Calumpit is considered to be a "flood loving community" since it is a catchment area. When a heavy rainfall pours, Calumpit is easily flooded since it is a municipality located in the downstream. 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 Defense for ensuring the protection and welfare of the people during disasters and emergencies, 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. The system can also monitor dams. It accesses its data from the government agencies such as PAGASA, NAMRIA and others. It has a 12- hour rainfall advisory, flood risk probability scale just like in the station of PAGASA.

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 database and only 7% occupied. It makes a general understanding about when will the typhoon comes in the region and how it affects Calumpit and correlate it to the other. The *systems* primary goal is acquiring the information in how much is the rainfall in whole Pampanga River Basin. A one update per day in the four (4) major dams is given by the DOST stream gauge.

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. The focus of the system is not only in Calumpit but also in all neighboring municipalities and farther. A water level is located at Barangay Canugan. It is a staff gauge. Every 2 hours whenever there is a rainfall, a resident from the said barangay will inform the municipality of the water level using a radio or even through texting.

If we are united nothing is impossible. More vigilant residents' means fewer disasters will happen caused by flood. That's what I have learned in Calumpit that day.

5.1 Mega Dike and Bacolor Church

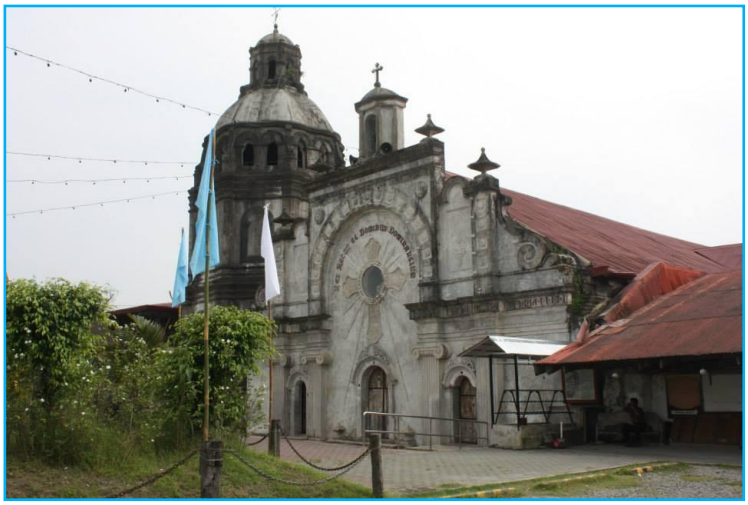
The Mega Dike

After the stop in Calumpit, Bulacan the trainees got a glimpse of the Mega Dike. It is situated just beside the road going to Bacolor Church.

Mega Dike is a 56 kilometer dike. It was built primarily as a last defense against lahar when Mt. Pinatubo erupted on June 15, 1991. It produced the second largest terrestrial eruption of the 20th century after the 1912 eruption of Novarupta in the Alaska Peninsula

On October 1, 1995, Typhoon Sibyl (Mameng) struck the town. It unleashed floodwaters and mudflows from Mount Pinatubo into the town. The Barangays of Sto. Nino, San Juan, San Pedro Cutud and Magliman were severely damaged by lahar. The citizens of San Fernando rallied to save the town by raising funds to build the St. Ferdinand People's Dike. The Pampanga Megadike was constructed the following year, thus preventing further damage to the town.

5.2 San Guillermo Parish (Bacolor Church)



San Guillermo Parish

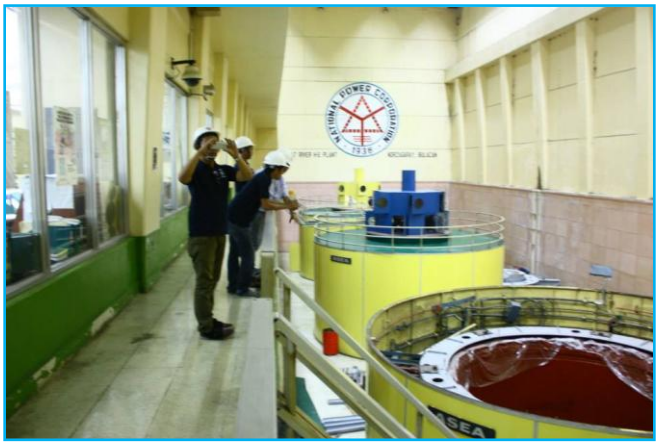
Bacolor is one of the oldest towns in the Philippines. The first church was constructed by the Augustinian Friars in 1576 on the lot of Don Guillermo Manabat, a rich landlord believed to be the founder of Bacolor.

San Guillermo Parish Church is named after San Guillermo the patron Saint of Bacolor, Pampanga, Philippines where the church is erected.

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 the world notice ofJune 15, 1991, buried the church at a half its 12-m height prompting its more than 500,000 residents to evacuate to safer grounds in resettlement areas.

Today, the church is already world famous tourist destination prior to lahar tragedy.It is a part of a main venue of ABS-CBN primetime show “May Bukas Pa” from February 2, 2009 to February 5, 2010 as their monastery. Still the church remains its solemnity and beauty.

6. Angat Dam



The last dam that the HTC trainees had visited is the Angat Dam. Aside from seeing the gigantic spillways of the dam, Engr. Russel A. Rigor the dams Principal Hydrologist tackled about the Angat Dam Flood Forecasting and Warning System. This is a vital thing to be learned as future hydrologists.

Angat Dam is a concrete water reservoir embankment hydroelectric dam that supplies the Manila metropolitan area water. The Angat River Basin is 963 sq. km. 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

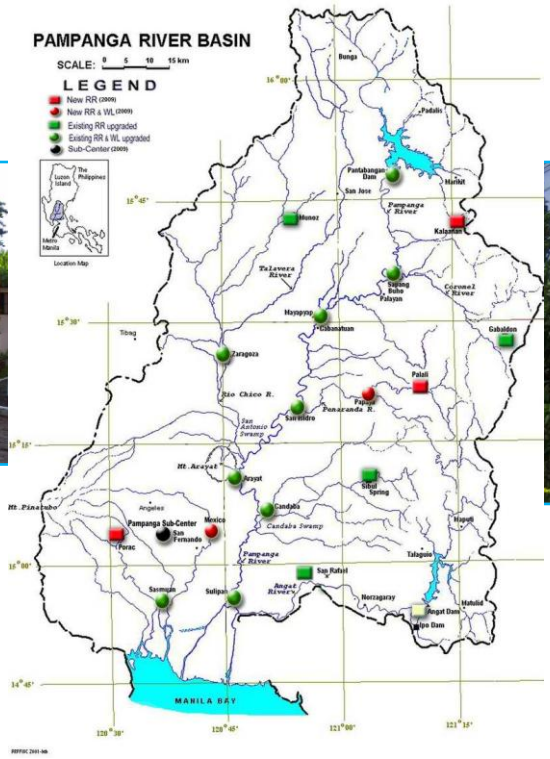
impounded water. On April 1983, the Angat started its Forecasting and warning system implemented by the National Power Corporation with PAGASA and NIA as cooperating agencies. The system is composed of 4 remote raingauges upstream of the reservoir and 1 water level gauge. It senses data every hour for 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.

After, the group visited the Angat Dam and the hydroelectric plant. There in the plant one of the heads explained to us how the dam operates and produces electricity. We are so lucky to enter the place and saw its magnificent structures.

7. Pampanga River Flood Forecasting and Warning Center (PRFFWC)



The Pampanga River Flood Warning and Forecasting Center (PRFFWC) or PRBFFWC is an office center of PAGASA, DOST which is tasked to monitor hydrological stations forecasts and provide flood warnings to the flood prone areas within the Pampanga River Basin and gauges River Basin Systems, mainly flooding events that can cause to the overflowing of rivers. The station also monitors and operates several rainfall and river gauging stations that are strategically located within the said basin areas.

IN last 1973, a pilot Flood Forecasting and Warning System (FFWS) for Pampanga River Basin was established because the areas within the basin suffered from several destructive floods caused by typhoons. Lives and millions of properties were destroyed.

The PRFFWC is one of the most updated in terms of flood forecasting and warning system. It has an eight (8) Rain gauge stations and it is an hourly automatic reading. Rain gauges are located in Pantabangan, Munoz, Cabanatuan, Mayapyap, Calaanan, Arayat, Sapang Buho and Porac. It has a 10 water level stations. The WL station Sapang Buho is located upstream. Just like in other Flood forecasting system the PRFFWC system has also a color coding in distinguishing data. Gray for No data, blue=normal, orange= alert, red= alarm, pink=critical. The flood forecasting system is also given by the JICA.

VII. CONCLUSION AND RECOMMENDATION

The Hydrologists Training Course 2013 Field work and field trips under the Stream Gauging subject of the PAGASA was successfully done. The objectives were met. The trainees learned a lot about the 4 methods of discharge measurement which plays a vital role in molding them to be competent hydrologists in the future.

In terms of measuring the discharge of a river, each method has its own pros and cons. The ADCP method is the most convenient type of measuring the discharge. ADCP measures the absolute speed of the water, not just how fast one water mass is moving in relation to another.

The equipment is quite expensive. The operator of the said equipment must be literate in terms of using the computer. Bubbles in turbulent water or schools of swimming marine life can cause the instrument to miscalculate the current. Users must take precautions to keep barnacles and algae from growing on the transducers. On the other hand the current Meter method is the second handy type of method that was used per observation. It's also an expensive type of equipment and if you don't know how to manipulate the equipment well it's hard to get the accurate measurement for a certain point. Current Meter is also affected by water lilies and other materials that will stuck in its rotor while it is turning. In the shallow part of the river, you can no longer use the current meter because the waters current is too low that it can't make the rotor spin.

The indirect methods, the float and slope area are methods that are less expensive but time consuming. The float method is the only method that can be used during flood time. Since you cannot use the ADCP and the current meter for the reason that during flood the water pressure is high and it's hard to tow an ADCP. While in the current meter the angle of suspension will be too high that adding an additional weight will be ineffective. The slope area method is the technique that is seldom used by the hydrologists in getting river discharge since it is time consuming in getting all the elevations and there are complications in calculating for the discharge.

More time for field works and field trips can make the trainees more enthusiastic in learning about the subject. Through these the knowledge that a certain person has acquired through reading will be enhanced.

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