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Physical Characterization of Kibalagon Creek Catchment Basin

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ABSTRACT

Activities and rainfall events at Kibalagon Creek catchment basin contribute to flooding problems at CMU. The study characterized the physical characteristics of the basin to serve as input in policy formulation of campus flooding problems. One year data collection included profile leveling, water flow measurements, soil and water sampling, and rainfall data collection. The basin is 464.3 hectares with 9.91-kilometer perimeter and thematic maps on a slope, elevation and soil were made. Kibalagon Creek has a total length of 8.61 kilometers with 12 streams and drainage density of 18.55 m/ha. Total suspended solid did not meet the minimum for agricultural purpose while pH and Total dissolved solid qualified.

Keywords: *catchment basin, characterization, physical*

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INTRODUCTION

Kibalagon creek wiggles from the upland side of the western part of Dologon, Maramag, Bukidnon which is part of the Kalatungan Mountain ranges. It crosses the Sayre highway between the Central Mindanao University (CMU) Laboratory High School and the University Commercial Complex. The catchment basin covers part of the University's land, and the creek irrigates portion of the CMU lowland rice project. However, it causes a flood at the vicinity where the stream crosses the highway during the rainy season. The floods are getting worst over the years which results in damage to properties and spoilage of assorted items in the CMU market. Occasionally, the floods were sometimes life threatening and cause serious traffic disruption.

Despite regular flood occurrences during the rainy season, no studies were conducted to check the present physical characteristics of the catchment. Information gathered may serve as input in policy formulation of CMU campus flood problems as a basis for drainage system design and reference for water utilization. Hence, this study aims to determine the present status of the catchment basin based on its physical characteristics. Specifically, the study delineated the Kibalagon Creek catchment and determination of water quality parameters consisting of Total Suspended Solids (TSS), Total Dissolved Solids (TDS) and pH.

METHODOLOGY

The project was conducted from January to December 2013. The creek catchment basin is located at Maramag, Bukidnon at coordinates North latitude 7°50'30" to 7°53'00" and East longitude 125°1'30" to 125°3" (Figure 1a). It has a total area of 464.3 hectares and covers portion of barangay Dologon specifically the southern part of CMU and portion of barangay Kisanday. The eastern part of the basin is bounded by Sayre highway and Dologon-Kisanday barangay road on the southwestern part.

Ocular and reconnaissance survey of the catchment basin were done by conducting a transect walk and actual situation of the field were observed and noted. Data points were identified along the creek network where the coordinates and elevation were collected using the GPS (Figure 1b). Soil samples were collected for laboratory analysis. Experiments on infiltration rate were also done on-site. Topographic maps were used as the reference in the delineation of the catchment basin to determine the boundary, area, and shape including the creek network and done using GIS. The base flow was measured by a digital current meter. Water sampling sites were identified, and water samples were collected during rainy days

and dry day for analyses of Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and pH. A standard non-recording rain gauge was installed to collect daily rainfall.

Map of Maramag, Bukidnon

Figure 1a. Location Map of Kibalagon Creek Catchment Basin

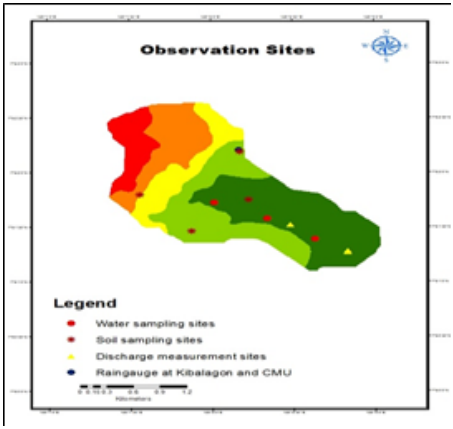

Figure 1b. Study Observation Sites

RESULTS AND DISCUSSION

The Kibalagon Creek catchment basin has a total area of 464.3 hectares with a perimeter of 9910 meters. It has an axial length of 3711.87 meters with an average width of 1744.76 meters. Its elongation ratio is 0.34 (Table 1 and Figure 2).

The Kibalagon catchment basin's small area is easily affected by the amount of rainfall which results in flash floods of the low-lying areas. Considering the basin steep terrain, a high portion of precipitation become surface flow which rapidly flows towards the Kibalagon creek resulting in flooding at CMU.

Table 1.
Morphology of Kibalagon Creek Catchment Basin

Parameter	Value
Area, hectares	464.3
Perimeter, kilometer	9.91
Axial length, meter	3,711.87
Average width, meter	1,744.76
Drainage shape (elongation)	0.34
Gravelius form factor	0.47
Relief Features	
Elevation, meters above sea level(masl)	
Lowest point	289.64
Highest point	544.37
Slope, (%)	
Minimum	0.00
Maximum	87.15
Basin relief, meter	254.73
Basin relief ratio	0.069

The lowest elevation at the catchment basin is 289.62 meters above sea level (masl) and the highest elevation is 544.37 masl giving a basin relief of 254.73 meters. This indicates a big difference in elevation and a slope of about 7%. The high elevation areas consisted 40% of the total area of the catchment basin and located in the northwestern part covering the areas in Kisanday while the low elevation areas consisted 60% of the catchment basin and located in the southeastern part of the basin particularly at the CMU area (Figure 3).

Basin relief influences flood patterns while the velocity and extent of runoff depend on the slope of the basin. Hence, when rainwater falls on that upper part of the catchment basin, it drains down to the low-lying areas, particularly at CMU. Also, basin relief influences the amount of sediment that can be transported. Sediment load increases exponentially with relief.

Table 2.
Elevation at the Kibalagon Creek Catchment Area

Elevation Range (masl)	Area Covered (hectares)	
	Area, ha	% of Total Area
289.62 – 342.57	163.01	35.11
342.57 – 390.52	116.54	25.12
390.52 – 444.47	61.25	13.19
444.47 – 496.41	77.16	16.62
496.41 – 544.37	46.36	9.98
Total	464.30	100.00

Figure 2. Kibalagon Creek Catchment Basin

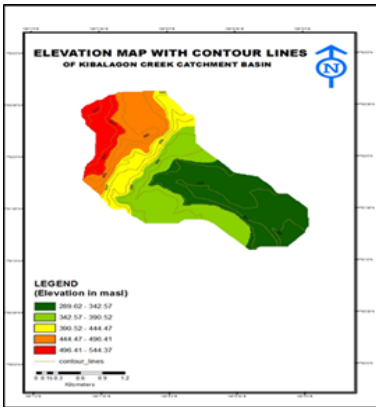

Figure 3. Elevation Map

More than 50% of the area in the catchment basin has slope of a level to undulating slope (0-8%). Land with these slopes is favorable to agricultural activities and in the basin these are mostly located within CMU area. Another 30% had a slope between 8% to 30% and located mostly in the upper part of the basin. About 10% of the area has a steep slope of 30% to greater than 50% which is only favorable as grasslands and forest areas. These high slope areas are located beside the creek at the southern part of the basin and on sides of gullies on the northern part of the basin. Using steep slope areas for agricultural purposes increases erosion problems (Table 3 and Figure 4).

Table 3.
Slope Classification at the Kibalagon Creek Catchment Basin

Slope Class	Range	Area Covered (hectares)	
		Area, ha	% of Total Area
Level to gentle sloping	0-3	90.89	19.58
Gently sloping to undulating	3-8	162.30	34.96
Undulating to rolling	8-18	107.89	23.24
Rolling to moderately steep	18-30	58.38	12.57
Steep to very steep	30-50	37.18	8.00
Very Steep	>50	7.70	1.66
Total		464.3	100.00

Soil analysis conducted at SPAL showed that clay is the dominant soil texture (Figure 6). The pH is within the range of moderately acidic which is still favorable for agricultural purposes and it has low organic matter content. The soil bulk density is within the range of agricultural soils (Table 4). On-site infiltration rate is 1.5 cm/hr. The observed flood in the creek during the study period has a high rainfall intensity of 85.95 mm/hr. These indicate that the low infiltration rate of the clay soil in the catchment basin would result in surface run-off and cause an increase in water level at the creek resulting in floods in the low lying areas especially at the vicinity of the CMU Commercial Complex.

Table 4.
Soil Characteristics in the Different Sampling Sites

Sample No.	pH	Total OM %	WHC	Bulk Density g/cc	Particle Density g/cc	Soil Texture
1	5.22	2.92	42.29	1.41	2.55	Clay
2	5.38	3.45	39.75	1.55	2.49	Clay
3	5.22	5.08	38.95	1.49	2.52	Clay
4	5.51	1.13	40.02	1.84	2.46	Clay
Average	5.33		40.25			

Sampling Site
1-Kibalagon 2- Kisanday(Manuta Area) 3-Musuan (Rubber Area) 4- Kisanday (Narukdukan)

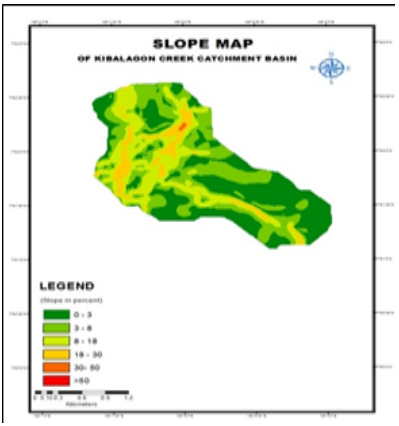

Figure 4. Slope Map

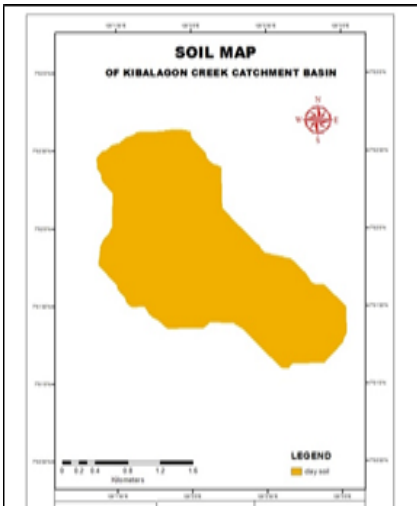

Figure 5. Soil Map

The Kibalagon Creek drains the surface runoff from the upland at the western side and joins the Taganibong Creek at the lowland of the eastern side. It is a tributary of Pulangui River and eventually drains into the Mindanao River. The creek has a total length of 8610 meters consisting of 12 streams. Three streams are classified as a perennial stream, and the other nine streams are classified as either intermittent or ephemeral streams (Figure 6). The creek's main channel is about 2800 meters. It is a third order stream, and the drainage pattern is dendritic. The drainage density is 18.55 meters per hectare resulting in about three streams per one hundred hectares, and the average stream slope is 0.006 (Table 5). Three water sources forming the three perennial streams are (a) Source 1 located at 7°51'50" N latitude and 125°1'40" E longitude; (b) Source 2 at 7°51'45" N latitude and 125°2'05" E longitude; and (c) Source 3 at 7°52'10" N latitude and 125°2'10" E longitude. The catchment basin has a measured mainstream length is 2.5 kilometers and gradient or basin relief ratio of 0.069. The computed lag time (TL) and time of concentration (TC) are 1.15 hours and 1.64 hours, respectively. This indicates that surface runoff reaches the point of interest at the CMU Commercial Complex area on a lapse of 1.64 hours after it heavily rains at the upper part of the catchment area with time to peak at 1.47 hours. The peak runoff rate is 0.76 cms per mm excess of rainfall.

Table 5.
Morphology of Kibalagon Creek

Parameter	Value
Total stream length, km	8.61
Length of Main Channel, km	2.80
Number of streams	12.00
Drainage Density (D), m/ha	18.55
Stream Density, stream/hectare	0.03
Stream Slope	0.006
Drainage or stream pattern	3rd Dendritic
Average Length of overland flow, ha/m	0.026
Sinuosity Index, S.I.	0.754

Note: Elevation at 85% length = 1,148 ft and Elevation at 10% length = 1,105 ft

Rainfall data were collected from June 2013 to February 2014 from two stations: one at sitio Kibalagon at Elevation 419 masl and at the CMU-PAGASA Agromet Station at elevation 302 masl with elevation difference of 117 meters. The two stations are approximately 2.8 km. apart. Kibalagon station received higher total amount of rainfall of 1948.6 mm for June to Nov (rainy season) as compared to the Agromet station which received 1728 mm. However, the daily rainfall is not significantly different. The mean daily rainfall at Kibalagon is 10.7 mm.

Figure 6. Creek Network with Stream Order

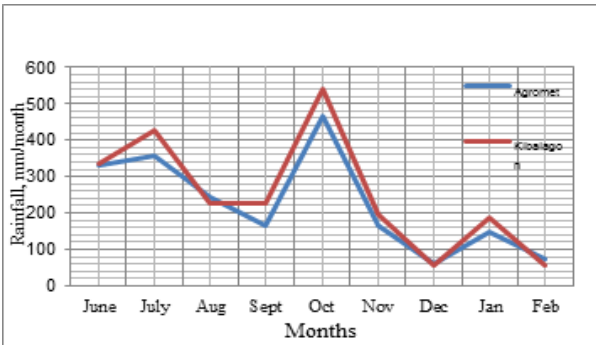

Figure 7. Monthly Rainfall from June 2013 to February 2014

The pH of creek water has values between 6 to 8 (Table 6) and TDS values of 128 to 420 mg/l which is below 1000 mg/L limit for irrigation water. Both pH and TDS are within the range suitable for irrigation purposes. On the other hand, TSS during rainy days range between 177 to 545 mg/l which is higher than the limit of not more than 60mg/L for irrigation water.

Table 6.
Water Quality at Kibalagon Creek During Rainy Days and Dry Days

Station		pH	Alkalinity, ppm	TDS,mg/L	TSS,mg/L
Downstream	Dry Day	7.18	109.19	360.00	94.00
	Rainy Day	7.10	77.27	128.67	545.67
Midstream	Dry Day	6.85	123.28	420.00	100.00
	Rainy Day	7.14	110.805	170.00	217.00
Upstream	Dry Day	7.37	120.23	400.00	104.00
	Rainy Day	7.085	61.235	240.00	177.00

CONCLUSION

Based on the results of the study, a delineated map of the basin with the creek network was made. Thematic maps produced include slope, elevation and soil maps that describe the physical characteristics of the catchment basin. Only TSS did not meet the minimum value for agricultural purposes while pH and TDS qualified.

RECOMMENDATION

Based on the data gathered, simulation studies of erosion using different land uses at the catchment basin may be conducted to provide information to farmers to sustain agricultural production with less off-site effects

REFERENCES

Catacutan, D.C., Mercado, A.S., Midmore, D. & Reyes, M.R. (Eds.). (2012). *Vegetable agroforestry systems in the Philippines.* Bangkok, Thailand: Funny Publishing.

DOST-PAGASA. (2010). *Manual on surface observations: Methods of operation.* Philippines: Author.

Institute of Water Resources Hydrologic Engineering Center. (2002). *HEC-RAS river analysis system.* Hydraulic Reference Manual. USA: Author.

Midmore, D. (2001). *Saving soil: Integrating erosion control in upland agricultural systems.* Georgia, USA: SANREM-CRSP.

Schwab, G.O., Fangmeier, D.D., Elliot, W.J. & Frevert, R.K. (1993). *Soil and water conservation engineering.* (4th ed.). USA: John Wiley & Sons, Inc.

USACE. (2008). *HEC-RAS river analysis system, application guide*. USA: Author.