SEASONALITY OF STREAM DISCHARGE AND LEAF LITTER DEPOSITION IN KAMALABOGONAN CREEK, CANDUGAY, SIATON, NEGROS ORIENTAL

Laurie J. Raymundo
Department of Biology
Silliman University
6200 Dumaguete City, Philippines

ABSTRACT. Stream discharge and leaf litter deposition data were collected for Kamalabogonan Creek, Candugay, Siaton, Negros Oriental, for January to December 1990. Discharge varied directly with monthly rainfall. Low values were recorded during the dry season (from January to May 1990), ranging from 0.09 m^3/min to 1.94 m^3/min, with markedly higher values observed during the rainy season (June to December 1990), ranging from 10.52 m^3/min to 41.10 m^3/min. Differences in leaf litter deposition into the stream were observed as well; deposition was generally higher and showed more fluctuation during the dry season (0.42 - 13.04 g dry weight/m^2) while values obtained during the rainy season were less variable (1.95 - 8.81 g dry weight/m^2). As leaf litter deposition represents a source of primary productivity for this stream via allochthanous input, quantification of the amount of input, the amount exported downstream, and the seasonality of input may lead to further understanding of the role of leaf litter in stream productivity.

INTRODUCTION

It is unfortunate that many of the rivers throughout the Philippines suffer from some degree of disturbance, even while their own biology remains largely unknown and unstudied. Research efforts have historically focused primarily on freshwater fisheries and lake biology (Juliano, 1975; Anonymous, 1975, 1981), with little or no mention made of stream or river systems. Locally, preliminary efforts have been made toward understanding the ecology of the major rivers of southern Negros Oriental (Luchavez, 1983; Alcala and Luchavez, 1982; Alcala and Alcala, 1987), but data were, for the most part, unpublished and sampling was limited. Cabanban and Luchavez (1982) studied the yield of the food plant 'kangkong' (*Ipomea aquatica* Forsskäl) in Ocoy River and Heideman, and Erickson (1987) completed a fairly extensive study of the Lake Balinsasayao watershed.

The objective of this study was to attempt to quantify the seasonal fluctuations in leaf litter deposition into a small, undisturbed stream. The importance of leaf litter to primary production of stream systems is particularly relevant considering the escalated rate of deforestation and forest conversion plaguing Philippine forests today. It has long been proven that deforestation upsets the hydrologic regime and biota of a watershed (Dunne and Leopold, 1978; Merilainen, *et al*., 1982), but little is known about its effects on stream productivity. Quantified data of this kind may be useful in formulating management policies for sensitive stream areas.

Study Area

Kamalabogonan Creek, Candugay, Siaton, is a small, undisturbed second-order stream, arising in the foothills of southern Negros Oriental (Fig. 1). It flows in a southwesterly direction through protected pastureland before joining the Canaway River north of the town of Siaton.

The stream is not subjected to chemical pollution, and biological pollution is minimal. Vegetation along the stream bank is thick and continuous (Fig. 2). Although the leased property is not heavily forested and largely covered with pasture grass, the ravine through which the creek flows has young secondary tree growth along the length of the stream. These trees were planted by the lessee over the last 40 years with narra (*Pterocarpus indicus* Willd.), teak, *Gmelina*, 'dalakit' (*Ficus balete* Merr.), 'kapok' (*Ceiba pentandra* (L) Gaertn.), mango (*Mangifera indica* L.), and bamboo (*Bambusa* sp). The tallest trees appear to be approximately eight to ten meters in height, and the width of this forest cover extends several meters on either side of the stream, depending on the width of the ravine. Understory growth has been allowed to develop naturally. A stream section approximately three kilometers long, in the center of the property, was chosen as the study area, due to its accessiblility and lack of disturbance.

Southern Negros is well-known for its marked dry season, due to the rain-shadow effect of the mountain range of Cuernos de Negros. This phenomenon has had a marked effect on the living conditions and agricultural practices of the inhabitants of this area mainly because of the seasonality of the water supply.

MATERIALS AND METHODS

Sampling was carried out monthly from January to December 1990. Five sampling stations were established along the stream, starting at the top of the major waterfall, to three kilometers upstream (Fig. 1). Stations were approximately equidistant from each other within this distance. During the first day of each field trip, at each station, stream width and depth were measured using a meter stick. Velocity was measured in the middle of the channel by timing how fast a square piece of rubber traveled one meter. Rubber was used because it does not absorb water and will not sink. This was done three times, and the mean value was calculated.

To determine leaf litter deposition, five pieces of 1m x 1m nylon fishing net were suspended above ground beneath overhanging trees and shrubs, next to the stream bank at each site. These nets were left in place at each site for 24 hours and retrieved the next day. Leaves caught in the net were considered to have fallen from the trees above, were collected, and brought to the laboratory. To determine how much leaf litter settled into the stream itself, plastic trays were placed in the water at each site, in protected areas away from the major currents where leaves were most likely to settle. These trays were also retrieved 24 hours later and all debris which had settled on the trays were collected and brought to the laboratory. In addition, a fish net with a 0.5-cm mesh size was stretched across the stream downstream of the first sampling site at the waterfall. This was also left in place for 24 hours to catch leaves washed downstream. These leaves represented those that were exported to areas downstream. Collected leaves were placed in aluminum foil trays, oven dried to constant dry weight at 40°C for seven days, then weighed using a triple beam balance.

Discharge was calculated using the following formula (modified from Dunne and Leopold, 1978): Q=WDaU; where W = stream width (in m); D = stream depth (in m); a = bottom friction factor; (0.8 = rock, gravel; 0.9 = mud, hardpan, bedrock) and U = stream velocity (in m/min).

RESULTS AND DISCUSSION

The dry season of southern Negros lasts from January to late April and is characterized by frequent brush fires. Many farmers, including the lessee, practice prescribed burning to control these fires and to stimulate the growth of new pasture grass. Rains begin in May, followed almost immediately by new vegetative growth. Within the duration of the project, two major storms occurred during the rainy season.

Stream parameters are presented in Table 1. Stream discharge demonstrated a marked seasonality, reflecting rainfall patterns characteristic of the Siaton area (Fig. 3). Two monthly trips, in fact, had to be postponed (August and November) because heavy rains and strong winds made the road impassable. Discharge, had it been obtained for these months, might have risen substantially higher than the 41.10m^3/min measurement obtained for July, especially during the few days of active storm weather.

Data on leaf litter deposition and settling rates in the stream appeared to be inversely proportional to discharge data (Table 2). Leaf litter in the stream was highest from February to April, corresponding to the dry season. This was typical of many tropical tree species, which shed their leaves in response to higher temperatures and low rainfall (Larcher, 1983). Deposition lessened somewhat as soon as rainfall increased and new growth appeared. It must be noted, however, that these figures include leaves exported from upstream areas which settle during periods of lower discharge, not just newly-fallen litter. This is best indicated in both the September and December values, as both these collections were made after major storms, when higher-than-normal turbulence flushed out debris and carried it downstream.

Deposition on the ground did not show any seasonal variation, but remained fairly low throughout the year. This may be due to the difficulty in sampling fallen leaves, many of which may have been blown out of the net before they could be retrieved. The amount of litter trapped in the export net reflects the volume and velocity of stream discharge, as the amount of material carried downstream by moving water is a function of the water velocity.

Because discharge was observed to vary widely throughout the year, it had a marked impact on litter settling and export. During the dry season, parts of the stream above the third sampling site actually dried up, so large sections of the stream became isolated from each other and little downstream export could occur. The dry season, therefore, was the time when leaves were deposited, settled and began to decompose, while the rainy season flushed out a great deal of litter, in various stages of decomposition, and washed it downstream.

Leaf litter represents an important source of allochthonous primary production in this stream. Past research has shown that most stream systems worldwide exhibit detrital food chains, using leaf litter as the basic source of primary organic matter (Cole, 1979). Fisher and Likens (1973) measured allochthonous input into a small second-order temperate stream and found that leaf litter settling into the stream and exported from upstream areas contributed 99% of its energy input. The other 1% was contributed by autochthanous mosses. Qualitative ocular observation in Kamalabogonan Creek showed very little live plant growth. During April and May, a single dense patch of the freshwater tracheophyte, *Hydrilla* was observed, but aside from this, only occasional single plants were found. Filamentous green algae were rarely observed. This indicates that leaf litter input and settling may be the most important source of primary production for this stream and are probably the basis for the food chain.

CONCLUSIONS

Kamalabogonan Creek exhibited a marked seasonality in terms of both stream discharge and leaf litter deposition and export. Discharge was uniformly low during the dry season, and at times even zero, as portions of the stream dried up. Fluctuations and higher measurements were characteristic of the rainy season, serving to re-oxygenate the water and flush out accumulated debris. Leaf litter deposition into the stream, on the other hand, tended to be higher during the dry season, as many trees shed their leaves in response to lack of rain. Although the data were incomplete due to the nets being torn, there were indications that downstream export appeared to be more a function of the velocity of stream discharge than litter input.

These observations indicate that, on a yearly basis, the months from January to May were marked by low discharge and water mixing, and settling of deposited material. The rains from June to December served to increase discharge, flushing out the stream and washing partly-decomposed material downstream. This suggests that overall stream productivity would tend to fluctuate as well, as nutrient inputs and chemical characteristics of the water change.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people: my field assistants, Aldrin Amistoso, Sandy Hurtado and Michael Alcala, for their dedication, helpfulness and good humor; Roy Olsen de Leon, for his assistance with graphics and formulation of the methodology; Jojo Legaspi, for his help with the map of the study site; Myrissa Lepiten, for her support and encouragement, and the University Research Center, for funding. Last, but certainly not least, I would like to express my deepest appreciation for the support that Dr. and Mrs. Jose Garcia provided. Their commitment to environmental awareness and conservation serves as a message and inspiration to us all.

REFERENCES

Alcala, A. and T.F. Luchavez. 1982. Studies of Ocoy, Pagatban, and Ilog Rivers ir Southern Negros, Philippines: I. Physico- chemical characteristics and domestic uses. Unpublished report.

Alcala, A. and L. Alcala. 1987. Baseline survey of invertebrates of Tanjay River. Unpublished data.

Anonymous. 1975. First PCAR Fisheries Research Congress: Inland Waters. Philippine Council for Agricultural Research, Fisheries Research Division, March 7-10.

Anonymous. 1981. State of the Art: Lakes and Reservoirs Research. Philippine Council for Agricultural and Resources Research, Fisheries Research Division, Fisheries Series No. 1.

Cabanban, A.S. and T.F. Luchavez. 1982. Yield of kangkong (*Ipomea aquatica* Forsskäl) in the Okoy River, Southern Negros Island, Philippines. Silliman J. 29(1-2):44-45.

Cole, G.A. 1979. Textbook of Limnology (2nd ed). C.V. Mosby Co., pp. 70-73.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. New York: W.H. Freeman and Co., pp. 151-153 and 590- 649.

Fisher, S.G. and G.E. Likens. 1973. Energy flow in Bear Brook, New Hampshire: an integrative approach to stream ecosystem metabolism. Ecological Monographs 43(4):421-439.

Heideman, P.D. and K.R. Erickson. 1987. The climate and hydrology of the Lake Balinsasayao watershed, Negros Oriental, Philippines. Silliman J. 34(1-4):82-107.

Juliano, R.O. (ed.) 1975. Inland Fisheries Project Progress Report, Jan. 1-June 30.

Larcher, W. 1980. Physiological Plant Ecology (2nd ed). New York: Springer-Verlag, pp. 68-70.

Luchavez, T.F. 1983. Invertebrates of Pagatban, Ocoy, Tiabanan, and Ilog Rivers and Ilog Estuary (1981-1983). Unpubl.

Merilainen, J., P. Huttunen and K. Pirttiala. 1982. The effect of land use on the diatom communities in lakes. Hydrobiologia 86(1-2):99-103.

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). 1990. Monthly summary of rainfall data, Siaton station.

Table 1. Stream parameters for Kamalabogonan Creek, Siaton, January to December, 1990, (n = 5).

Month	Mean Velocity (m/min)	Mean Width (m)	Mean Depth (m)	Mean Discharge (m^3/min)
Jan	4.50 ± 3.90	1.23 ± 0.60	0.14 ± 0.03	0.47
Feb	0.66 ± 0.90	4.91 ± 2.00	0.75 ± 0.45	1.94
Mar	0.20 ± 0.40	4.03 ± 1.70	0.53 ± 0.29	0.36
Apr	0.11 ± 0.20	2.99 ± 0.31	0.32 ± 0.15	0.09
May	0.86 ± 0.60	3.45 ± 0.92	0.24 ± 0.15	0.59
Jun	16.00 ± 5.50	3.98 ± 0.97	0.51 ± 0.04	26.63
Jul	25.00 ± 20.00	4.59 ± 0.65	0.42 ± 0.08	41.10
Aug		- - - no data collected - - -		
Sep	7.67 ± 2.20	4.08 ± 0.79	0.41 ± 0.05	10.52
Oct	12.36 ± 5.50	4.62 ± 0.69	0.54 ± 0.09	25.87
Nov		- - - no data collected - - -		
Dec	11.34 ± 6.90	3.42 ± 1.07	0.39 ± 0.08	13.70

Table 2. Leaf litter deposition and downstream export, Kamalabogonan Creek, Siaton, February to December, 1990, (n = 5).

Month	Downstream export (g dry weight)	Deposition on ground (g dry weight/m^2)	Accumulation in stream (g dry weight/m^2)
Feb	30.95	1.41 ± 1.10	16.10 ± 12.40
Mar	12.20	0.47 ± 0.13	13.04 ± 12.88
Apr	23.70	1.19 ± 1.47	12.14 ± 10.59
May	6.50	0.78 ± 0.88	0.41 ± 0.72
Jun	15.87	0.05 ± 0.04	4.30 ± 0.64
Jul	net torn-	1.28 ± 1.49	3.44 ± 0.59
Aug		- - - no data collected - - -	
Sep	110.70	0.18 ± 0.24	8.81 ± 13.40
Oct	-net torn-	1.25 ± 1.50	1.95 ± 2.19
Nov		- - - no data collected - - -	
Dec	-net torn-	0.40 ± 0.67	6.76 ± 9.12

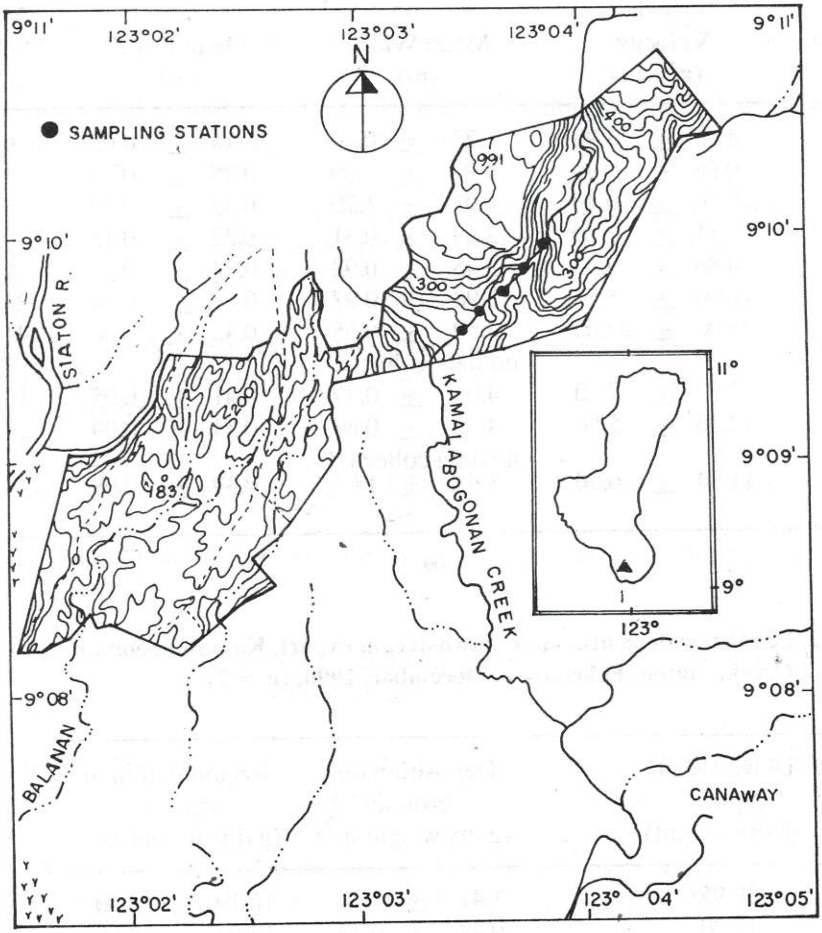

Figure 1. Map showing Kamalabogonan Creek and Canaway River in Candugay, Siaton, Negros Oriental.

Figure 2. Kamalobogonan Creek, Siaton. Photo shows bankful discharge, characteristic conditions during the rainy season, and continuous vegetation along the stream bank.

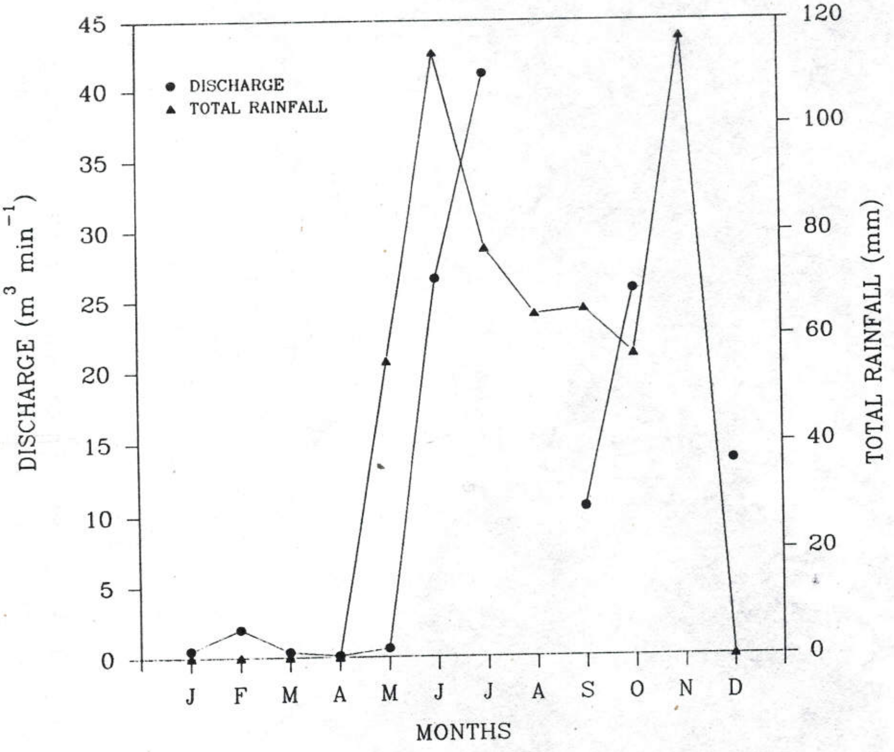

Figure 3. Monthly total rainfall vs. stream discharge, Kamalabogonan Creek, for the period of January to December, 1990.