

Rate of Loaded Sediments in Honda Bay, Puerto Princesa City, Palawan, Philippines

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ABSTRACT

A study in Honda Bay, Puerto Princesa City, Palawan, Philippines was conducted to determine and compare the rate of loaded sediments of and among six sites in Honda Bay and during two seasons, and to discuss sedimentation rate in relation to selected environmental parameters commencing on April 2003 to November 2003.

Results showed that the Babuyan River significantly contributed to the amounts of sediments being loaded to Honda Bay, Puerto Princesa City of which the amount of sediments loaded between the two sampling season and among the six sampling events had no significant difference. Sediment's color and texture affirmed the land-based activities in Babuyan and Mauyon watersheds, which eventually carried into the Bay during storm weather condition.

The amount of trapped sediments in all stations is probably affected by the river's discharge capacity and the river's water velocity, although the duration sediment traps were mounted could also affect the measurement of sedimentation rate.

Keywords: Sedimentation rate, loaded sediments, Honda Bay, Puerto Princesa City, Philippines

INTRODUCTION

Honda Bay is one of the bays of Puerto Princesa City. Surrounded by 18 coastal barangays, it is a major fishing ground of both artisanal and commercial fishers (Figure 1.) The bay has an area of approximately 280km² and located in the northeast of mainland Palawan between 9°50' to 10°00' N latitude and 118°44' to 119°00' E longitude. Six major rivers namely: Bacungan, Tandayak, Babuyan, Tanabag, Langugan,

and Tapul and numerous small tributaries drain into the bay (Figure 1). During rainy season, these rivers carry high amounts of sediments into the bay (personal observation).

Siltation is considered to be a problem on a national scale (UPMSC 1979 as cited by Aliño 1983) particularly in the coastal resources. In fact, dead corals in the northeast interior part of Puerto Princesa Bay were attributed to siltation and sedimentation coming from household wastes and/or the degrading watershed (Cruz et al 1988 as cited by FRMP 2001) which finally affects fish catch. In Palawan, devastating land-based activities in the watershed of Honda Bay have caused

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erosion and siltation may have likewise contributed to a decrease of fish catch per unit effort from 36.5kg in 1985 to 8.4kg in 1989 (Sandalo 1994) and to 5kg in 1996 (ICLARM 1996).

This study was conducted to describe the status of sedimentation in Honda Bay with the following specific objectives: 1.) to determine and compare the rate of loaded sediments of and among the six rivers in Honda Bay and during two seasons, and 2.) to discuss sedimentation rate in relation to selected environmental parameters.

MATERIALS AND METHODS

A total of six sampling sites were selected. These are in Bgy. Tagbueros, Sta. Lourdes, Bacungan, Sta. Cruz, Tandayak and Babuyan (Figure 1). In the mouth of each of these rivers, a sampling station was established. All stations were assessed in terms of sedimentation rate, water temperature, salinity, water velocity, pH, total dissolved solids and transparency. Sampling of

physical and chemical parameters was conducted thrice during the dry season (April, May, and June 2003) and thrice during rainy months (August, September and November 2003). Sampling of all stations was conducted within one day except during the first sampling in April 2003 when two days were needed.

Three sets of sediment traps were installed in all 6 stations with 3 replicates per set (a set is composed of 3 individual traps measuring 11.5cm in length and 5cm in diameter) (English et al 1997) on the same day. For each established stations, sediment traps were mounted 100 meters away from the mouth of the river towards the sea. The three replicates were mounted close (0.3m) to each other.

RESULTS AND DISCUSSION

In Babuyan River, the sedimentation rate ranged from 57 to 168 mg/cm²/day; in Tandayak it ranged from 13 to 63mg/cm²/day; in Sta. Cruz it ranged from 9 to 52mg/cm²/day; in Bacungan it ranged from 31 to 56mg/cm²/

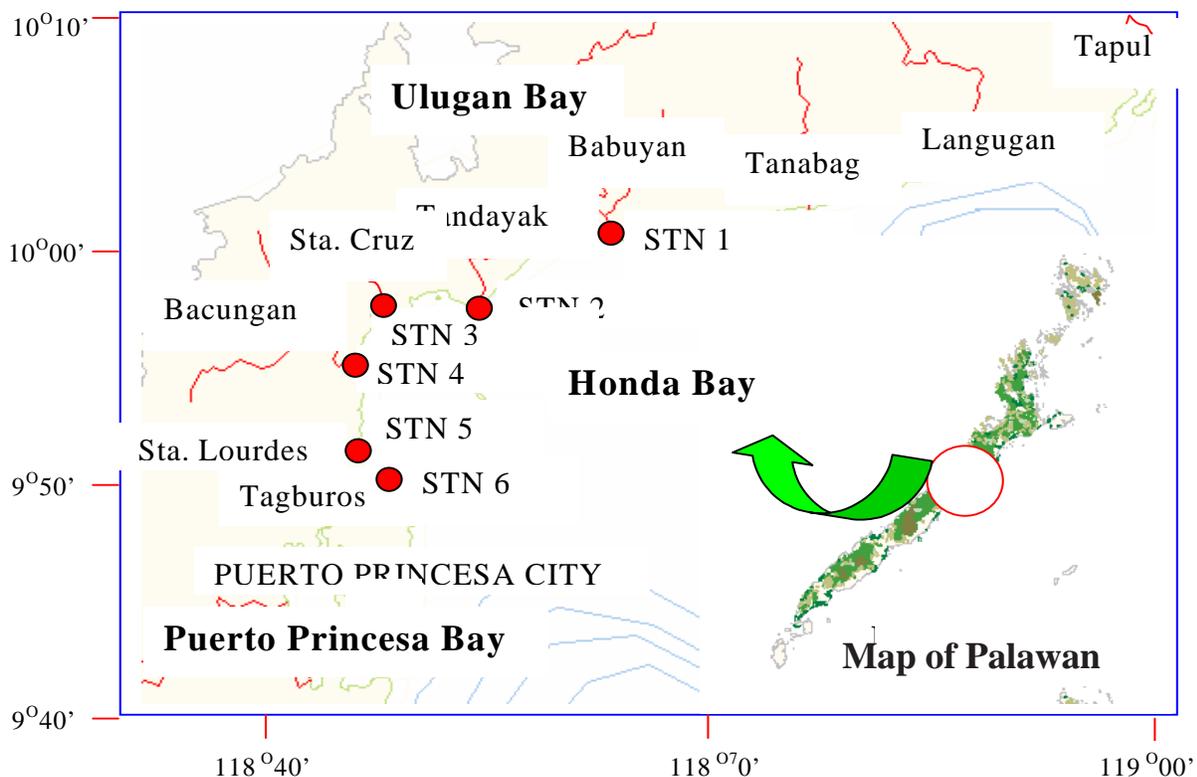


Figure 1. Map of Palawan (lower right) showing the study area and the location of the sampling sites in Honda Bay, Puerto Princesa City.

day; in Sta. Lourdes it ranged from 9 to 49mg/cm²/day; and in Tagbueros sedimentation rate ranged from 21 to 111mg/cm²/day. The average rate of sedimentation in the six stations established near the mouth of the rivers ranged from 27 to 125mg/cm²/day (Figure 2). The amount of sediment in Babuyan River was higher than in all other stations. This was true for both seasons. The sedimentation rate of Babuyan River is significantly differs (P<0.05) from the rates of all other stations.

T-test and ANOVA showed that sedimentation in each of the six sites is significantly different from each other (P<0.05). Furthermore, the test revealed that sedimentation during dry season was significantly different from sedimentation during the wet season. Sedimentation was also significantly different between the six sampling events in the rivers of Babuyan, Tandayak, Bacungan, Sta. Lourdes, and Tagbueros. Significant differences in sedimentation during sampling seasons (wet & dry) were established in the rivers of Tandayak, Bacungan, Tagbueros.

Among the six river stations, mean sedimentation was highest in Babuyan River, 125mg/cm²/day. Noticeable was that the sedimentation in Babuyan River was higher during the dry season (136mg/cm²/day) than during the wet season (115 mg/cm²/day). This could be attributed to the fact that during the dry season only data for the month of May were available. The sediment traps set up in April and June were lost. Similar pattern of higher sedimentation rate during the dry season was observed in Bacungan, Sta. Lourdes and Tagbueros. Also in the former two of these sites sediment traps were lost. The higher sedimentation rate during the dry season at these sites might be due to the duration of sediment entrapment. The sediment traps were set up for one month during the dry season, while during the wet season they were set up over a day only. The lowest river sedimentation rate was recorded in Sta. Cruz with a mean value of 27mg/cm²/day.

Sedimentation in Babuyan and Bacungan River are perceived to be attributed to the intense land use in the area. The two barangays had intensive agricultural

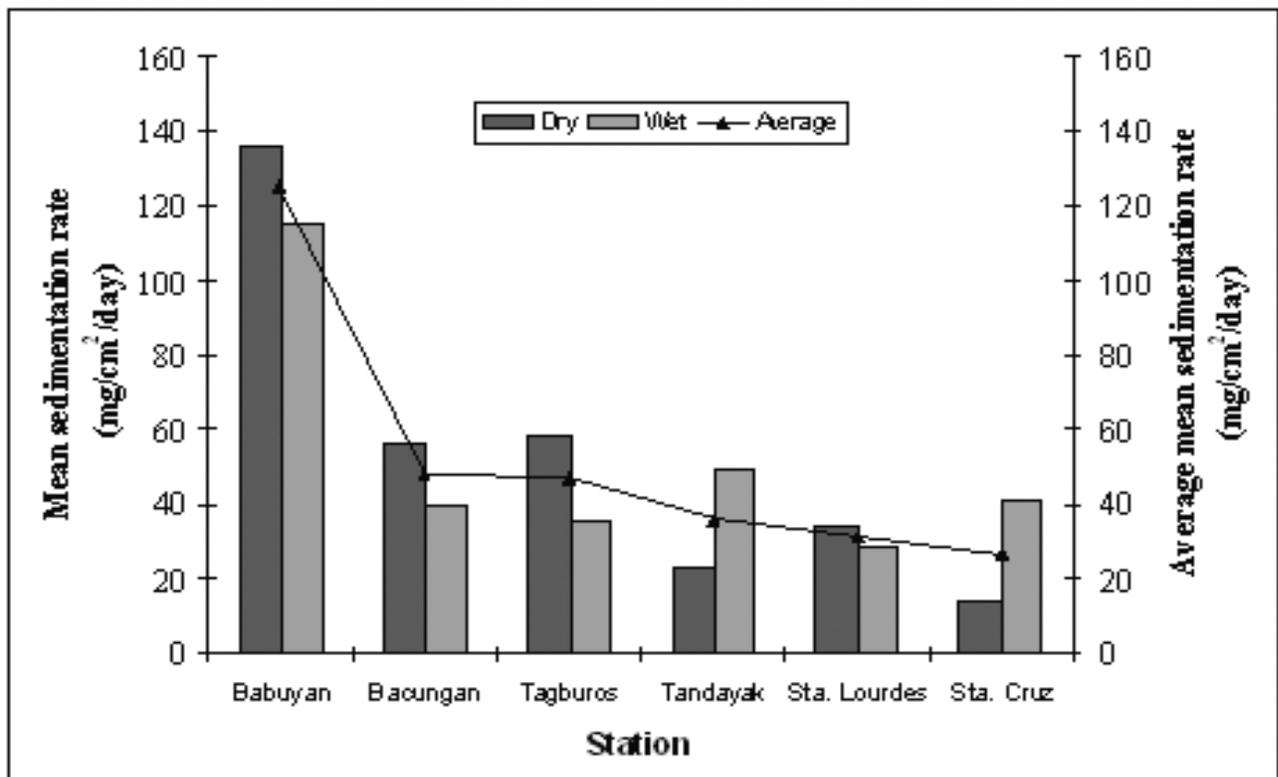


Figure 2. Mean sedimentation rate in the studied river discharging Honda Bay during dry and wet season.

practices in vast areas. Sediments collected in these rivers were characterized by very fine particles and reddish colored sediments, a characteristic of a fluvial type of soil. The fine grain size of the collected sediments and its brownish to reddish color indicate that this is an eroded soil which is carried by the storm water during heavy rains. Sedimentation in Sta. Lourdes was probably attributed by making a site for quarrying during road construction. Collected sediments are composed of sands and organic particles. In Tagburos, though fishpond in the coastal part of the barangay was present, high sedimentation is probably attributed by the road construction, which just finished during the collection period. These findings conformed to the statement of Winger (1981) that infusion of the eroded sediments into the river systems is caused by improper land use. In Sta. Cruz and Tandayak, sedimentation was probably influence by the presence of mangroves in the mouth of the river and in along the shore and the planting of fruit trees in the hillsides as well. Agricultural activities were not much observed in these barangays. Of the six rivers understudied, Babuyan and Bacungan were the one having the wider river mouth (120m and 50m) and still the deeper ones (both had an average depth of 3.5m), respectively which may also influence the siltation and sedimentation processes.

Average rate of loaded sediments in Honda Bay was much higher ($50.55\text{mg}/\text{cm}^2/\text{day}$) compared to Dona Paula Bay, west coast of India (Bhaskar et al. 2000), which only ranged from 0.11 to $1.34\text{mg}/\text{cm}^2/\text{day}$ with an average of $0.54\text{mg}/\text{cm}^2/\text{day}$. However, direct comparison may not be advisable due to differences in trap designs (pvc pipe used had a diameter of 20cm), exposure periods, and differences in the hydrological aspects of the different marine environments.

A study conducted by Aliño (1983) in three areas (Matab-ang, Bato, and Looc) in Toledo City, Cebu using 2" x 8" PVC pipe had an average sedimentation of 16.20, 10.10 and $33.5\text{mg}/\text{cm}^2/\text{day}$, respectively. These values are similar to those measured in Honda Bay (27 to $36\text{mg}/\text{cm}^2/\text{day}$). Only Babuyan River, Bacungan River and Tagburos River (125, 48, and $47\text{mg}/\text{cm}^2/\text{day}$, respectively) had higher values. In

Singapore, increasing coastal development has led to increased sedimentation from $3\text{-}6\text{mg}/\text{cm}^2/\text{day}$ in 1979 (Chan 1980) to $5.45\text{mg}/\text{cm}^2/\text{day}$ (Lane 1991, Low & Chow 1994), which is lower than the loaded sediments in Honda Bay.

The water transparency in the 6 rivers during all the sampling events was similarly low (Figure 3). For all rivers the mean transparency was 1.65m (± 0.4) during the dry season and 0.98m (± 0.6) during the wet season (Table 1). The lowest transparency (0.98 ± 0.21) was measured in Sta. Lourdes. The water velocity in Bacungan ranged from 29.41 to $52.63\text{cm}/\text{sec}$ while in Babuyan it ranged from 16.98 to $45.45\text{cm}/\text{sec}$, which is consistently lower than in Bacungan River. The lowest mean water velocity was in Sta. Lourdes with a value of $13.86 \pm 6.17\text{cm}/\text{sec}$ (Table 2). The high mean water velocities were observed in Bacungan and Babuyan River with 40.59 ± 12.44 and $32.96 \pm 12.13\text{cm}/\text{sec}$, respectively. Total dissolved solids were high in Sta. Lourdes (24.58 ± 0.74). Lowest total dissolved solids were taken in Babuyan (12.03 ± 5.81) and Bacungan (14.67 ± 6.25) rivers (Table 5). In all stations, temperature did not vary much from the mean (ranges from 28.5 ± 1.64 to 30.43 ± 1.25). The highest reading was taken in Sta. Cruz and the lowest reading was taken in Babuyan River (Table 2). The mean pH reading in all stations was almost neutral to slightly basic. The lowest pH reading was taken in Bacungan River (7.99 ± 0.44).

Total dissolved solids had a high correlation with the sedimentation rate in Babuyan River ($r = -0.90$), Tandayak ($r = 0.79$), Sta. Cruz ($r = -0.85$) and Bacungan ($r = -0.97$). In Sta. Lourdes ($r = 0.47$), a moderate correlation was established.

Water velocity in Bacungan and Tandayak River had a high positive correlation with the sedimentation rate. A substantial relationship between these two parameters was established in Tagburos ($r = -0.61$). In this site, sedimentation might have been affected by incoming high tide. The turbulences caused when sea and river waters meet during incoming high tide might have affected the settling of particulate matter, which then remained suspended in the water column.

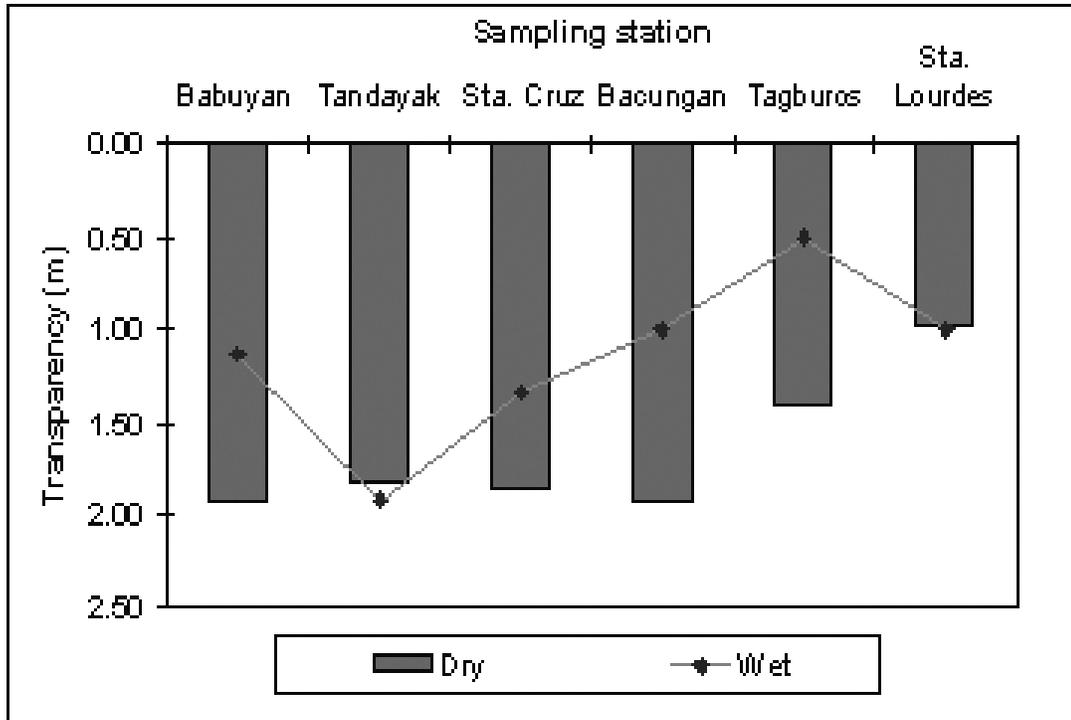


Figure 3. Water transparency in six river stations in Honda Bay, Puerto Princesa City.

Station/ Physico-chemical parameters	Salinity (ppt)	Temperature (°C)	pH	TDS (mg/L)	Transparency (m)	Velocity (cm/sec)
Babuyan	8.90-27.30	26.80-31.25	6.88-10.21	634-18.36	0.50-2.50	16.98-45.45
Tandayak	8.10-33.10	28.60-33.10	7.82-10.00	7.02-25.20	0.50-3.75	8.00-33.33
Sta. Cruz	25.50-32.90	29.60-32.90	7.81-9.30	20.10-25.10	1.00-1.90	11.11-29.41
Bacungan	7.30-32.20	28.40-33.10	7.31-8.43	6.36-23.60	0.50-2.50	29.41-52.63
Tagbueros	13.30-32.50	28.40-30.80	7.58-8.69	11.06-24.90	1.00-2.70	11.00-27.87
Sta. Lourdes	30.80-33.70	29.50-31.00	7.90-8.58	23.70-25.70	0.75-1.25	8.06-22.22

Table 1. Range of the physico-chemical parameters in all six stations in Honda Bay, Puerto Princesa City from April 2003 to November 2003.

RECOMMENDATIONS

For further study, inorganic contents of the collected sediments should be measured and the relationship between total dissolved solid and sedimentation rate should be examined and be evaluated as for the total dissolved solids be an indicator of sedimentation rate.

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