Contents lists available at Science-Gate

International Journal of Advanced and Applied Sciences

Journal homepage: http://www.science-gate.com/IJAAS.html

Assessment of the organic pollution level in rivers of Philippines

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ARTICLE INFO

Article history:
Received 15 January 2015
Received in revised form
15 February 2015
Accepted 17 February 2015

Keywords:
Water quality
Rivers
Physico-chemical parameter
Cebu
Philippines

ABSTRACT

The organic pollution levels of Buhisan, Bulacao and Lahug Rivers were assessed using temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD_5) as test parameters. Samples were taken monthly for a period of six months from three established sites in each river designated as upstream, midstream and downstream. Results were compared with the DENR Administrative Order 90-34 criteria for surface waters. The mean values of all the parameters observed at Bulacao River except for % O_2 saturation (30.45 %) at the downstream site were within the acceptable limits. For Buhisan and Lahug Rivers, the mean values for DO and BOD did not comply with the Class D standard set by the DENR. Among the three rivers, Bulacao River appeared to have the lowest levels of pollution which could be due to better implementation of solid waste management observed in Bulacao compared to Buhisan and Lahug. Moreover, the river banks of Bulacao River were observed to be less populated thus, lesser amount of wastes discharged in the area. Apparently, there is a need for a collaborative effort among the community, the academe, the NGOs as well as the LGUs for the protection, restoration and rehabilitation of these rivers.

1. Introduction

Water is becoming a critical resource due to the increased pressure on freshwater resources by the rapid growth of population, fast industrial, agricultural and economic development. Although the country is endowed with abundant water resources, usable water is becoming limited due to contamination and pollution. Forty of the more than 400 major rivers in the Philippines are contaminated in varying degrees (Dayrit, 2001).

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water and when it is unfit for its intended use. Although some kinds of water pollution can occur through natural processes, it is mostly as a result of human activities (Dulo, 2008). Uncollected garbage, street refuse, agricultural pesticides, traffic emissions, industrial effluents eventually find their ways into the rivers and the groundwater aquifers. Water pollution compounded by poor sanitation and hygiene practices has led to an upsurge of waterborne and water-related diseases (Dayrit, 2001).

Cebu City has five major river systems namely: Buhisan, Bulacao, Lahug, Subangdaku and Guadalupe. Cebu Rivers are currently facing problems like encroachments, disposal of untreated domestic wastes, and dumping of solid wastes. The Department of Natural Resources – Environmental Management Bureau Region VII (DENR – EMB 7) conducts quarterly monitoring on Subangdaku and Guadalupe Rivers. However, Buhisan, Bulacao, Lahug Rivers remain less examined and monitored. Hence, this study was conducted. The results of the study could be used as a basis for management options of these rivers.

The purpose of the present study was to assess the level of organic pollution in Buhisan, Bulacao, and Lahug Rivers using pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD_5) (2) compare the test results in each river; and (3) compare the data obtained with the recommended DENR standards for surface waters

2. Materials and methods

2.1. Study Site

The water quality assessment study was conducted in the three rivers of Metro Cebu namely Buhisan, Bulacao, and Lahug Rivers. Three sampling points along each river were established. The coordinates and locations of the sampling sites are shown in Table 1 and Fig.1 respectively.

2.2. Sample Collection

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Water samples were collected monthly by grab sampling for a duration of six months from three identified sites (upstream, midstream and downstream) in Buhisan, Bulacao and Lahug Rivers as shown in Fig. 1. Samples were taken about 10 cm below water using polyethylene bottles and BOD bottles. Samples were kept in ice for further analyses in the laboratory. Collection of water samples followed protocols and standard methods described in APHA AWWA WEF (2005), US EPA Volunteer Stream Monitoring Manual (1997) and Maglangit, *et al.* (2014).

Table 1: Coordinates of the sampling sites

River	Sampling Point	Coordinates
Buhisan	Upstream (BnS1)	N 10° 48' 24.8'' E 123° 51' 16.3''
	Midstream (BnS2)	N 10° 17' 55'' E 123° 52' 11.7''
	Downstream (BnS3)	N 10° 17' 32'' E 123° 52' 50.6''
Bulacao	Upstream (BoS1)	N 10° 16' 49.6'' E 123° 50' 26.4''
	Midstream (BoS2)	N 10° 16' 18.2'' E 123° 50' 49.4''
	Downstream (BoS3)	N 10° 15' 54.6'' E 123° 51' 23.3'
Lahug	Upstream (LaS1)	N 10° 20' 33.1" E 123° 53' 19.4"
	Midstream (LaS2)	N 10° 19 '30.3" E 123° 53' 48.8"
	Downstream (LaS3)	N 10° 18' 4.90" E 123° 54' 14.70"

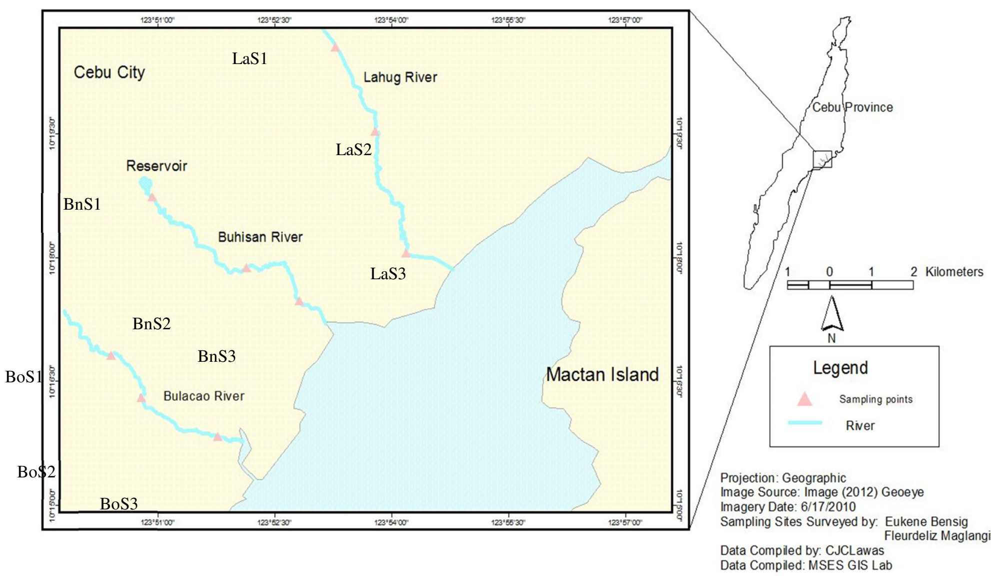

Fig1: Location of sampling sites along the Buhisan, Bulacao and Lahug Rivers

2.3. Analysis

Water temperature and pH measurements were done on the field using a standard, calibrated portable meter (Thermo Scientific Orion 5-star Model EW-58822-20). DO and BOD analysis were done in the laboratory as prescribed in the methods for the examination of water and wastewater (APHA AWWA WEF, 2005 and as described in Maglangit, *et al.* (2014). Three replicates were performed for each analysis.

3. Results and discussion

The results obtained in the analysis were compared with the DENR Class D standard for freshwaters (Table 2, Fig. 2).

The water temperatures observed at Buhisan, Bulacao, and Lahug Rivers were 27-30^{o}C, 27.3-31.1^{o}C, and 25-29^{o}C, respectively. Throughout the entire study period, all the readings fall within the DENR standard of not more than 3^{0}C increase in ambient temperature. Observed temperatures increased from upstream to downstream in the three rivers (Fig. 2a, Table 2) an d these results were comparable with those reported by Flores and Zafaralla (2012).

Table 2: Mean values of the parameter results compared with the DENR Class D standard for surface waters

	Buhisan River			Bulacao River			Lahug River			**DAO 90-34 Standard (Class D)**
	BnS1	BnS2	BnS3	BoS1	BoS2	BoS3	LaS1	LaS2	LaS3	
Temp ^{0}C rise	27.5	28.4	28.9	28.1	28.5	29.5	26.4	27.5	28.6	3
pH	7.2	7.6	7.3	8.0	7.5	7.4	7.7	7.6	7.4	6.0-9.0
DO, ppm	4.4	0.1	0.07	8.1	3.5	2.1	6.5	0.08	0	3.0
BOD, ppm	2.0	66.7	53.8	1.2	7.8	7.8	1.8	58.0	72.2	**10 min 15 max**

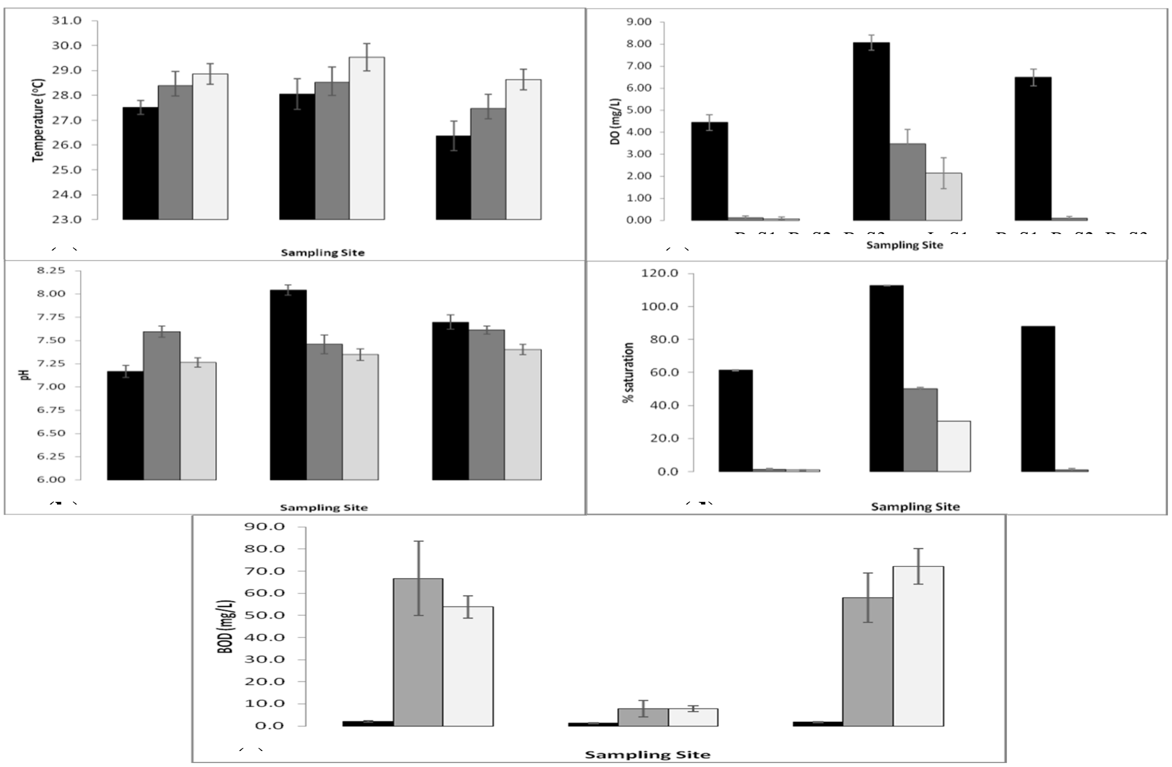

Fig.2: Mean (a) temperature (b) PH (c) do in ppm (d) do % saturation and (e) bod levels in Buhisan, Bulacao and Lahug Rivers

Temperatures were taken first from S1 to S3 during each sample collection. The presence of trees in BnS1, BoS1 and LaS1 shaded the river water from the sun resulting in lower temperature readings than in other areas. Direct exposure to sunlight can significantly raise the temperature of a water body. Other factors that contributed to the temperature variation included water depth, air temperature, amount of shade, and thermal pollution from human activities (Surubaru *et al.,* 2012).

The pH is a measure of hydrogen ion concentration or a measure of the acidity or

Alkalinity of a solution. The mean pH values in Buhisan River, Bulacao and Lahug Rivers varied from 7.19-7.50, 7.32-7.62 and 7.32-7.73 (neutral to slightly alkaline), respectively. The pH readings obtained in Buhisan, Bulacao and Lahug Rivers (Fig. 2b, Table 2) were within the 6.5-8.0 US EPA (1997) standard and the 6.0-9.0 Class AA to Class D guidelines (DENR, 1990). The natural pH range of a river is largely determined by the geology and soils of the area (Dhillon, et *al*. 2013). Changes in stream acidity can be caused by atmospheric deposition (acid rain), surrounding rock, and certain wastewater discharges (US EPA, 1997).

DO is the amount of dissolved oxygen in water and is essential to aquatic life. The DO levels in Buhisan, Bulacao and Lahug Rivers ranged from 1.1-2.0 mg·L-, 3.3-6.1 mg·L- and 1.8-2.7 mg·L- (Fig. 2c). Their equivalent % O_2 saturations were 15.9-27.9%, 45.5-85.8%, and 26.9-36.8% (Fig. 2d), respectively. The national standard set by DENR (1990) for DO are 70% O_2 saturation (5.0 mg·L$^-$) for Classes AA to B; 60% (5.0 mg·L$^-$) for Class C; and 40% (3.0 mg·L$^-$) for Class D freshwaters for water samples taken between 9:00 AM-4:00 PM. The DO values observed in midstream and downstream areas of the three rivers were below the required minimum level for Class C freshwaters set by DENR (Fig. 2c and 2d, Table 1). Low DO (less than 2 mg·L$^-$) indicates poor water quality and thus would have difficulty in sustaining many sensitive aquatic lives (CKSB, 2012). Levels below 2 mg·L$^-$ will not support fish at all. Dissolved oxygen levels below 3 mg·L$^-$ are stressful to most aquatic organisms. Fish growth and activity usually require 5-6 mg·L$^-$ of dissolved oxygen (CRC, 2009). The depleting DO levels in these areas were attributed to the influx of organic pollutants, agricultural and urban runoff, domestic and industrial waste water discharges (Olatayo, 2014). Other factors that affected the amount of dissolved oxygen in stream water included temperature, salinity, altitude, photosynthesis, stream flow and aeration (Gandaseca, et *al*., 2011).

Biochemical oxygen demand, or BOD, measures the amount of oxygen consumed by microorganisms for the decomposition of organic matter in river water. The mean BOD values (Fig. 2e, Table 2) ranged from 14-63 mg·L$^-$ in Buhisan River, 2.6-11.3 mg·L$^-$ in Bulacao River, 25.8-62.3 mg·L$^-$ in Lahug River. The DENR (1990) standards for BOD vary from 1-15 mg·L$^-$ based on beneficial water usage and classification. For Class A and B, the acceptable BOD limit is 5 mg·L$^-$; for Class C is 7(10) mg·L$^-$ and 10(15) mg·L$^-$ for Class D freshwaters. The BOD levels of Buhisan and Lahug Rivers were beyond the acceptable limit of 1-15 mg·L$^-$ standard set by DENR indicating organic pollution in these areas. Sources of BOD included leaves and woody debris, decaying solid wastes, dead plants and animals, animal manure, piggery, failing septic systems, and urban storm water runoff (Singare, *et al,* 2012). These wastes ended up in the rivers due to the improper waste disposal system at the local community level. The higher the BOD, the faster oxygen is depleted in the water. The consequences of high BOD are similar as those for low DO; aquatic organisms become stressed, suffocate, and die (Singare, *et al.* 2012; US EPA, 1997).

References

APHA AWWA-WEF (2005). Standard Methods for the Examination of Water and Wastewater, 21st edition. United Book Press, Inc., Baltimore, Maryland, USA.

CKSB (2012). Water Quality Parameters and Definitions. Available from: http://www.sabah.gov.my/jpas/Assessment/eia/sp-eias/kalabakan/App-D.pdf)

[CRC] Chehalis River Council (2009). Water Quality Monitoring. A How to Guide.

Dayrit H (2001). From Vision to Action. A Synthesis of Experiences in Southeast Asia. The Philippines: Formulation of a National Water Vision.

DENR (1990). Department of Environmental and Natural Resources Administrative Order No. 34 Series of 1990. Revised water usage and classification water quality criteria.

Dhillon MK, George MP and Mishra S (2013). Water quality of River Yamuna – Delhi stretch. International Journal of Environmental Sciences, 3(5), 1416-1423.

Dulo SO (2008). Determination of Some Physico-chemical parameters of the Nairobi River, Kenya. J. Appl. Sci. Environ. Manage, 12, 57 – 62.

Flores MJ and Zafaralla M (2012). An Assessment of the Physicochemical Parameters of Mananga River, Cebu, Philippines. IAMURE International Journal of Ecology and Conservation, 4, 34-62.

Gandaseca S, Rosli N, Ngayop J and Arianto CI (2011). Status of Water Quality Based on the Physico-Chemical Assessment on River Water at Wildlife Sanctuary Sibuti Mangrove Forest, Miri Sarawak. American Journal of Environmental Sciences 7(3), 269-275.

Maglangit F, Galapate R and Bensig E (2014). Physico-chemical Assessment of the Water Quality of Buhisan River, Cebu, Philippines. International Journal of Research in Environmental Science and Technology, 4, 83-87.

Olatayo AA (2014). Assessment of physico-Chemical parameters of Waters in Ilaje Local Government Area of Ondo State, Nigeria. International Journal of Fisheries and Aquatic Studies, 1, 84-92.

Singare PU, Talpade MS, Dagli DV and Bhawe VG (2012). Water pollution monitoring study of Bhavan's College Lake of Andheri, Mumbai: Assessment of physicochemical parameters. Research & Development, 2(3), 79-84.

Surubaru BC, Pricope D, Stratu A and Costica M (2012). Preliminary aspects regarding some physico-chemical and biological Characteristics of the Water Bistriţa River (lower course). Analele Ştiinţifice ale Universităţii, 58, 65-72.

US EPA (1997). United States Environmental Protection Agency. Volunteers Stream Monitoring: A Methods Manual.