Mindanao Journal of Science and Technology Vol. 8 (2010) 73-80

Bitan-ag Creek Water: Its Physical, Chemical, and Biochemical Characteristics

Romeo M. Del Rosario* and Nenita D. Palmes
College of Arts and Sciences
Mindanao University of Science and Technology
CM Recto Ave., Lapasan, Cagayan de Oro City, 9000 Philippines
*rmdelr@yahoo.com.ph

Date received: 20 January 2010
Revision accepted: 9 July 2010

Abstract

This is almost a one-year study of the quality status of the water of Bitan-ag Creek in Cagayan de Oro City. It mainly covers the characterization of the creek's water quality. It also includes an ocular inspection of a major stretch of the creek from upstream to the sea. The whole endeavor was part of the big objective of rehabilitating the creek as initiated by a task force composed of the local barangays through which the creek winds itself as it travels towards the sea. A number of physico-chemical parameters were included: color, appearance, temperature, pH, conductivity, nitrate, phosphate, suspended solids, dissolved oxygen (DO), chemical oxygen demand (COD), and biochemical oxygen demand (BOD). To complement this information, biochemical tests on kangkong test plants were also carried out: chlorophylls, carotenoids, total phenolics, and electrolyte leakage. Bioassays were also done in terms of kangkong (Ipomoea reptans) wilting and bulb onion (Allium cepa) root growth inhibition. The results point to the sad state of the Bitan-ag Creek. It is an appalling dumpsite of all sorts of solid wastes and other wastes. The impacts of these indiscriminate disposals were also revealed by the physico-chemical test results that describe a substantial level of pollution. Further, the bioassays and biochemical tests have indicated highly stressful conditions for aquatic organisms and a worrisome level of general toxicity.

Keywords: physico-chemical, bioassay, characterization, biochemical test

1. Introduction

The increasing urbanization of Cagayan de Oro City is a matter of serious concern since this greatly affects the city's rivers and creeks. Local data are hardly available to describe the present state of the water in the Bitan-ag Creek as the creek winds through a significant portion of the city. This is partly because of the lack of facilities and expert interest and the lack of concerted effort to study the creek's water in connection with plans of rehabilitating it. The creation in 2004 of the Bitan-ag Creek Rehabilitation and Development Task Force, composed of the different barangays affected by the creek, has initiated the integrated and holistic effort to improve the condition of the creek and prevent it from deteriorating further. As a way of reinforcing this effort, the Mindanao Polytechnic State College (now the Mindanao University of Science and Technology), being also situated along the creek, volunteered its effort through the signing of the Memorandum of Understanding with the Task Force on December 17, 2004.

The Bitan-ag Creek is one of the five major creeks of Cagayan de Oro City. The four other creeks are Binono-an, Indulong, Kolambog, and Sapong Umalag. The Bitan-ag Creek water has been classified as Class D inland water. As such, it should be useful for agriculture, irrigation, livestock watering, and more. It should be usable also as industrial water supply (DENR, 1990). There have been a few unpublished researches on Bitan-ag Creek. Maglaque (1996) made a survey in relation to health hazards from the polluted water in the creek. Kiamco (2000) conducted another survey on the solid waste management practices of the people living along the creek. An attempt to characterize the creek’s water was done by a group of students as part of their undergraduate thesis (Baynosa, Maagad, and Morata, 1999). However, only a few selected parameters were included and the monitoring was only for a short period of 6 weeks. In short, there are only very limited information as regards the quality of the Bitan-ag Creek water. The results so far obtained are more exploratory and tentative than anything else. It is, therefore, imperative to have baseline data on the physico-chemical and biochemical properties of the water.

2. Methodology

The study involved ocular inspection and the collection of physico-chemical data as well as data from bioassays and biochemical analyses covering a period of close to one year.

Ocular Inspection. A series of ocular inspections were carried out. The inspection in the uppermost part of the creek was undertaken with the assistance of the Camaman-an Baranggay Chairman and personnel. Other inspections were also done as needed.

Sampling. A number of sampling points were identified. These included 5 different parts of the creek from high upstream to the lowest downstream near where the creek empties into the Macajalar Bay adjacent to the city's port. These points from upstream to downstream are: Tierra del Puerto, LIMKETKAI and SONS Commercial Center (LKKS), Mindanao Polytechnic State College (MPSC) which is now the Mindanao University of Science and Technology, Tabako, and Gaabucayan. These sites were sampled at a frequency of once per month.

Physico-Chemical Tests. The following parameters have been included: color, appearance, temperature, pH, conductivity, nitrate, phosphate, suspended solids, dissolved oxygen, chemical oxygen demand (COD), and biochemical oxygen demand (BOD). Standard methods were used for the above items or methods that have been found acceptable by various agencies (e.g., USEPA) like the Hach methods. At least two trials were done for each test.

Bioassays and Biochemical Tests. Since not everything that is deleterious to health, human or ecological, can be determined completely by way of chemical and physical testing and since there can be various forms of synergism arising from the complex make up of water, it was deemed a good complementary strategy to conduct bioassays. Measuring these bio-effects can be related to the toxicity level of samples (Keddy, Greene, and Bonnel, 1995). All runs were made with aerated water from the faucet as control for comparison.

The bioassays were done using upland kangkong (*Ipomoea reptans*) plantlets and onion bulbs (*Allium* test). The latter test measured the effect on the growth of the roots of onion bulbs. Considering greater variability compared to physico-chemical testing, the bioassays were conducted with five replicates per sample. The biochemical tests were carried out on the leaves of the upland kangkong which were on the average 20 days old (+/- 5 days). At this age, enough leaves would already be available for testing. The tests included cell membrane stability, total phenolics, lipid peroxidation, chlorophylls and carotenoids (Hendry and Grime, 1993). Each test result is the average of at least two trials.

3. Results and Discussion

Ocular inspection. The site inspections of the various segments of the creek has revealed a great deal of abuse—the treatment of the creek as a sewage canal. It is a case of increasing deterioration as one proceeds from the upstream part to the downstream portion of the creek where it empties into the Macajalar Bay. The pictures in Figure 1 speak of this situation.

Figure 1. The changing face of the Bitan-ag Creek from upstream to downstream.

Physico-Chemical Characteristics. Table 1 summarizes the results of selected physico-chemical tests. The other tests are not shown since they reveal not much to invite serious consideration.

Table 1. Results of selected physico-chemical characteristics (in ppm)[a]

Sampling sites	DO	Dissolved solids	COD	Nitrates	Phosphates
Tierra del Puerto	1.66 (0.14)	2.00 (0.00)	11.76 (44.5)	5.97 (0.73)	39.36 (1.21)
LKKS[b]	0.52 (0.52)	70.15 (63.70)	168.1 (119.4)	nil (7.21)	58.04 (12.58)
MPSC[c]	0.42 (0.32)	55.75 (28.53)	85.49 (142.9)	nil (2.33)	67.95 (11.31)
Gaabucayan	0.00 (0.00)	16.50 (3.04)	100.3 (25.11)	5.021 (1.02)	55.57 (1.23)
Tabako	5.19 (0.10)	62.50 (27.78)	128.6 (19.17)	nil (0.65)	5.72 (0.26)

[a] Figures presented without parentheses are the overall means; those inside parentheses are the overall standard deviations.

[b] LIMKETKAI and Sons Commercial Center.

[c] Mindanao Polytechnic State College; now, Mindanao University of Science and Technology.

The dirty segments of the creek (Gaabucayan, MPSC, and LKKS) registered zero or almost zero dissolved oxygen unlike the upstream water (Tierra del Puerto) which still has some and the farthest downstream (Tabako) which showed about 5 ppm although this was more due to some amount of dilution with seawater. In the whole, relatively high dissolved solids contents and COD are indicated in the downstream portions. The phosphate levels are observed to be high most likely due to detergents.

Biochemical Effects. Table 2 shows results that are quite revealing as to the metabolic effects on kangkong plantlets of the pollutants in the creek's water. The data are the ratios of sample to control test results. Ratios bigger than 1 are not good signs since they indicate substantial stress experienced by the plants while immersed in the water samples. The pollution stress caused the plants to metabolize phenolics, which are antioxidants, in an attempt to attenuate the effects of deleterious substances. Despite this, some damage to the cell membranes have been indicated by the leakage of the electrolytes out of the cells. The effect on the chlorophylls and carotenoids is not very clear.

Table 2. Selected biochemical effects of creek water samples as ratio of sample to control[a]

Sampling sites	Total phenolics	Electrolyte leakage	Chlorophyll / Carotenoids
Tierra del Puerto	0.771	1.112	1.156
	-0.3	-2.28	-0.25
LKKS[b]	1.202	1.242	0.819
	-0.21	-0.05	-0.018
MPSC[c]	1.361	1.07	0.798
	-0.21	-0.18	-0.14
Gaabucayan	1.445	1.986	0.996
	-3.43	-22.7	-0.14
Tabako	1.615	3.152	1.298
	-6.62	-3.7	-0.17

[a] Figures presented without parentheses are the overall means; those inside parentheses are the overall standard deviations;

[b] LIMKETKAI and Sons Commercial Center;

[c] Mindanao Polytechnic State College; now, Mindanao University of Science and Technology

These negative impacts indicated by the data above are corroborated by the extent of wilting when comparing plantlets in sample and in control. A typical case is shown in Figure 2 for the sample from LKKS.

Allium test. Table 3 presents measures of the toxicity of the different water samples from the creek in terms of EC_{50} which is the effective concentration of the water samples when diluted with clean water that will bring about a 50% reduction in the growth of the onion roots. The lower the EC_{50} value is, the more toxic is the sample. The results indicate that below Tierra del

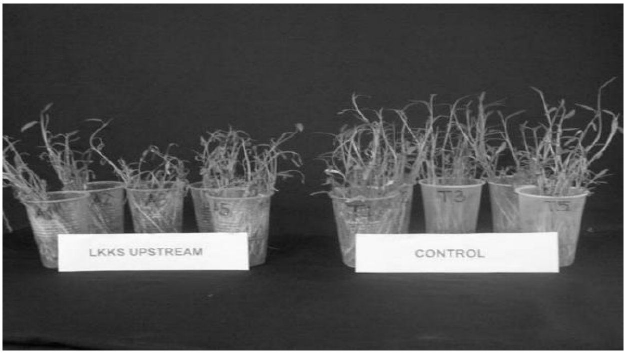

Figure 2. Extents of wilting of plantlets in sample and in control.

Puerto, which is the uppermost segment included in the study, the waters are already phytotoxic. It can be extrapolated from this that these downstream waters already exhibit general toxicity to living organisms. Figure 3 highlights this effect.

Table 3. Allium test results as effective concentration at 50[a]

Sampling sites	EC50
Tierra del Puerto	391.7 (162)
LKKS[b]	45.5 (10.1)
MPSC[c]	24.7 (19.4)
Gaabucayan	98 (5.57)
Tabako	23.33 (4.04)

[a] Figures presented without parentheses are the overall means; those inside parentheses are the overall standard deviations.

[b] LIMKETKAI and Sons Commercial Center;

[c] Mindanao Polytechnic State College; now, Mindanao University of Science and Technology.

4. Conclusions and Recommendations

The Bitan-ag Creek seems to be a victim of abuse of the watershed. Because of this, there is no continuous flow of water during the year. A good water flow only happens during rainy days. During the dry season, portions of the creek are without water while other portions still have although quite limited.

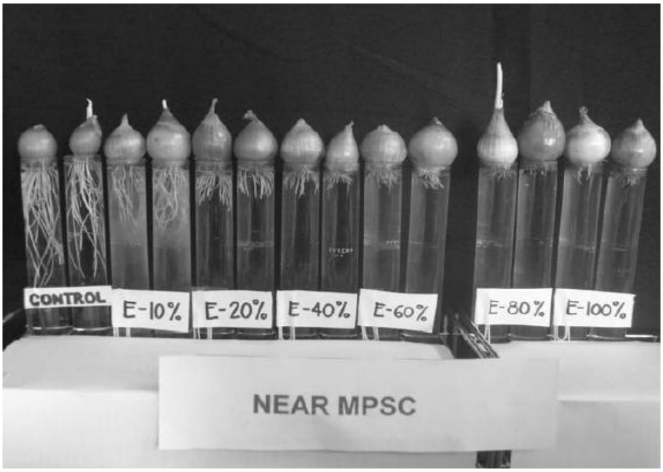

Figure 3. Typical Allium test results showing how onion roots got stunted in growth at higher concentrations of polluted sample water.

Water apparently seeps underground and surfaces at other portions. The volume of water is only rather big downstream because maybe of the wastewaters coming from all sources that are dumped into the creek.

Indeed, the Bitan-ag Creek has, by and large, ceased to be a really useful creek except as disposal site for whatever wastes people can think of—solid wastes and non-solid wastes alike. The survey and ocular inspections made simply revealed that where there are communities that have sprouted near the creek, then, that part of the creek becomes a victim of human abuse. This is even true in the high upstream portions of the creek where people use the water from the creek for washing clothes and for other household purposes. Even there, the evidence of dumping lawn wastes glares to the observers. In fact, the people even make "lapog" of the disposed solid wastes right on the bed of the creek where there is no water.

In spite of these, there are still cases of children bathing or swimming in the waters of the creek whether this is upstream where it is relatively clean or downstream where it is definitely soaking with all sorts of dirt and garbage. During high tide, it is interesting to note many young people having some kind of a picnic and swimming spree in that part of the creek near the sea. The dangers of the creek's water are manifested not only by what can be seen but also by those that are not at once discernible by the eyes. The results of the physico-chemical tests practically have nothing good to say. There are the extremely low dissolved oxygen levels, high dissolved solids, sizable amounts of organic matter, and high levels of nitrates and phosphates.

The bioassay/biochemical tests have also shown that the waters exert stress on life forms. This is based on the tests using kangkong plantlets. This stress leads to damages to the cell membranes and the other parts of the cell. In this connection, the Allium tests also indicate strong signs of general toxicity that cannot just be ignored. These are all alarm signals that confirm what are readily visible. In the light of the findings, there is a need for the following: advocacy and training of affected communities so that the different households and establishments will begin to respect the creek as a useful body of water; for them to help clean and maintain the creek; greater involvement of the local government unit and the environmental agency in the rehabilitation efforts; continued monitoring to assess progress made; and further research on other pollutants like heavy metals which may have endangered further the quality of the water.

5. References

Baynosa, Maagad and Morata (1999). The Extent of Pollution of Bitan-ag Creek Based on Selected Physico-Chemical Characteristics. Unpublished Undergraduate Thesis. Mindanao Polytechnic State College, Cagayan de Oro City.

DENR (1990). DAO 34 – Revised Water Usage and Classification Water Quality Criteria Amending Section 68 and 69, Chapter III of the 1978 NPCC Rules and Regulations. DENR, Manila.

Hendry, G. A. F. and Grime, J. P. (1993). Methods in Comparative Plant Ecology: A Laboratory Manual. London: Chapman and Hall.

Keddy, C. J., Greene, J. C., and Bonnell, M. A. (1995). Review of Whole-Organism Bioassays: Soil, Freshwater Sediment, and Freshwater Assessment in Canada. Ecotoxicology and Environmental Safety 30:221-251.

Kiamco (2000). The Rivers, Creeks and Main Drainages along the Coastal Areas of Cugman-Macabalan in the City of Cagayan de Oro: An Exploratory Study. Unpublished Research Paper. Cagayan Capitol College, Cagayan de Oro City.

Maglaque (1996). A Case Study on the Health Effects of Polluted Water in Bitan-ag Creek. Unpublished Research Paper. Mindanao Polytechnic State College, Cagayan de Oro City.