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SANITARY INSPECTION, WATER AND SEDIMENT ANALYSIS OF ESTERO DE SAMPALOC- A MOVEMENT TOWARDS ENVIRONMENTAL SUSTAINABILITY AND STEWARDSHIP

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ABSTRACT: *Sanitary inspection, water and sediment analysis are essential factors in characterizing the safety of water in recreational areas like esteros. This research has two (2) phases: assessment and implementation. In assessment, water and sediment sample was used to analyze the status of estero de Sampaloc. While in implementation, a careful undertaking by National Service and Training Program (NSTP) students of Far Eastern University in approaching the sanitary and waste management system was used to address the problem. It was found out by NSTP students thru observation and survey that the community near the estero don't practice good sanitary and waste management. And also, the water and sediment quality did not passed both local and international standards as set by Department of Environment and Natural Resources (Philippines) and the Ontario Ministry for the Environment (Canada). Overall assessment of estero de Sampaloc revealed that water quality was deteriorating due to unsanitary practices from nearby residents, business establishments and schools. A long term sustainable effort of the community near the estero is necessary to restore water quality*.

KEYWORDS: **Estero De Sampaloc, Environmental Sustainability, Sanitary Inspection, Stewardship, Water and Sediment Analysis**

INTRODUCTION

Nature has given us so much but man did nothing but to abuse and destroy the environment. Man is said to be stewards of God's creation. Although, the tributaries or also known as esteros are not included as natural bodies of water, it can be considered as a basic unit of water system in Pasig river. Since water from the different esteros in Metro Manila will go to rivers, streams or lakes as run-off water. Therefore, it is atmost important to sustain this esteros because nature has its own curse for abusing and destroying the natural resources as evidence of massive floods and epidemic diseases.

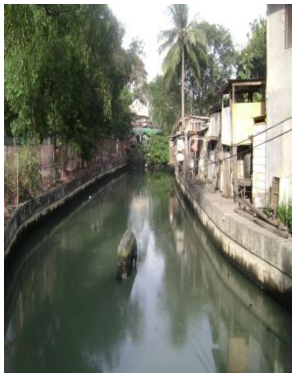
Water quality in urban streams is deteriorating to an alarming extent. Esteros are urban streams or creeks that are heavily polluted from various human activities (Orozco & Zafaralla, 2012 in Enguito,et.al.,2013). At the global scale, hydrologic modifications have detrimental consequences to aquatic environment and human health (O'Toole et al., 2009).

Description of estero de Sampaloc

According to Metropolitan Manila Development Authority (MMDA) has a total area of 1,087m in length and an average of 7m in width. Estero de Sampaloc starts at Margal St. and ends at estero de Aviles. It has a several short reaches and is interconnected to drainage mains. Josefina-Lepanto main conveys runoff from the eastern boundary to estero de Sampaloc and turns westward to Lepanto-Governor Forbes main. Estero de Sampaloc is also connected to estero San Miguel and Estero de Aviles. It is assumed that it divides between estero de Quiapo and Sampaloc lies close to the Mendiola bridge. The runoff from the 307 hectare catchment area is disposed of to the Pasig River by the Aviles-Sampaloc pumping stations, which has a capacity of 14.0m^3/sec.

According to barangay councils, historically and culturally, estero de Sampaloc has been existing since time immemorial that it was named after the name of the street which is Sampaloc. It is a confluence of two other esteros namely estero de Aviles and San Sebastian. A confluence is where two or more tributaries flow together which may or may not flow directly into a river. At a glance we can say that estero de Sampaloc (picture b) was clean, but when as we roam around from its boundaries going to estero de Aviles, it was annoying because there's a pile of garbage around it. While in going towards estero de San Sebastian a lot of informal settlers are nearby the estero and it serves as their comfort room since all of them don't have septic tanks for their waste. Based on the ocular inspection and some interview around the community, estero de Sampaloc was then a beautiful body of water, it is clean and has fishes around it, but now it is just a reservoir of garbage and waste water coming to esteros like Aviles (picture a) and San Sebastian (picture c).


(a)


(b)


(c)

1.2 Review of Related Studies

Sediments provide habitats for many benthic organisms and also influence the environmental fate of many chemical substances in aquatic ecosystems by acting as both sinks and subsequently sources of substances that can enter the aquatic environment (Persuad, et.al., 1995). The study of sediments is an important aspect in evaluating the water quality and this particular investigation can provide the technical data for the holistic assessment of the water quality.

The development of sediment quality guidelines is an evolving science. There is a need to continually modify or improve the appropriate use of SQCs as management tools and to refine uses of SQCs to better predict toxicity and / or biological community impairment (Fairey at al 2001). Over the past several years, different countries like United States and Canada have developed sets of effects-based SQGs. The guidelines were generally developed using empirical approaches that established databases that related a range of effects (reduced survival, growth, or reproduction of benthic macro invertebrate organisms) to a range of increasing concentrations of individual sediment-associated contaminants. The guidelines generally established two concentration levels based on effects – a lower effect level at which no or minimal effects are predicted and an upper effect concentration level at which adverse effects are highly probable or will frequently be seen. The focus for all the sets of guidelines was primarily on developing concentrations that would be protective of the majority of bottom dwelling species that reside on or in the sediment and sediment pore water. The developed guidelines generally do not consider the food chain aspects of some bioaccumulative compounds like methyl mercury and nonpolar organic compounds like PCBs.

The pioneering study in the Philippines on the approaches in assessing contamination of sediments by trace elements was initiated by Dr. Jacinto and Dr. Duyanen et al., in 1999 from the University of the Philippines – Diliman, Quezon City. The study conducted an extensive assessment of the contamination of sediments by trace elements and polyaromatic hydrocarbons along Manila Bay. In 2005, Taberna and Wenclawiak assessed the heavy metal contamination in the surfacial sediments of Iloilo River. Their study identified that copper and nickel as pollutants of primary concern in the Iloilo River and the lower channel of the Iloilo River as the area of immediate concern.

Background of the study

The massive pollution in esteros can be related to the frequent occurrence of flood-related disasters in highly urbanized areas in the Philippines (Gilbuena et al.,2013) as wastes impede water flow during flooding making the country one of the flood prone countries in the world (Gaillard et al.,2008). With the impact of climate change at present time, water pollution is reaching a critical state in developing countries as human health is also at great risk (Smith, 2007). Increased human settlements along esteros are exacerbating water pollution by exposing the streams to contamination from untreated sewage going directly into the water.

According from the data of Natural Resources Defense Council in the book of Wright (2005) entitled Environmental Science Towards Sustainable Future, the following organic and inorganic substances are found toxic which was analyzed in this research.

Heavy Metal	Sources	Health effects
Pb	Lead gasoline, fuel oil, smelting of lead	Damages to the nervous system, impairment of hemoglobin synthesis, possible effects on kidneys and reproductive function, possible brain damage
Cr	Electroplating of alloys like jewelry	Dermatitis, skin ulcers, lung diseases
Cd	Smelting of metals, manufacturing and industrial processes	Chronic respiratory disease, anemia, hypertension effects
Cu	Construction and demolition of houses/buildings, corrosion of metals, consumer products	Fibrosis, calcifation, cancer of the lungs, pleural cavity
Zn	Building materials	Respiratory illnesses and possible cancer of the lungs
Hg	Broken thermometer, industrial and metallurgical processes	Inhibition of enzymes, impairment of nervous system, fetal malfunction
PCB	Disinfectants, residue of insecticides and pesticides	Eye and nose irritation, suspected causes of cancer and mutagenicity

1.4 Standards for quality

Natural waters are subject to important changes in their microbial and water quality that arise from agricultural use, discharges of sewage or wastewater resulting from human activity or storm / flood runoff. Sewage effluents contain a wide variety of pathogenic micro-organisms that may pose a health hazard to the human population when the effects are discharged into recreational waters. The density and variety of these pathogens are related to the size of the human population, the seasonal incidence of the illness, and dissemination of pathogens within the community. The DENR-EMB (2005) set a standard for type C water, using semi-qualitative analysis:

Temp.	pH	conductivity	hardness	color	turbidity	odor	Dissolved oxygen
25-30^{0}C	6.5-9.0	Non-electrolyte	no formation of soap suds	colorless	Not turbid and not viscous	odorless	5.0 mg/L

The Ontario Ministry of the Environment (Persaud et al. 1990) developed sediment quality guidelines based on screening level concentrations from data for a range of local sediments and benthic biota. Two levels were reported, a low level which is the lowest that toxic effects become apparent, and a severe level, representing concentrations that could effectively eliminate most of the benthic organisms. For organics, the values are normalized to 1% organic carbon.

The Canadian approach to the derivation of sediment quality guidelines have been outlined in a publication by the Canadian Council for the Ministry of the Environment (CCME) in 1995. In earlier studies the Ontario Ministry of the Environment has been prominent in the development of dredged sediment guidelines, which have been summarized. This underwent several revisions but basically defined three levels of long-term chronic effects on benthic organisms, a no-effect level, a lower effect level and a screening level. The screening level (mg/kg) represents a concentration that would have a pronounced effect on sediment –dwelling organisms and would be detrimental to most benthic species, while the lowest effect level could be tolerated by most benthic species. Here is the standard for sediment quality based on Ontario Ministry of the Environment (Persaud, et.al.,1995):

Cd	Cr	Cu	Pb	Ni	Zn	Hg	PCB
0.6	26	16	31	16	120	0.2	70

1.5 Statement of the problem

Water is an essential resource for living systems, industrial process, agricultural production and even domestic use. The principal factors that were taken into consideration in determining the sanitary, water and sediment quality of estero de Sampaloc:

a. What are the common garbage present in estero de Sampaloc?
b. What is the status of the water quality of estero de Sampaloc?
c. What is the amount of sediments present in estero de Sampaloc?
d. How can FEU students help in the environmental sustainability and promotion of stewardship of estero de Sampaloc?

METHOD

Collection of samples and data

In sanitary inspection, the purpose of the on-site visit is to identify and evaluate the different waste and unsanitary practices that is happening at estero de Sampaloc. Attention should be paid to the presence of sewage disposal facilities, industrial outfalls and informal settlers within the estero.

a. What is the type of water?
b. Who are the responsible authorities in monitoring the estero?
c. What land or human, industrial sources and other activity surrounds the area?
d. What are the waste that is present in the estero?
e. What are the unsanitary practices observe in the estero?
f. Is water quality in the estero affected by discharges from _____?
g. Can water in the estero overflows during storm or floods?

h. Are there government and NGOs taking care of the estero?
i. Is water free flowing or stagnant?
j. Are there formal mechanism for reporting waste discharges like spills, and treatment bypass to the local authorities?

While for water and sediment samples were taken about 100 meters from the outfall at Pasig River and at every 200 meters upstream. There would be a minimum of three (3) sampling sites for every tributary or "estero". However, if the tributary or estero has a total length of less than 300 meters, samples would be taken at 50 meters from the outfall and at 100 meters thereafter in upstream direction (away from Pasig River). The procedure is as follows:

1. The water/sediment was scooped at three sampling points from the mid portion of the estero/water channel by grab sampling.
2. Depending on the depth of the water in a particular channel, there would be three methods that could be used for obtaining sediment sample – the use of sampling tube for shallow waters, the use of Ekman Grab sampler for deep waters and for the most difficult part- the aid of frogmen from Philippine Coast Guard (PCG).
3. The Ekman Bottom Grab sampler was lowered to get bottom sediment by the use of nylon rope. As the sampler is lowered, two hinged upper lids swing open to let water pass through and close upon retrieval preventing sample washout. When the sampler reached the bottom, a messenger was sent down the line tripping the overlapping spring-loaded scoops.
4. For estero with shallow water, sediment was obtained by plunging the beveled edge of the sampling tube to adequately collect bulk sediments.
5. The composite sample of sediment was prepared from the samples taken at three sampling points at midpoint of the estero.
6. The overlying water was removed as practically as possible from the sediment before placing it in the sample container.
7. The collected sediment was acidified with 5 –10 mL conc. HNO_3 and stored at the refrigerator if it could not be processed immediately or placed in an oven for drying.

Sampling technique

Composite sample of water and sediments was taken from each sampling station composed of grab samples taken from the surface (water) and mid portion (sediment). The sampling of water and sediments was done last Feb. 23 at around 8:30 am at estero de Sampaloc. There are three sampling sites namely:

Site A: 1st 100m away from estero de Aviles, the location of sampling site is near a vacant lot but some informal settlers are present around, start of sampling 8:52am and ended at 9:10am

Site B: 2nd 100m, the location of sampling site is infront of Claro M. Recto Highschool, start of sampling 9:15am and ended at 9:32am

Site C: 3rd 100m is going to estero de San Sebastian, the location of sampling site is near a residential area (left side are informal settlers while right side are middle class citizens), start of sampling 9:45am and ended at 9:55am

Site A Site B Site C

During the sampling of sediments, the "balsa" was already carried in site C, which is the farthest since it is the part of estero de Sampaloc going to estero de San Sebastian. So during the actual sampling, site C was the first one to get sediment samples then followed by sites B and A. In site A, it is located near estero de Aviles and at the same time it is near to the house of Mang James who is the owner of the rented balsa. Since according to MMDA, estero de Aviles is near the mouth of Pasig River, so it was agreed that the start of sampling is from estero de Aviles to estero de San Sebastian measuring 100m. It is impossible to have equidistance measurement of the sample site, since it should be around 335m each site from a total of 1,087m, because some part of estero de Sampaloc were already part of the road if not building and even commercial establishments. So it only took less than an hour to get the sediments sample in estero de Sampaloc with the help of Mang James, the owner of the balsa and Mang Salvador, a janitor personnel from FEU. The sample for each site was then stand for 30 minutes and undergone decantation process before putting or mixing concentrated nitric acid. Then it was transported to FEU and subjected it to drying by putting it in the freezer.

RESULTS AND ANALYSIS

Sanitary inspection

A sanitary inspection is a search for, and evaluation of existing and potential hazard (either physical, biological or chemical) that could affect the use of a particular streach of recreational water. It provides the foundation required to design and implement an effective water quality sampling program and provides valuable information to assist in the implementation of water quality. In particular, it provides public health authorities with information to help the selection of sampling locations, times and frequencies, inorder to estimate more accurately the quality of

water and therefore to allow for a sound risk management decisions. The following are the common waste that was observed by the NSTP students:

a. plastics and styrofoams;
b. tin cans and bottles;
c. wood scrap from trees and informal settlers;
d. feces and manure;
e. used diaper and clothes;
f. rubber tires; and
g. residuals like appliances, ceramics and home decors.

The following are the unsanitary practices that were observed by the NSTP students:

a. bathing area
b. urinating
c. disposing of laundry water
d. spitting
e. throwing of feces and manure
f. throwing of garbage

Water analysis

Chemicals may be present in many different forms in both treated and natural waters. The identification of the chemical species of interest in the exposure study is critical, not only from the viewpoint of estero de Sampaloc but also the Pasig river.

Temp.	pH	conductivity	hardness	color	turbidity	odor	Dissolved Oxygen
29^0C	6.2	Non-electrolyte	Curdy and formation of suds	Black to brown; green	With suspended particles,slightly turbid	Pungent odor but tolerable	6.60 mg/L

Temperature influences the amount of dissolved oxygen in water which in turn influences the survival of aquatic organisms, thereby raising the temperature of a freshwater stream. Increasing temperature also increases the rates of chemical reactions taking place in the water. Increases in temperature are often associated with hot water discharge. pH measures the acidity or alkalinity of water. A slightly high DO suggest that inhabitants of water in the estero require higher amount of Oxygen to sustain life. For the color of water in the estero, the green color which is seen approaching estero de San Sebastian that nitrates and phosphates is present due to eutrophication. While the black to brown color is seen in the water sample approaching estero de Aviles signifies polluted water due to residues of garbage and anthropogenic practices. Formation of curdy and suds precipitates indicates that water contains more magnesium and calcium and considered hard water. Although this can be verified thru chemical analysis, but the initial findings was salt concentrations is present in estero de Sampaloc. For the odor, the pungent odor could be the

result of the enormous amount of wastewater (urine, washed water) and sewage from domestic (residential) and commercial (school) sources within the confluence of estero de Sampaloc.

Sediment quality

To begin with, in lead (Pb) the content is ranging from 1.38 to 5.80 ppm (site A and C), but site B has non-detectable readings. Since the sample in site B was taken in front of a school (Claro M. Recto Institute), lead content imply either the absence of lead concentrations are below the detectable limit or sensitivity of the instrument. While site A and C are exposed area of the estero, public utility vehicle (PUV) like tricycles and jeepneys passed by on this area, then it is expected that lead present due to smoke belching. Table 1 shows the results of AAS analysis in the different metals and location of estero de Sampaloc.

site	Pb	Cu	Cr	Zn	Cd	Ni	Hg
A	1.38	3.46	0.40	13.30	<0.01	3.00	1.26
B	ND	2.77	0.30	9.50	<0.01	4.42	0.80
C	5.80	4.55	0.50	17.60	<0.01	6.71	0.85

*units in mg/kg

Sediment quality issues have become an important focus in the environmental assessment, protection, and management of aquatic ecosystems. There have been numerous sediment quality guidelines developed to monitor the sediments. Sediment quality guidelines are very useful to screen sediment contamination by comparing sediment contaminant concentration with the corresponding quality guideline; provide useful tools for screening sediment chemical data to identify pollutants of concern and prioritize problem sites; and, relatively good predictors of contaminations. The clean-up initiatives for any body of water will not be fully realized if sediment assessment would be excluded. The chemical assessment of the sediments can aid in setting realistic targets for environmental restoration and will ensure precise remediation objectives.

For copper (Cu) chromium (Cr), zinc (Zn) and mercury (Hg) as gleamed on Table 1, site A was much lower than site B which is intermediate, but in site C it was quite high. Since in site A, it is 100m away from another estero which is estero de Aviles, so all the sediments that were filtered from the garbage of this estero were reflected and affected on the analysis. While in site B, the samples were taken near a school, the garbage particularly solid wastes were disposing properly. But in site C, wherein it is located near residential areas, usually dormitory houses and

commercial establishments, the metal samples was quite high due to improper garbage disposal and no systematic drainage for waste disposal like urine, feces and even animal manure.

Non detectable levels of 0.01 were seen in cadmium implies either the absence or concentrations are below the detectable limit or sensitivity of the AAS instrument.

On the average, when taken individually site C have the highest concentration of metals in all sites. It is due to the fact that water disposed in the estero on this area was from residential and commercial areas. It is evident that water on this part will contribute to the euthrophication and anthropogenicity of the Pasig River. The average can be seen in Table 2, including its standard deviation:

Cd	Cr	Cu	Pb	Ni	Zn	Hg	PCB
0.01(<0.001)	0.40 (0.100)	0.31 (0.488)	2.50 (2.950)	4.71(1.872)	13.50 (4.053)	0.968 (0.254)	n.d.*

*not detected; () is the standard deviation; units in mg/kg

Overall, Mercury (Hg) exceeds the minimum requirement set by Ontario Ministry of the Environment. This is alarming because of its biomagnification and bioconcentrative potential for aquatic organisms.

DISCUSSION

The selection of sampling sites, time and frequency of sample collection should attempt to capture the overall water and sediment analysis of area. These choices should be based upon the information gathered during the sanitary and ocular inspection. The selection of sampling stations and time of sampling should take into consideration, variables known to affect the quality of water, such as the length of the bathing area, presence and periodicity of point and non-point sources of fecal contamination, influences of local weather, the physical characteristics of the bathing area and the presence of bathers. For example, at bathing areas with no detectable sources of external fecal contamination, samples should be collected at the places with the greatest bather densities. Bathing areas known to be influenced by direct or indirect fecal contamination will require additional sampling sites to help define the degree and extent of pollution. The time of day can be an important source of variation especially tides of water, consider a low tide. Accuracy and precission should also be given to collecting samples at times when bather densities are greatest for example, afternoons at weekends.

Water pollution in estero de Sampaloc

Water pollution is one of the most serious types of environmental abuse in rivers and lake throughout the world. In estero de Sampaloc I have seen such abuse as people living around throw their garbage in any forms around it. Ordinarily, flowing water cleanses itself if it is not too dirty but when contamination increases, life within the water starts to suffer and this may eventually lead to death of both aquatic life and the streams or lake themselves. This is what

exactly happened in estero de Sampaloc, before, they can catch fishes like round fish and catfish, but now only larvae of mosquitos and tadpoles are seen. If this happened in a small bodies of water like the esteros this could also happen in rivers and seas. So for the sake of the next generations, we must rehabilitate all the esteros, where no toxic substances releases to the environment; where our needs are met with renewable resources, and where the processes are in balance with Earth's natural resources. All this must be accomplished with the expenditure of the least amount of energy by living a simple life, which I think is one of the most probable solution. Also, the researcher believes that social awareness is the key to the problem in the esteros. Since if people living around it will be educated of the future damage that may occur once the estero is completely dead like floods, health problems, environmental effects and even possible landslide for sure they will take care of their esteros. As one of my students said, "*esteros should be part of their houses, they should maintain the cleanliness and beauty of it*". We should act now before any catastrophe happens around the estero, for we never know that nature will take back what is taken to them. MMDA, NGOs school, business establishments and the community should play part in the rehabilitation and stewardship of estero de Sampaloc.

Poor sediment quality in estero de Sampaloc

The SQGs are effective tools in providing effective basis for screening sediments and site assessment, more importantly if there are limited resources. However, since these guidelines are generally derived from effects-based data that do not consider synergism between contaminants and do not include biomagnifications or secondary toxicity, it is therefore important that further biological screening or toxicity testing must be conducted for final regulatory action or basis for policy decision-making.

The analysis of sediment and the subsequent application of sediment quality guidelines in other countries have never been done before for Pasig River. It is hoped that the assessment of metal contamination on selected "esteros" and the subsequent application of sediment quality guidelines can assist the policy makers and environmental regulators in providing scientific benchmarks to be used as a basis for the evaluation, protection and enhancement of its water quality. This guideline can help in setting targets for clean-up initiatives within broader management strategies that will sustain the integrity of the aquatic ecosystem for the long term.

Rehabilitation of estero de Sampaloc

Due to current pressures from the people's organizations and initiatives from the society, there are increasing demands for greater environmental protection of aquatic resources through the restoration of degraded rivers and estuaries. The ecologists and scientists in several countries have developed a range of methods for evaluating the extent to which sediment-associated contaminants might adversely affect aquatic organisms. While some methods focused on the derivation of numeric chemically based sediment concentration limits, other methods have

focused on descriptive statements or bench marks that define acceptable and potentially unacceptable sediment quality. The results of both approaches are typically referred to as sediment quality guidelines (SQGs).

The sediment quality guidelines (SQCs) are informal point of reference or aid in interpreting sediment chemistry figures. SQCs have been used to elucidate historical trends, identify potential pollutants, categorize hot spots, rank contaminated waterways, and help choose sites for more extensive ecological studies. Other applications of SQGs, which have generated considerable dispute within scientific, industrial, and environmental regulatory communities, include identification of the source control measures to address pollutant release, triggering regulatory action as mandatory standards and establishing target remediation objectives.

The most important reason for the all the clean up initiatives of polluted water ways is not only about improving the aesthetic quality of the river but rather the end objective of valuing human health.

Conclusion and Recommendation

Water and sediment quality in estero de Sampaloc is slowly deteriorating due to relatively high density of waste from residents, business owners, and nearby schools. Continuous influx of water pollutants and unsanitary practices is detrimental because of the limited buffering capacity of water especially in esteros. Also, water in esteros is overflowing during flood and strong storm and it becomes surface water. Therefore, it may pose danger to human health like diarrhea, gastrointestinal flu, cholera dysentery, dengue, and leptospirosis. The present condition of estero de Sampaloc could possibly pose a threat to the water quality in Pasig River, Manila bay and Laguna de bay.

A continuous clean-up and stewardship program of estero by the MMDA and monitoring of water and sediment quality are essential to evaluate the effects of this research. But also, proper solid waste management should be implemented. Further comprehensive research and development are necessary to assess the impact of industrial effluents in other esteros surrounding estero de Sampaloc (estero de Aviles and San Miguel). A collaborative and sustainable community extension program not only from the school but also the local government is needed to restore the water and sediment quality of estero de Sampaloc.

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