A Study of Fecal Contamination of Cagayan de Oro River Along the Upstream (Lumbia) and the Factors Affecting Contamination, August 2008-March 2009

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Abstract - The main objective of this study was to determine the extent of fecal contamination of Cagayan de Oro River along Barangay Lumbia. The study was conducted from August 2008 to March 2009. Taking samples of the river was done to identify the presence of fecal coliform in the 3 different sampling periods done every first week of the month as well as confirm the presence of the indicator organism *Escherichia coli*. The water samples were collected approximately 25 meters from the sides. Proper collection procedures were followed in order to obtain accurate analytical results. The Multiple Tube Fermentation Technique which consisted of the Presumptive Phase, Confirmed Phase, and Completed Phase. A survey was also conducted to determine possible factors that contribute to fecal contamination of the river. In Barangay Lumbia the results showed a high mean MPN value of 3,500 fecal coliform/100ml, followed by an increased value of 5,400 fecal coliform/100ml, and a decreased value of 1,300 fecal coliform/100ml. The total coliform values computed showed fluctuating average MPN score from all the samples which exceeded the standard acceptable value set by the Department of Environment and Natural Resources water quality guidelines (DENR) at 1000 fecal

coliform organisms/ 100ml. The results revealed that the river near Barangay Lumbia is fecally contaminated. It indicates a threat to the residents in the area since it is infested with many bacteria and other types of microorganisms which could lead to diarrhea and other types of diseases. The factors that may have contributed to the river's fecal contamination were: the improper disposal of animal manure in the river, the number of comfort rooms having no appropriate drainage allowing it to directly drain into the river, and the discarding of human wastes on the river for those who don't have comfort rooms.

Keywords - Fecal contamination, *E. coli*, River, Barangay Lumbia

INTRODUCTION

Environment health compress those aspects of human health, including quality life, that are determined by physical, chemical, biological, social and psychosocial processes in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health and the interrelationship between the health of a country, a community on individual, and the everyday environments (Kozier et. al, 2004).

E. coli is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. *E. coli* is short for *Escherichia coli*. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination. Sewage may contain many types of disease-causing organisms. The health of a home or community is a critical component in the individual's health. These components are the healing properties which include fresh air, light, warmth, and cleanliness. The interrelationship of a healthful environment with nursing provides the detection of the external influences of and conditions which can prevent, suppress, or contribute to disease of death. With these nurses have the responsibility to help patient's whether an individual or community, retain their own vitality by meeting their basic needs through control of the environment (Kozier et. al, 2004).

Moreover, *E. coli* comes from human and animal wastes. During rainfalls, or other types of precipitation, *E. coli* may be washed into

creeks, rivers, streams, lakes, or ground water. When these waters are used as sources of drinking water and the water is not treated or inadequately treated, *E. coli* may end up in drinking water. Wide spread contamination of rivers has been evident in many areas of the country. Agriculture, urban, runoff/storm, water, and municipal point sources included pesticide, metals, nitrates, solvents, and host-specific microbes past through fecal route. According to the department of Health, improved disposal of human waste protects the quality of drinking water sources. Each year more the 200 million tons of human wastes go uncollected and untreated around the world, fouling the environment and exposing millions of people to disease and squalor. (http://www.doh.gov.ph). This study mainly focuses of the microbial contamination found along the rivers of major barangays in Cagayan de Oro City, Philippines that contributes a serious social and environmental threat, particularly the river of Barangay Lumbia Cagayan de Oro City.

Fecal coliforms are bacteria that are associated with human or animal wastes. They usually live in human or animal intestinal tracts, and their presence in drinking water is a strong indication of recent sewage or animal waste contamination. Different strains of *E. coli* are often host – specific, making it possible to determine the source of fecal contamination in water samples. *Escherichia coli* is the primary facultative organism of the human gastrointestinal tract. *E. coli* normally colonizes an infant's gastrointestinal tract within 40 hours of birth, arriving with food or water or with the individual's handling the child in the bowel; it adheres to the mucous of the large intestines. It is the primary facultative organism of the human gastrointestinal tract. As long as these bacteria do not acquire genetic element encoding for virulence factors, they remain benign commensally in the gastrointestinal tract. Recently it is thought that *E. coli* and certain other food borne illnesses can sometimes trigger serious health problems months or years after patient's survived that initial bout (Evans, 2007).

The presence of fecal coliform in a drinking water sample often indicates recent fecal contamination-meaning that there is greater risk that pathogens are present than if only total coliform bacteria is detected. *E. coli* is a sub-group of fecal coliform group. The presence of *E. coli* in a drinking water sample almost indicates recent fecal contamination-meaning there is a greater risk that pathogens are

present. *E. coli* outbreaks receive much media coverage. Most outbreaks have been caused by specific strain of *E. coli* bacteria known as *E. coli* O157:h7. Confirmation of fecal coliform bacteria or *E. coli* in a water system indicates recent fecal contamination, which may post an immediate health risk to anyone consuming the water.

River water as an essential element of life can be one of the most common carrier of harmful contaminants to enter the body. On a daily basis, reports of drinking water contamination appear in magazines, newspapers, and in news programs on television (Wilson, 2007).

In the river of Barangay Lumbia, speaks of somewhat like untouched river. This river still has its beauty since the people living near it, are giving the river an importance but with this further studies still needed to see if the people living near the river really do have what it takes to take good care of the said river.

As a health care provider and an advocate for health, determinance of *E. coli* would provide a better understanding of the potential public-health risk of Barangay Lumbia, Cagayan de Oro city. We as future nurses would like to provide a better view of the disease process, its preventions, health promotion, and health maintenance to the people and the community.

The study of Alvarez et. al, (2008) prompted the researchers to conduct this study as well as our concern for the environment especially to the Cagayan de Oro river along Barangay Lumbia. The outcome of the study made us aware especially the residents along barangay Lumbia that the river pause a threat to the community.

OBJECTIVES OF THE STUDY

Generally, the study aimed to determine the extent of fecal contamination of the Cagayan de Oro River along Barangay Lumbia. Specifically, it aimed to (1) determine the MPN index in fecal coliform, the total coliform and *E. coli* in the water samples obtained from Cagayan de Oro river along Barangay Lumbia (2) determine whether the MPN index of fecal coliform, total coliform and *E. coli* is acceptable according to specific standards and (3) determine the possible factors that contribute to fecal contamination. It is limited to the assessment of the coliform especially *Escherichia coli* in the Cagayan de oro River, chemical, BOD and bioassays of the water analysis were not included in this research.

FRAMEWORK

The zebra mussel (*Dreissena polymorpha*) was used as an indicator of previously elevated bacteria concentrations in a watershed was examined. The ability of the zebra mussel to accumulate and purge *Escherichia coli* over several days was investigated in both laboratory and field experiments. In laboratory experiments, periodic enumeration of *E. coli* in mussels exposed to dilute a solution of raw sewage demonstrated that (i) maximum concentrations of *E. coli* are reached within a few hours of exposure to sewage, (ii) the tissue concentration attained is higher than the concentration in the ambient water, and (iii) the *E. coli* concentrations take several days to return to preexposure concentrations when mussels are subsequently placed in sterile water. In field experiments conducted in southeast Michigan in the Clinton River watershed, brief increases in *E. coli* concentrations in the water were accompanied by increases in mussel concentrations of *E. coli* that lasted 2 or 3 d. The ability of mussels to retain and to concentrate *E. coli* made it possible to detect *E. coli* in the environment under conditions that conventional monitoring may often miss. Sampling caged mussels in a river and its tributaries may enable watershed managers to reduce the sampling frequency normally required to identify critical *E. coli* sources, thereby providing a more cost-effective river monitoring strategy for bacterial contamination Abbreviations: cfu, colony forming units; MPN, most probable number the presence of *Escherichia coli* and other coliform bacteria in streams, rivers, and lakes has been used as an indicator of the possible presence of human pathogens. Surface waters may be exposed to numerous sources of bacteria, including domestic and wild animals, agricultural runoff, failed septic systems, combined sewer overflows, and illicit connections of sanitary sewers to storm water sewers. Federal, state, and local regulations limit the allowable concentrations of bacteria in the aquatic environment (USEPA, 1979), requiring frequent monitoring and remedial actions when allowable concentrations are exceeded. High bacterial concentrations and resultant remedial actions, such as closing beaches and changing water treatment methods, have important human health and economic implications. Therefore, it is important to locate, evaluate, and, if possible, eliminate sources of bacterial contamination. A key component of this process is developing efficient monitoring methods

for locating bacterial sources (Bruneau et. al, 2004).

The present study investigates the use of the zebra mussel as a bacterial uptake mechanism to provide an indicator of prior exposure to bacteria in a freshwater environment. One of the problems with traditional water monitoring methods is the necessity of collecting water samples precisely at the time that bacteria are actually present. In a flowing system, such as a river or stream, a short-term pulse of bacteria flowing past a point may be missed completely if the water sample is not taken at the appropriate time. The present study evaluated whether zebra mussels are able to accumulate and retain *E. coli* when exposed to high concentrations of bacteria. Retention of bacteria would enable the mussels to be used as an indicator of bacterial contamination even after bacterial concentrations in the water have returned to relatively low concentrations (Haygarth et. al, 2005).

The zebra mussel, a bivalve mollusk indigenous to Russia and Europe, was inadvertently introduced into the Great Lakes region of North America in the mid-1980s. It spread rapidly from its original site of introduction throughout much of the eastern United States largely due to its high reproductive capacity and its ability to live in densities as high as 700 000 animals per m[sup2]. As a highly efficient filter feeder, the zebra mussel draws water into its inlet siphon, passing it over and through the gills where particle capture is mediated by gill cilia and mucus. Many of the bacteria, algae, and zooplankton captured by this filtration, sorting, and selection process may still be viable even after passing completely through the gut, indicating that digestion of captured organisms is often incomplete in the zebra mussel. Since bivalves do not normally contain fecal coliform bacteria in their gut, the presence of such bacteria in a zebra mussel is hypothesized to indicate a recent environmental exposure of the mussel to bacteria rather than to reflect their endogenous presence in the mussel. This hypothesis was examined in the present study in both laboratory experiments and field observations, and the temporal parameters of bacterial uptake and depuration by zebra mussels were measured. The field setting of this study was the Clinton River watershed. This watershed is located in southeast Michigan and drains approximately 2000 km[sup2], including portions of Lapeer, Macomb, Oakland, and St. Clair Counties. The basin is highly urbanized with a population of approximately 1.3 million people (Clinton River Watershed Council,

personal communication, 1999). The Clinton River receives frequent exposures to fecal bacteria A new, potentially more efficient method of monitoring the occurrence of high bacterial concentrations was examined in this study (Selegean et. al, 2001).

Investigation of an acute gastroenteritis outbreak involving >100 persons at a summer camp in Girona, Spain, in June 2002 led to the detection of Salmonella enterica and extended-spectrum cephalosporin-resistant *Escherichia coli* (ESCREC). Stool cultures were performed for 22 symptomatic campers, three asymptomatic food handlers, and 10 healthy household members. Of the 22 campers, 19 had Salmonella enterica, 9 had an ESCREC strain carrying an extended-spectrum beta-lactamase, and 2 had a second ESCREC strain carrying a plasmidic cephamycinase. Related ESCREC were detected in two (salmonella-negative) asymptomatic food handlers and in none of the healthy household members. Fecal ESCREC and its beta-lactamases and plasmids were extensively characterized. Three of the five ESCREC clones were recovered from multiple hosts. The apparent dissemination of ESCREC suggests a food or water vehicle. The observed distribution of resistance plasmids and beta-lactamase genes in several clones indicates a high degree of horizontal transfer. Heightened vigilance and increased efforts must be made to discover the reservoirs and vehicles for community dissemination of ESCREC (Guber et. al, 2005).

Strains of *Escherichia coli* that produce enzymes capable of degrading extended- spectrum cephalosporins (ESCs), i.e., extended-spectrum beta-lactamases (ESBLs), or these drugs plus cephamycins, i.e., plasmidic or hyperproduction of chromosomal cephamycinases have recently emerged as important nosocomial pathogens. Some of these strains cannot be reliably detected by clinical microbiology laboratories by using conventional susceptibility tests, and even when recognized, treating infections caused by these strains can be challenging because therapeutic options are limited. Infections attributable to such strains are associated with prolonged hospital stays, increased healthcare costs, and an increased number of deaths if appropriate therapy is delayed. To date, almost all reports of infection or colonization with ESBL- and plasmidic cephamycinase-producing *E. coli* (i.e., extended-spectrum cephalosporin-resistant *E. coli* [ESCREC]) have involved hospitalized patients or nursing home residents. The few reported patients with

community-acquired infection have been elderly and debilitated and have had hospital contact, important coexisting conditions, or both. *E. coli*, including resistant strains, may be transmitted within the community through the food supply. Indeed, other gram-negative enteric pathogens, notably Salmonella enterica, are a frequent cause of foodborne disease and, increasingly, are associated with antibiotic resistance, including antibiotic resistance to ESCs. Available data regarding other resistant *E. coli* suggest that ESCREC could also be disseminated through the food supply (Nevers et. al, 2007).

The cefoperazone-containing medium routinely used in our laboratory for the isolation of Campylobacter occasionally yields other bacteria with hyperproduction of chromosomal beta-lactamases or their plasmidic derivatives, as well as strains carrying extended-spectrum beta-lactamases (unpub. data). By using this media, we have isolated several resistant enterobacteriaceae strains from patients with sporadic cases of gastroenteritis (unpub. data). During an investigation of a summer camp-associated salmonellosis outbreak, we observed that stool cultures from nine campers unexpectedly yielded, on cefoperazone-containing medium, colonies resembling enterobacteriaceae, with a uniform mucoid appearance. This result suggested the possibility that the same, probably ESC-resistant, enterobacterial strain was present in all these persons, findings consistent with possible foodborne spread. Consequently, all samples were reevaluated on media containing cefotaxime (see Methods) to increase sensitivity for detection of ESC-resistant organisms. To gain more knowledge of foodborne spread as a potential mechanism of dissemination of resistance genes, we undertook an extensive molecular epidemiologic analysis of these isolates (Prats et. al, 2003).

MATERIALS AND METHODS

A. Entry Protocol

Before the group conducted the study, the group had an ocular survey along the area together with the group's team leader Dr. Lubos, and then a courtesy letter was then prepared that was addressed to the Barangay Captain of Lumbia. The content of the letter was to allow them to collect water samples from the river bank of Lumbia. Moreover,

the group promised to give a copy of *E. coli* on the river. Before the letter was forwarded to the Barangay Captain, the leader and was then approved by Mrs. Chona V. Palomares, Dean of the College of Nursing. Thereafter, with the letter at hand, they went to Barangay Lumbia and had their courtesy call. The group thoroughly explained the purpose as well as the objectives of the study to the Barangay Captain. After the letter was being approved by Barangay Captain, the group did the first step of the study.

B. Setting

Cagayan de Oro City is situated on its excellent harbor in Macajalar Bay in the North Mindanao cost, is the capital of Misamis Oriental Province. To the south, the city is bordered by the Bukidnon Province and Lanao del Norte (Iligan City). The Municipality of Opol, Misamis Oriental to the east. To the North lies Macajalar Bay facing the Bohol Sea. Its total land area is 488.86km2 presenting 13.9% of the entire Misamis Oriental Province. According to 2007 census the city has total population of 553,966 Cagayanons.

There are 80 Barangays composing Cagayan de Oro. One of which is Barangay Lumbia. The study was conducted on the aforementioned barangay. This place is situated on the second district of the city along the river side. The houses in Barangay Lumbia were situated very close from its neighbor. Most of the houses were one storey and made of wood. There were times that the river was very murky. There were households who raised livestock animals especially pigs which caused a foul smell in the area.

C. Methods Used and Description

The study utilized a descriptive method to detect the presence of *Escherichia coli* along the river in Lumbia, Cagayan de Oro City. The method used for analysis based on the DOST was the Membrane Filter Method.

The water samples were collected at the center point, approximately 25 meters from the riverbank. A red flag was used as a marker which enabled us to collect water samples at exactly the same area.

The study includes collection of water samples along the riverbank

of the said area. Proper collection procedures are implemented to prevent any significant change in the composition of the sample prior to its analysis to ensure accurate analytical results. The sample are taken from the center of the river 25meters from the side depending on the size of the river Factors such as time holding temperature can affect microbial density, in this connection, since the water sample to be collected is to be held in a container, a temperature of 4-10C must be maintained and it should then be analyzed within 6 hours after collection. In no case should time lapse between sampling and analysis exceed 30 hours.

The Standard Total Coliform Fermentation Technique was used which consisted of the Presumptive Phase, Confirmed Phase and Completed Phase. During the Presumptive Phase, the reagent and culture medium used was the lauryl tryptose broth. Incubate inoculated tubes or bottles at 35 ± 0.5 ^{O}C. Production of an acidic reaction or gas in tubes or bottles within 48± 3 h constitutes a positive presumptive reaction. The tubes with a positive presumptive reaction are submitted to the confirmed phase. The use of a brilliant green lactose bile broth as the culture medium for the fermentation tubes was used in the confirmed phase. Incubate the inoculated brilliant green lactose broth tube at 35 ± 0.5 ^{O}C. Formation of gas in any amount in the inverted vial of the brilliant green lactose bile broth fermentation tube at anytime within 48 ± 3 h constitutes a positive confirmed phase. To establish the presence of coliform bacteria and to provide quality control data, the use of the completed test on at least 10% of positive confirmed tubes. Simultaneous inoculation into brilliant green lactose bile broth for total coliforms and EC broth for fecal coliforms or EC-MUG broth for *E. coli* was used. Consider positive EC and EC-MUG broth elevated temperature (44.5 ^{O}C) results as a positive completed test response. Parallel positive brilliant green bile broth cultures with negative EC or EC-MUG broth cultures indicate the presence of non-fecal coliform (Eaton et. al, 2005).

D. Population and Sample used

The riverbank of barangay Lumbia, Cagayan de Oro City was our area of study. Barangay Lumbia has a total population of 12, 168 as of the year 2007 according to the National Statistical Coordination Board.

The study measured the fecal bacteria indicators including the Total Coliform Count (MPN/100 mL). There was a one-day microbial sampling which was conducted in 3 consecutive months (September 8, 2008 to November 3, 2008) with 28 days interval. Environmental samples in 5 dilutions were experimented for 4 days, Fecal Coliform Count was experimented for 5 days, *E. coli* detection/enumeration was experimented for 6 days based on the Regional Standards and Testing Center.

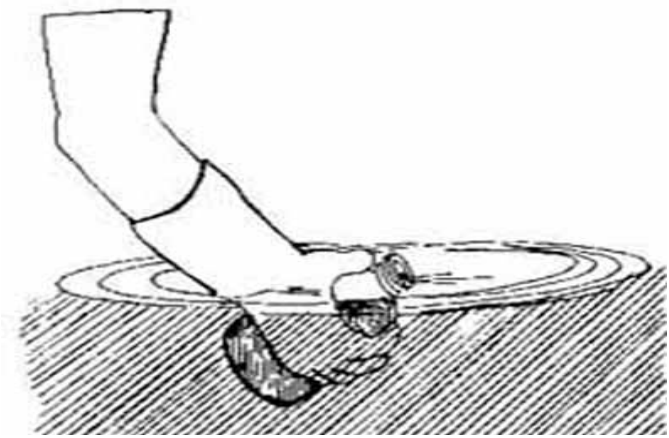
The Water Quality Criteria for Conventional and other Pollutants contributing to Aesthetics and Oxygen Demand for Fresh Waters, Section 6 of the Revised Water Usage and Classification/Water Quality Criteria according to the Department of Environment and Natural Resources (Administrative Order Number 34) was the basis for the standard value for the three parameters.

Material	Representation	Purpose
Sterile bottle (250ml) with cap		Receptacle for the water sample
Ice		To maintain a temperature of 4-10 ºC, thus ensure accurate analytical result
Sample container		For collection, storage and transport of water samples
Water sample from Lumbia river		Sample used to detect presence of fecal coliform and *E. coli* bacteria

The following guidelines were observed during the collection of water samples:

1. Planned out the sampling schedule. Sampling was ideally carried out with sufficient frequency to be able to detect any temporal or seasonal variations in quality of water.
2. Prepared suitable sampling containers for collection, storage and transport of water samples. Sampling bottles contained the amount required for all the analysis that were conducted and in no case the final volume of water was less than 100 ml for microbiological analysis according to the requirements of BFAD, the volume of water was 300ml.
3. Selected representative sampling points in the water supply system.
4. Aseptic technique during sampling was strictly observed to prevent contamination of the sample being collected. Kept sampling bottles closed until filled. When about to take the sample, the cap was retained in the nook of the hand. The cap was not placed on dirty surfaces when taking the sample.
5. The bottle was filled leaving ample air space about 2.5 cm, which allowed adequate mixing of the sample preparatory for analysis.
6. Samples were properly labeled and adequately described.

II. Collection of water sample from the river, stream, lake, reservoir, spring or shallow well

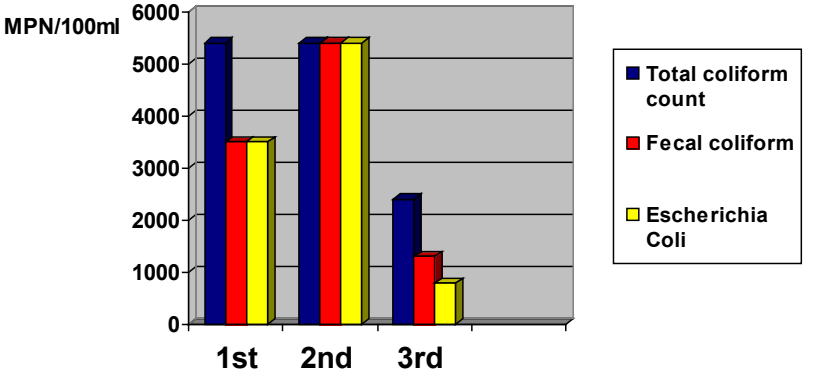


RESULTS AND DISCUSSIONS

Objective 1: To determine the MPN index of fecal coliform, total coliform and *E. coli* in the water.

Table1. Microbial Analysis For Total coliform count, Fecal coliform and *Escherichia coli* during the 1st,2nd and 3rd sampling

Sample	Date	Total Coliform Count	Fecal Coliform Count	*Escherichia coli*
1St	September 8, 2008	5,400 MPN/100ml	3,500 MPN/100ml	3,500 MPN/100ml
2Nd	October 6, 2008	5,400 MPN/100ml	5,400 MPN/100ml	5,400 MPN/100ml
3Rd	November 3, 2008	2,400 MPN/100ml	1,300 MPN/100ml	790 MPN/100ml
Total Average		4,400 MPN/100ml	3,400 MPN/100ml	3,230 MPN/100ml



The result showed that the level of coliform count pause a threat to the lives of the residents in the area since there is so much infestation of bacteria, parasites and different types of microorganisms which would lead to diarrhea and other types of disease. This result confirms the study of Alvarez et.al, that site is highly infested which much more than the standard level of the total coliform in which we are able to see the difference and importance of our study. Coliform has been defined as a group of bacteria, that ia an indicator of the contamination of water and possible presence of intestinal parasites and pathogens, this means that as the level of coliform rises in a water system then there is an evidence that there is also a rise in the number of bacteria, parasites,

and pathogens in the water system. For the Fecal coliform there is still a rise in their number which implies that there are great amount of fecal matters in the river, fecal coliform are used to assess the presence of fecal matter in situations where fecal coliforms of non-fecal origin are not commonly encountered. Fecal coliforms include the genera that originate in feces; Esherichia as well as genera that are not of fecal origin; Enterobacter, Klebsiella, and Citrobacter. The assay is intended to be an indicator of fecal contamination, or more specifically *E. coli* which is an indicator microorganism for other pathogens that may be present in feces. These pathogens are threats not just to the families but also with the animal that are living near the river. The result of the study confirms the observation of the researchers that there are many of the residents with no comfort rooms, some of the residents have livestock's in which the waste goes directly to the river. There are also open canals from the houses that goes to the river directly.

Objective 2. To determine whether the MPN index of fecal coliform, total coliform and *E. coli* is acceptable according to specific standards which is 1000MPN/100ml.

The First Sample was taken last September 8, 2008 had a very high level of Total Coliform, fecal Coliform and *E. coli* while the second Sample taken last October 6, 2008 had a increased values in the Fecal Coliform and *E. coli* an same result for the Total Coliform. Standard values given by department of Science and Technology was 1000 MPN/100ML therefore the first sample results did not meet the acceptable standards since there was a very high results in the total Coliform, Fecal Coliform and *Escherichia coli* while in the second sample there was increased level of results in the number of Fecal Coliform, and *Escherichia coli* which is to high if compared to the standard values given by Department of Science and Technology.

The improper disposal of wastes by the residents in the area was not only the main cause of contamination in the river but we must also consider that the water is flowing from upper barangays, thus, it may also contributed to its contamination.

Objective 3. To determine the possible factors that contribute to fecal contamination.

A survey conducted before the actual sampling involved households living along the banks of the sites where sampling was done. A total 50 respondents were interviewed. In Table 2 below shows the important results of the survey related to factors that may have a ring in fecal contamination.

In Barangay Lumbia, most of the family that the proponents were able to survey had toilets draining directly to the river while others didn't have toilets, 20% instead their exactly throw their feces in the river. Most of the families in the said barangay had farm animals as goats, cow, and pigs and domestic animals like dogs and cats, 40% disposed their animal wastes into the river. The surveyed households were all throwing their wastes in the river since it is closer to their house and such more convenient for them 100%.

These table shows that these results of the surveys is telling us that these families/households are factors affecting the rise in the number of fecal coli form, *E. coli*, Total fecal coliform. If these activities are continued then these families could cause other people of having disease, which is a very bad thing to happen since almost these entire families relay on the river in their daily activities like washing of their clothes, bathing and other things.

CONCLUSIONS

The results of the study revealed that the river near Barangay Lumbia is fecally contaminated.

Therefore, it indicates a threat to the residents in the area since so much infestation of bacteria and other types of microorganism which could lead to diarrhea and other types of disease. Proper implementation of environmental sanitation is advised to the officials of the barangay.

Factors that were determined to be present that may contributed to the river's fecal contamination were: (1) the improper disposal of animal manure in the river, (2) the number of comfort rooms having no appropriate drainage allowing it to directly drain into the river, (3) the discarding of human wastes on the river for those who don't have comfort rooms.

RECOMMENDATIONS

On the basis of the findings, the following are hereby recommended:

1. That the DENR should properly monitor and implement the appropriate legislation for enforcement to protect the river and environment

2. Schools should be involved in the advocacy of environmental protection at the implementation of the result of the study.

3. That the SAFER RIVER,LIFE SAVER should be the prime mover in implementing program related to the findings of the study for proper utilization and protection of the river.

4. Continuous education and information dissemination should be evaluated in all barangay near the river banks, by schools, barangay officials and the DENR to ensure protection and participation of the residence.

5. Education of the public especially those families living along the river regarding its importance and the implications of fecal contamination of the river especially on health must be done. This goes along with stricter and more extensive implementation of laws by concerned government agencies that serve to protect the water quality of the river and the welfare of the people. Residents that raise livestock must be educated f the proper disposal of animal wastes as well as warned of possible sanctions upon violation of the regulations.

6. LGU's (DOH, HC, City Health Office) should be informed of the results of these study since these government units will be able to inform their people of the threats that might affect them if the rise in the number of fecal coliform continues.

7. Future Researchers on the other variables related to river protection should be conducted.

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