

**Epidemiological Study on Kawasan Waterfalls****Marife Matic Mustacisa¹, Clyde Bodiongan², Vanesa Montes³, Wenzeliza Morial⁴ Iris April Ramirez⁵, Marchee Tabotabo⁶**¹*Professor in Samar State University Paranas Campus, Philippines*²*Bohol Island State University, Tagbilaran City, Philippines*³*Secondary School Teacher in Cebu City, Philippines*⁴*Secondary School Teacher in Agusan Del Sur, Philippines*⁵*Professor in Bukidnon State University, Philippines*⁶*Secondary School Teacher in Cebu City, Philippines***Abstract**

A place with clean water is worth living for, however, if it runs counter to the usual, it corollary results in some diseases. This epidemiological study does not intend to give a false image on the Kawasan Waterfalls of Badian Cebu, Philippines rather, it aids to provide awareness among tourists to at least minimize anthropological activities that could contribute to water pollutants which cause an increased amount of heavy metals present in the water. With the collection of analyte and lab testing for the presence of cadmium, lead, and mercury in the aforementioned research environment, it was found that the water will not pose any health hazard to anyone in and around the river falls and even to any tourist in the place who wants to plunge into its azure water as far as cadmium and lead concentration is concerned. However, the mean concentration of mercury on the water projected a value, which is beyond the permissible concentrations and therefore may harm anyone in the community. Thus, it is recommended to strengthen measures to prevent and to control the release of these substances into the natural water. Shower facilities should be provided in the place and swimmers should wash first before plunging into the river. As part of an ongoing education and training effort, communicate all information on the health and safety hazards of mercury to potentially exposed individuals on the place. It is also suggested to conduct further concentration analysis of other metals present in the said water falls.

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Keywords*Waterfalls; Philippines; Epidemic***1. Introduction**

It is nice to visit places that are very inviting, seeing the flowing water from the top of the mountain especially with green environment. But in an inquisitive manner and scientific view, are you aware how safe the water where you enjoyed swimming and expose more or less hundred percent of your external parts?

Contamination of the environment with chemical contents has been one of the important concerns in scientific research. Exposure to certain levels of harmful chemicals damages the brain, heart, kidneys, lungs and immunity systems of humans of all ages (Darbha, & Ray 2007).

One of the sources of harms are cosmetics products which contain lead and mercury. These include creams, cleansing milk, shampoos, hair dyes, eye shadows, rouge, lipsticks, powders, and toothpaste (Al-Saleh, Enazi & Shinwari 2009, & World Health Organization 2011).

In the article of Stewart (2016), it was statistically cited that beauty product industries continue to grow year after year. The makeup market has an annual growth rate of 3.7 percent between 2009 and 2013 and is expected to grow

within the pattern of 3.8 percent for the period of 2013-2018. In terms of the skincare and lotions, they have the largest category in the global cosmetics industry, accounting to 35.3 percent of the global market in 2014; and hair care is amounted at 24 percent of the industry and is estimated to grow at annual rate of 2 percent.

Another influencing element which is dispersed into the water is the presence of cadmium that can be drawn from usage of phosphate fertilizers, sewage and sludge, various industrial use such as nickel cadmium batteries, plating, pigments, and plastics (Environmental Health and Medicine, 2013).

With those aforementioned facts, human impacts to the environment are in simple ways. It is evident that a common effect is the decreased water quality (Martonas, 2017). If we continue to use the products at a high rate, we will unceasingly endure our water surface. Imagine a basin with a lot of contaminants and then you suddenly dip your hand for several minutes, what do you think will happen?

This paper intends to (1) measure the level of cadmium, lead present in Kawasan Waterfalls of Badian, Cebu City. Part of its purpose is to (2) trace whether the presence of the said chemical contents may lead to certain skin diseases and other ailments and further (2) provide results to the tourists that suggest that the place has potentially good water quality, which makes this study very significant. Kawasan was chosen as the research environment because it has been a recipient of countless country-wide and international recognition. For the years 2000, 2001, and 2002 it is one of the cleanest inland body of water in the Philippines in the river category, however, in the successive years the recognition was stopped.

2. Literature Review

2.1. Cadmium

Cadmium is a metal with an oxidation state of +2. It is chemically similar to zinc and occurs naturally with zinc and lead in sulfide ores. Fertilizers produced from phosphate ores constitute a major source of diffuse cadmium pollution. The solubility of cadmium in water is influenced to a large degree by its acidity; suspended or sediment-bound cadmium may dissolve when there is an increase in acidity (Ros & Slooff, 1987). In natural waters, cadmium is found mainly in bottom sediments and suspended particles (Friberg et al., 1986).

Epidemiological studies of people chronically exposed to cadmium via the diet as a result of environmental contamination have not shown an increased cancer risk. The results of studies of chromosomal aberrations in the peripheral lymphocytes of patients with itai-itai, an epidemic bone disease due to the chronically exposure to cadmium via the diet were contradictory. No reliable studies on reproductive, teratogenic or embryotoxic effects in humans are available. Epidemiological studies of humans exposed by inhalation to relatively high cadmium concentrations in the workplace revealed some evidence of an increased lung cancer risk, but a definite conclusion could not be reached (Krajnc et al. 1987 & Cally 2002).

According to the World Health Organization (1992), high levels of Mercury, Cadmium, and Lead in water bodies are extremely harmful not only to the environment, but also to nearby communities that rely on these water bodies for their daily activities. These toxic metals can easily enter the body either through ingestion or skin contact, where prolonged exposure may result in symptoms such as nausea/vomiting, diarrhea, kidney and liver failure, cognitive and neuromuscular dysfunction and death.

2.2. Lead

Environmental exposure to low levels of lead has been associated with a wide range of metabolic disorders and neuropsychological deficits (NAS, 1980; EPA, 1986). The well-known toxic (metabolic and cellular) effects of lead in asymptomatic children include (i) impairments in haeme, vitamin D and red blood cell nucleotide metabolism, (ii) perturbations of calcium homeostasis in the hepatocytes, bone cells and brain cells, and (iii) neurological damage (Rosen, 1985; Lansdown and Yule, 1986).

It is tested in the laboratory that lead is a toxicant that is known to induce multiple organ damage, even at lower levels of exposure. This metal is also classified as either “known” or “probable” human carcinogens based on epidemiological and experimental studies showing an association between exposure and cancer incidence in humans and animals (Tchounwou 2004 & Yedjou 2008) .

Exposure to lead occurs mainly via inhalation of lead-contaminated dust particles or aerosols, and ingestion of lead- contaminated food, water, and paints (ATSDR 1992; 1999).

Adults absorb 35 to 50 percent of lead through drinking water and the absorption rate for children may be greater than 50 percent. Lead absorption is influenced by factors such as age and physiological status. In the human body, the greatest percentage of lead is taken into the kidney, followed by the liver and the other soft tissues such as heart and brain, however, the lead in the skeleton represents the major body fraction (Flora 2006). The nervous system is the most vulnerable target of lead poisoning. Headache, poor attention span, irritability, loss of memory and dullness are the early symptoms of the effects of lead exposure on the central nervous system (CDC 2001).

2.3. Mercury

Mercury is of the known elements in the periodic table because of its unique characteristic which is liquid at room temperature. It is very useful to objects that changes temperature at a certain time interval but has no significant role on biological function (Gochfeld 2003).

A case study of Cheuk & Chan (2006) showed that exposure to mercury affects the kidney and the central nervous system whether it is inhaled or in permeation.

3. Methodology

3.1. Research Procedure

This study is experimental in nature. To gather analyte from the surface of Kawasan Waterfalls, the researchers first consulted an expert on water testing. They went to San Carlos and asked about what particular chemical contents should be considered in order to attain the objectives of the study and the amount of analyte that should be collected.

When the chemical contents were already identified, the researchers planned and prepared the materials needed for the water testing. To be done on April 27, 2017, in the collection of the analyte, the researchers made use of scientific steps in safety handling of water samples like using sterilized bottled containers where the sample will be placed, maintaining the temperature of water so it will not be contaminated. Potential of hydrogen is also considered in taking

Subsequently, the analyte will be given to the testing center for the experiment proper to which the researchers are also present to witness that the water treatment is successfully done and to minimize errors that may occur, if not another collection of analyte will be replenished until the sample is sufficient.

After the results, the researchers make use of analytical techniques in qualitative form for the interpretation of data which is grounded with literature reviews. In the inclusion of the literature, the researchers considered its relevance as to the level of cadmium, lead, mercury and potential hydrogen that will be carried from the analyte testing.

Finally it will be presented in tabular and provide conclusions and appropriate recommendations for future use of the readers.

3.2. Research Environment

The Kawasan Falls is a cascading three-layered made up of eleven waterfalls and is a world class destination in the mountain of Badian, Cebu, Philippines. The first level of the Kawasan Falls has a drop that is around 40 meters high and wide with a very deep catch basin. The second level of the waterfall is a 15-minute hike from the first level and has a drop of 20 meters and also a deep catch basin. Several cottages are also built near the second level. Some mountaineers who climb the Osmena Peak (the highest peak in the Cebu Province) usually conduct a traverse from the peak going to Matutinao River which passes through Kawasan Falls. Aside from swimming, one of the known activities in the place is canyoneering. Other activities do not include tourism like direct selling and washing.

3.3. Sample Analysis

The sample was analyzed for Cadmium and Lead content using AAS flame method (APHA, AWWA, WPCF. Standard Methods for the Examination of Water and Wastewater, 21st ed., USA; APHA (2005). Cold vapor technique, AAS was used for the analysis of mercury (Instructional Manual, Shimadzu Atomic Absorption Spectrometer AA- 6300, Shimadzu Corporation, Kyoto, Japan, August 2006).

4. Results and Discussion

The values of heavy metal content of the sample water are shown in the table 1.

It can be gleaned from the table that the mean concentration of Cadmium is less than 0.004 mg/ L and Lead is less than 0.057 mg/ L respectively present in the water of Kawasan falls in Badian, Cebu. These values are within the permissible concentrations of heavy metals in natural waters for the protection of human health as set by the World Health Organization (WHO). These results depicted that the presence of these metals in the water will not pose any health hazard to anyone in and around the river falls and even to any tourist in the place who wants to plunge into its azure water as far as cadmium and lead concentration are concerned.

Table 1. Concentration of heavy metals in water from Kawasan waterfalls

PARAMETERS	CNCENTRATION	WHO Standards	WHO max
		(mg/ L)	permissible limits (mg/L)
Cadmium (mg Cd/L)	Less than 0.004	0.003	0.005
Lead (mg Pb/L)	Less than 0.057	0.01	0.05
Mercury (μ g Hg/ L)	0.3906 (\pm 0.0074)	0.002	0.144

Number in parenthesis, (), denotes 95% confidence level

However, the mean concentration of mercury on the water is 0.3906 mg/ L; this value is beyond the permissible concentrations and therefore poses a hazard to anyone in the community. Mercury is a very toxic substance that people can be exposed to in several ways. If it is swallowed, it mostly passes through the body and very little is absorbed. If touched, a small amount may pass through the skin, but not usually enough to harm a person. Mercury is the most harmful when vapors that are released are breathed in. Since mercury accumulates in the body, a single, exposure to a high concentration of mercury can have very serious effects; hence even small amounts may cause serious health problems.

Generally it may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes. Acute effects include headache, chills, fever, chest tightness, coughs, hand tremors, nausea, vomiting,

abdominal cramps and diarrhea. Chronic or longer term exposure to mercury causes personality change, decreased vision or hearing peripheral nerve damage and elevated blood pressure. Mercury overload can even lead to major neurological conditions like Alzheimer's or Parkinson's disease.

Hence, there is a need for strengthening measures to prevent and to control the release of these substances into the natural water. Shower facilities should be provided in the place and swimmers should wash first before plunging into the river. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of mercury to potentially exposed individuals on the place. It is also suggested to conduct further concentration analysis of other metals present in the said water falls.

Appendix A.



Figure 1. Map Showing the Locale of Cebu City, Philippines



Figure 2. Map Showing where Kawasan Falls is situated in Cebu

Appendix B.

Collections of Pictures Taken from the Research Environment



Figure 3. Showing the mess hall area located near the clean water of Kawasan



Figure 4. In the picture are people who enjoyed Kayaking out of a Bamboo



Figure 5. One of the activities people relished in Kawasan is the Canyoneering



Figure 6. Kawasan is surrounded by preserved forest



Figure 7. The passway of Kawasan which are made up of big rocks reached by flowing water

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