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Chemical and Microbial Analyses of Water Sources: A Basis for Environmental Policy Formulation in Taraka, Lanaodel Sur

Cabib B. Mecampong
Mindanao State University,
Marawi City, Philippines

Abstract
Determining the chemical and microbial parameters of the water sources of Taraka, Lanao del Sur was done by the use of standard laboratory procedures. Chemical analyses of water samples obtained from the eight (8) sampling stations showed that: (1) On the average, the acidity levels obtained are within the acceptable standard of 6.5-8.5 for rivers and streams; (2) The life supporting gas (oxygen) dispersed in the water and the microorganisms (decomposers) with strong need of oxygen, the values are within maximum standard level for surface water;(3) The values obtained from ammonia-N and phosphates exceeded the maximum requirements for surface water; (4) The water temperature varied with time and location but were within acceptable standards; (5) The total dissolved solid contents were within acceptable levels; and (6) The value obtained for hardness showed that the water samples were soft. Microbial analyses performed on the water samples revealed that the heterotrophic count ranged from 983.3 to 2333.3 CFU/mL which exceeded the standard CFU of 300/mL for potable surface water;(2) The rod-shaped bacteria count values is found at an interval of6.0-19.0 MPN/mL which is very much higher as compared to the standard requirement of 0 MPN/mL; and (3) The E. coli count ranged from 3.7 to 6.7 MPN/mL which is also exceeded the standard of 0 MPN/mL. Survey and interview results about the uses of the water sources showed that the respondents used the water sources as their main source of water supplies for household uses.

Keywords: chemical and microbial parameters, water sources, Taraka Lanaodel Sur, standard laboratory procedures, environmental policy formulation.

Introduction

Environmental degradation, particularly water resource deterioration, is a global concern. It leads to many a serious health problem confronting many people. At present, both residents in the urban areas as well as in the rural areas are affected by these problems. It is a known fact that one of the main causes of water deterioration is the rapid population growth. This is caused by the increasing demand of individuals and industry for the production of industrial materials. These products are very important to meet the changes towards modernization of lifestyles. They are used in food production, education, shelter, communication, sanitation, transportation, and many others. Most of these products are made up of synthetic chemicals. Some of them use plastics and tin cans as containers, which increase the amount of wastes, discharged every day. Worst of it all is that, these wastes introduce both chemical and biological substances into the water sources making them harmful to man's health.

In the agricultural areas, where economic development of residents depends on agricultural products, modern methods of farming are used. Application of agricultural chemicals such as fertilizers, pesticides, insecticides, etc. cannot be avoided. Farm machineries are utilized to increase production. Generally, water sources as outlined by some researchers have many important uses.

Rajiv et al. (2012) as cited by Kadam and Agrawal (2015) water possesses a variety of benefits that promote well-being, such as a means of transportation, a source or means of supplying energy, can be used for household purposes, can promote the process of making products and can elevate business firms in the community. Similarly, water serves as a foundation of every living matter; it enhances every aspect of the state of success. Ondor and Addo (2013) cited that good quality of water shapes the very basic constituent part of a living being. In the same manner, Kadam and Agrawal (2015) opined that it is water which forms the greater portion of all living matter and in turns the absence of it in the nature is very impossible for life to exist.

Rivers and lakes are better sources of drinkable water. As Muthuraman and Sasikala (2013) noted that since rivers and lakes are accessible, then they are suitable sources of domestic water. In spite of that, water from these sources makes unfit for use; this kind of water is either polluted by natural or man-made undesirable substances. Mubeena and Muthuraman (2014) stressed that materials that contaminate rivers and lakes are either introduced by the physical world or produced anthropogenically. According to Soniya and Muthuraman (2015) and Bellos and Sawidis (2005) as mentioned by Sasikala et al (2015) naturally occurring substances causing pollution of surface water include for example the deposition of dust, atmospheric process of evapotranspiration, by the natural leaching of organic matter and nutrients from soil, by hydrological factors that lead to runoff and by biological processes within the aquatic environment that can alter the physical and chemical composition of water.

However people must realize that the natural systems – the water and the air, the forest and the land – that yield food, shelter and the other necessities of life are susceptible to disruption, contamination and destruction. Since everything is connected to one another, our primary goal must be to preserve – not to degrade nor destroy – the life support system that keeps humans and other species alive. Environmental reform and awareness must be translated into action like the establishment of environmental protection and the formulation of environmental policies to help protect and conserve the environment.

The municipality of Taraka is not exempt from water deterioration and other environmental problems. It is one of the agricultural areas in the province of Lanao del Sur. Most of the residents in the place earn their livelihood through farming. They apply inorganic fertilizers, pesticides, and herbicides to their lands to increase the yield of their farms. Some of them use modern machineries such as tractors and threshers to ease and speed-up soil cultivation and harvesting of crops.

At present good quality of water for drinking purposes is a problem of the residents of Taraka, Lanaodel Sur. The sources of water supply in this area are the Taraka River and few wells situated in some barangays in the municipality. They use it for washing clothes, taking a bath and some, but not all, use it for water disposal. In spite of the critical conditions of the river, the situation is even worsened because of the residential houses and public toilets constructed at the banks of the Taraka River.

Objective of the Study

1. To determine whether the chemical parameters such as: ammonia (NH_3), a compound that contains phosphorus, the life-supporting gas dispersed in water samples, microorganisms (decomposers), acidity, and salinity present in the water samples taken from Taraka, Lanao del Sur exceed the standards for surface water;
2. To determine whether the microbial contents such as: heterotrophic plate, rod-shaped bacteria and colon bacteria of the water sources exceed acceptable level for potable water;
3. To identify what are environmental policies to be formulated and implemented in the Municipality of Taraka, Lanaodel Sur.

Statement of the Problem

This endeavour directed to study the existence of some non-living matter and microbial parameters of the water sources of Taraka, Lanaodel Sur. The results of the analyses were compared to the standard acceptable values for surface water. These served as the bases for formulation and implementation of environmental policies in the Municipality of Taraka, Lanaodel Sur.

Significance of the Study

Results of the study hopefully would provide vital information to the residents and the local government officials of Taraka, Lanaodel Sur about the present status of their water sources. Moreover, people may develop the awareness that the water sources in unpopulated and unindustrialized area, May not, at all times, provide good quality water.

The results may also guide health officials in their action on the possible ways and means by which the water sources could be treated and provide potable clean water to the community. It is hoped that the findings of this study may contribute necessary knowledge and baseline data for researchers, interested persons, policy makers and others who are concerned about environmental problems. Likewise, the study is very timely to the present trend of learning and teaching environmental topics in the field of environmental sciences in all levels of education.

Finally, findings of the study may prompt the local government of Taraka, Lanaodel Sur to give immediate action to the above-mentioned problem and prioritize its concerns to look for means of purifying the existing water supply while the residents are waiting for a new alternative water source.

Research Design of the Study

The research employed scientific experiment to identify and determine the amount of chemical and microbial impurities of the water sources in Taraka, lanaodel Sur. Standard laboratory procedures and instruments were used in determining the extent of the non-living matter and microbial contents in the water samples. The chemical analyses done at the Chemistry Department Laboratory of MSU-Main Campus, Marawi City while analyses of the microbial parameters were done at the Department of Science and Technology (DOST) Regional Office, Carmen, Cagayan de Oro City. Questionnaires and interview were used by the researcher to determine the common uses of the Taraka River and wells, the natural activities and human practices of the respondents that may have contributed to water pollutants.

Sampling Stations

There are eight (8) areas which were considered as stations of the water sources in Taraka, Lanaodel Sur where the samples taken. Six (6) stations were located in Taraka River and other two (2) stations were in the two (2) shallow wells. The stations are given in Table 1.

Table 1: Sampling Stations

Station	Location and Its Description
1a	downstream, River at Datu-maas, 2 m from shore
1b	downstream, River at Datu-maas, center
2 Upper	mid-stream, MoriataoLuksadatu, surface
2 Middle	mid-stream, MoriataoLiksadatu, middle depth
3	upper stream, Pitakus, 2 m from shore
3a	upper stream, Pitakus, center
5	shallow well, Dimayon
6	shallow well, Sigayan

Stations 1 and 3 are in the shallow portions of the river. Station 2 is deeper than station 1 or 3 and is more than six (6) feet deep. Stations 1 and 3 are about 1.5 m deep.

Method of procedure

With the use of standard laboratory procedures and instruments, the extent of the chemical and microbial parameters of the water samples are identified (Kistemann, 2002).The measured concentrations of each of the identified chemical and microbial parameters of the water sources (Kistemann, 2002) were compared with the established standard for surface water. Results and findings of the study would become the basis of the local government to formulate and implement environmental policies in order to protect the existing water sources of Taraka, Lanaodel Sur.

Collection of Data

The researcher first wrote a letter to the mayor of Taraka, Lanaodel Sur to allow him to do a research about the Taraka River and shallow wells in the municipality. After having been granted permission to do so, the researcher requested from the microbial analysis to be done at the Department of Science and Technology through a letter addressed to the Regional Director of the agency. Likewise, a letter-request for the chemical analysis of the water samples was also sent to the Chairman of the Chemistry Department of the College of Natural Sciences and Mathematics, MSU – Main Campus, Marawi City. Letter-request addressed to the respondents was also attached to the questionnaires used by the researcher in collecting related information from the respondents. The questionnaires were distributed among the selected respondents one after the other. Interviews were then conducted after the questionnaires have been collected.

Results

The following results were obtained from the chemical analyses conducted at the Chemistry Department, MSU – Main Campus, Marawi City to the water samples.

Table 2: Results of Chemical Parameters Obtained from Chemical Analyses Conducted in the Water Samples

Parameter	**Value** **Source**
pH	6.9 - 7.3 (water samples taken from river) 6.9 – 7.2 (water samples taken from wells)
Temperature	19 – 24 ^{0}C (water samples taken from river) 20 – 24 ^{0}(water samples taken from wells)
Hardness	1.155 – 1.489 mg $CaCO_{3/}$/L (water samples taken from river) 1.297 – 1.455 mg $CaCO_3$/L (water samples taken from wells)
Dissolved Oxygen (DO)	8.185 – 8.475 mg/L (water samples taken from river) 7.395 – 8.285 mg/L (water samples taken from wells)
Biological Oxygen Demand (BOD)	3.02 – 3.63 mg/L (water samples taken from river) 1.76 – 3.05 mg/L (water samples taken from wells)
Ammonia Nitrogen (NH_3-N)	0.418 – 1.297 mg/L (water samples taken from river) 1.305 – 1.357 mg/L (water samples taken from wells)
Total Dissolved Solid (TDS)	139 – 144 mg/L (water samples taken from river) 90 – 93 mg/L (water samples taken from wells)
Phosphate (PO^-_4)	7.100 – 9.900 mg/L (water samples taken from river) 8.500 – 9.400 mg/L (water samples taken from wells)

Determining the value of the acidity plays an important role for water treatment processes as well as an indication of the presence of carbonate, bicarbonate and other related compound in the water sources (Spring Nature, 2007). It is also the clue of the firmness of the water sources. Standard for pH in rivers and streams is between 6.5- 8.5. In the water sources of Taraka, Lanao del Sur, its measured acidity is at the interval from 6.9-7.3in river *(banglajol.info)* and 6.9 to 7.2 in wells. This suggests that the value acidity the water taken from the Taraka River and wells falls within the standard pH in rivers and streams.

The degree of hotness or coldness of water taken from the water sources in Taraka, Lanaodel Sur lies between 19- 24 ^{0}C. This is expected since the water sources are wells and the river. Although the time of sampling was done approximately at the same time of the day there were times when it was hotter than other sampling periods.

Hardness of natural waters is caused largely by calcium and magnesium salts and to a small extent by iron, aluminium, and other metals (Microsoft Corporation 2008). This is the ability of water to separate soap from the water. It is defined as the characteristic of water that represents the total concentration of calcium and magnesium ions expressed as calcium carbonate. The hardness of water taken from the Taraka River and wells lies between 1.155 to 1.489 mg $CaCO_3$/L. According to the Guidelines for Canadian Drinking Water Quality Summary Table (2007), water containing 0 to 50 mg $CaCO_3$/L is considered as soft. The water therefore in Taraka, as the result shows, is soft.

Adequate dissolved oxygen is essential for the survival of fishes and other lives living in the water sources. Determining the level of dissolved oxygen in the water sources is one of the most significant sanitary chemical tests because as long as oxygen is present, no water putrefaction can take place (Muralikrishna and Manickam, 2017).The dissolved oxygen in the samples from the river ranged from 8.185-8.475 mg/L while that in the wells ranged from 7.395-8.285 mg/L. As mentioned values obtained were above the minimum Philippine requirement of 5 O/L DO for inland waters and within the maximum DO level of 8.2 to 9.1 mg O/L (Phil. Standard for Air and Water) for surface waters.

The measurement of biological oxygen demand is the reliable means of determining the extent of microorganisms present in the water sources which are strongly needed to consume the dissolved oxygen in it. For the water samples, the BOD for the river is in between the values of 3.02-3.63 mg/L while those of the wells is in between 1.76-3.05 mg/L.BOD standards for water states that for BOD of 1 to 2 mg O/L, the water is very clean but for BOD of 3 to 5 mg O/L, the water is only moderately clean and for water with pollution sources nearby, the BOD would be equal to or greater than 7.5 mg O/L. The least measurement of BOD which is 1.76 from wells is within the standards but those which were higher than 2.0 indicates that possible harmful microorganisms, which is a part of the undetermined aquatic lives dwelling in those water sources. Since the BOD values obtained from the river sampling stations are greater than the standard for clean water, the water from the river and wells are not safe for drinking purposes.

The presence of ammonia nitrogen in the water sources can be used as a reliable proof of sanitary pollution when seen in water sources (Muralikrishna and Manickam, 2017). Ammonia concentrations encountered on water should vary to less than 10 μg N/L. In the water samples analysed, it was noticed that the amount of ammonia present in the river (0.418 to 1.297 mg NH_3-N/L) would already be harmful to the fishes in the river. Ammonia in the amount of 0.06 mg/L could cause gill damage to fishes.

According to standards, the maximum total dissolved solid for a water source is 500 mg/L. Total dissolved solids higher than 100 mg/L are considered objectionable because of mineral taste and possible health effects. As seen in Table 2, the total dissolved solids of the water sources of Taraka, Lanaodel Sur is acceptable.

The data presented in Table 2 shows that the phosphate contents of the samples taken from river ranged from 7.100-9.900 mg/L and for wells 8.500-9.400 mg/L. There is no maximum contaminant level for phosphate according to standards, but the maximum recommended concentration in rivers is 0.1 mg/L. As seen from the results, the phosphate contents of the water sources are quite high and are near the maximum recommended level.

Table 3: Results of Microbial Parameters Obtained from Microbial Analyses Conducted in the Water Samples

Parameter	**Value Source**
Heterotrophic Plate Count CFU/mL)	2100-2,333.3 CFU/mL (water samples taken from river) 983.3-1366.1 CFU/mL (water samples taken from wells)
Coliform Count (MPN/mL)	16.0-19.0 MPN/mL (water samples taken from river) 6.0-6.3 MPN/mL (water samples taken from wells)
E. coli (MPN/mL)	4.7- 6.7 MPN/mL (water samples taken from river) 3.7 - 5.3 MPN/mL (water samples taken from wells)

Table 3 shows that the presence of microbial contents of water sources in Taraka, Lanaodel Sur. The heterotrophic count of the water samples range from 983.3 to 2333.3 CFU/mL. The Bureau of Food and Drugs places the standard for drinking water at 300 CFU/mL, the US Public Health places it at 500 CFU/mL while the World Health Organization has a standard of 100 FU/mL. This means that the water samples have heterotrophic plate counts much higher than the standard for drinking water. The coliform count in the water samples range from 6.0 to 19.0 Most Probable Number Per mL (MPN/mL). The standard for drinking water is 0 MPN/mL The E. coli count range from 3.7 to 6.7. The standard for drinking water is 0 MPN/mL. This shows that the water samples have high microbial counts, which means that the water sources have disease-carrying microbes and are thus not fit for drinking purposes.

Findings

Chemical analyses showed that pollutants are found in the water sources at levels higher than the acceptable levels for drinking water. Nitrogen, the chemical indication of water pollution, is present in large amounts in the river and shallow wells of Taraaka, Lanaodel Sur causing increase in harmful microorganism contents of the water sources (Sila, 2019). The microbial analyses, especially, show that the water is unfit for drinking because the bacterial count is very high. Human activities like waste disposal and farming practices of the respondents all contribute to the cause of pollution in the water sources.

Conclusion

Based on the experimental data obtained in the two analyses, the following conclusions were drawn: The DO and BOD values of the water are within the maximum standard level for surface waters. The hardness indicates that the water is soft. On the average, the acidity, temperatures, and salinity obtained are within the acceptable levels (Daud M. K. et al 2017). The values for ammonia and phosphate are very high that they exceed the maximum requirements for surface water.

The concentration of the harmful microorganism contents of the river and shallow wells of Taraka, Lanaodel Sur (Shamsudin et al., 2015) are more than the standard level for potable water. Heterotrophic count was high and so presence of both pathogenic and non-pathogenic microorganisms was abundant. The result of E. coli is also very high indicating an appreciable number of pathogenic organisms.

Finally, with the given analyses, the water sources are not potable and unfit for drinking purposes.

Implications

As a general implication, the respondents may be aware of the detrimental effects of polluting their source of water; however because of continuously using it as waste disposal area has not yet reached critical and serious level of concern; these effects are taken for granted,. Besides, municipal ordinance relative to sanitation and environmental protection, if any, remains to be just in paper. If ever implementation has been done, these policies were not consistently monitored and implemented. Environmental protection is a concern of all sectors in the community.

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Cabib B. Mecampong graduated PhD educational management, MST physical science, CPT high school chemistry in Mindanao State University and finished BSE in Pacasum College, Marawi City, Philippines. He is a Chief of administrative and technical staff of the Technology and Innovation Center, Office of the Vice Chancellor for Research, Extension and Development, MSU-Main Campus, Marawi City. He is also handling subjects in both college and senior high school of MSU- Lanao National College of Arts and Trades, Marawi City. Dr.Mecampong is eligible in professional board examination for teachers and amember and press relation information officer of the Science Club Advisers Association of the Philippines, MSU-Main Campus, Marawi City Chapter.