ANALYSIS OF GROUND WATER SAMPLES AND THEIR POSSIBLE HEALTH EFFECTS IN MON STATE

Shwe Sin Oo[1], Nyein Thida[2], Aye Aye Mar[3], Shwe Nan Htet[4]

Abstract

Analysis of water sample is one of the major issues during water quality monitoring of either surface or ground water sources. The objective of this study was to determine elemental concentration, some properties of ground water of hand-dug wells in one village of Mawlamyine district and two villages of Thaton district at Mon State, Myanmar and also their possible effects on the health of the inhabitants. Apparently, ground water in most countries is contaminated by the large number of chemical fertilizer used in our daily life and disposal of massive industrial effluents and mining activities. These wastes have negative effects on human health. Different waste products have different affects depending on their locations and kinds. It is essential to examine the water quality to avoid its hazard on local people. In this paper, ground water samples were analyzed using atomic absorption spectroscopy (AAS) to determine the concentration of some dissolved elements. The metal analysis is done to detect (i) arsenic (ii) lead (iii) cadmium (iv) iron (v) magnesium (vi) copper (vii) zinc using AAS method and some water parameters such as (i) pH (ii) electrical conductivity, (iii) temperature. The results obtained are compared with guidelines for drinking water quality World Health Organization (WHO) (2011). All the observed values except Cd are within the safe limitations (WHO). The observation from this job revealed that the measured pH values were in the range of 7.1 to 7.5, the values of electrical conductivity were found 43 to 625 μS/cm. The achieved turbidity values of all ground water samples are less than 5.

Keywords: water quality, AAS method, health effects, concentration of elements.

Introduction

Water is not only an absolute necessity for life but also a carrier of many diseases. As water is referred to as a universal solvent, the composition and quality of ground water is dependent not only on natural factors such as geological, topographical, meteorological, hydrological and biological and climatic effects but also on human influences such as industrialization, human activities and vast population. Therefore, the deterioration of aquatic system is common in everyplace for the developing world. So, water quality analysis is urgently required to achieve the water quality standards determined by WHO (2011) and Myanmar Emission Guideline (2015). Water quality standards are needed to determine whether ground water of a certain quality is suitable for its intended use. Ground water is the water stored beneath Earth's surface in aquifers. Once ground water is contaminated, its quality cannot be restored back easily and to device ways and means to protect it.

The natural concentration of metals in raw water which has not been treated or purified varies from state to state and country to country. Most metal species in natural fresh water occur in organic compounds, organic complexes or colloids. From the point of health, elements can be divided into two categories:

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(i) Elements with undesirable effect such as
   (a) Iron (Fe)
   (b) Magnesium (Mg)
   (c) Copper (Cu)
   (d) Zinc (Zn)

(ii) Elements with a potential toxic effect (inorganic chemicals) such as
   (a) Arsenic (As)
   (b) Lead (Pb)
   (c) Cadmium (Cd)

Arsenic is a great health problem worldwide and heavy metals such as lead and cadmium are toxic and can be large potential to cause carcinogenic. Therefore, the above elements are oriented to analyze in this work.

Materials and Methods

(i) Study Sites

Three sampling sites were selected in various villages of two districts, Mon State in Southern part of Myanmar. Mon state lies between Kayin State to the east, the Andaman Sea to the west, Bago Division to the north and Tanintharyi Division to the south. Traditional agriculture is the most important income source of the districts. Besides, there are industrial zones such as gold purification and production of minerals. Water samples were collected from each site to assess it for a period of May, 2019. All water samples were collected in the morning hour from 9:00 to 12:00 am using dry and clean plastic bottle. The study area (Mawlamyine) lies between latitude 16º 29' N and longitudes 97º 37' E. It is situated at elevation 52 meters above sea level. Thaton district is located between latitude 16º 56' N and longitudes 97º 22' E and is situated at elevation of 24 meters above sea level.(Figure 1)The depth of all three hand dug wells are round about 30 feet. The water of all wells is used for drinking, domestic usage and agriculture.

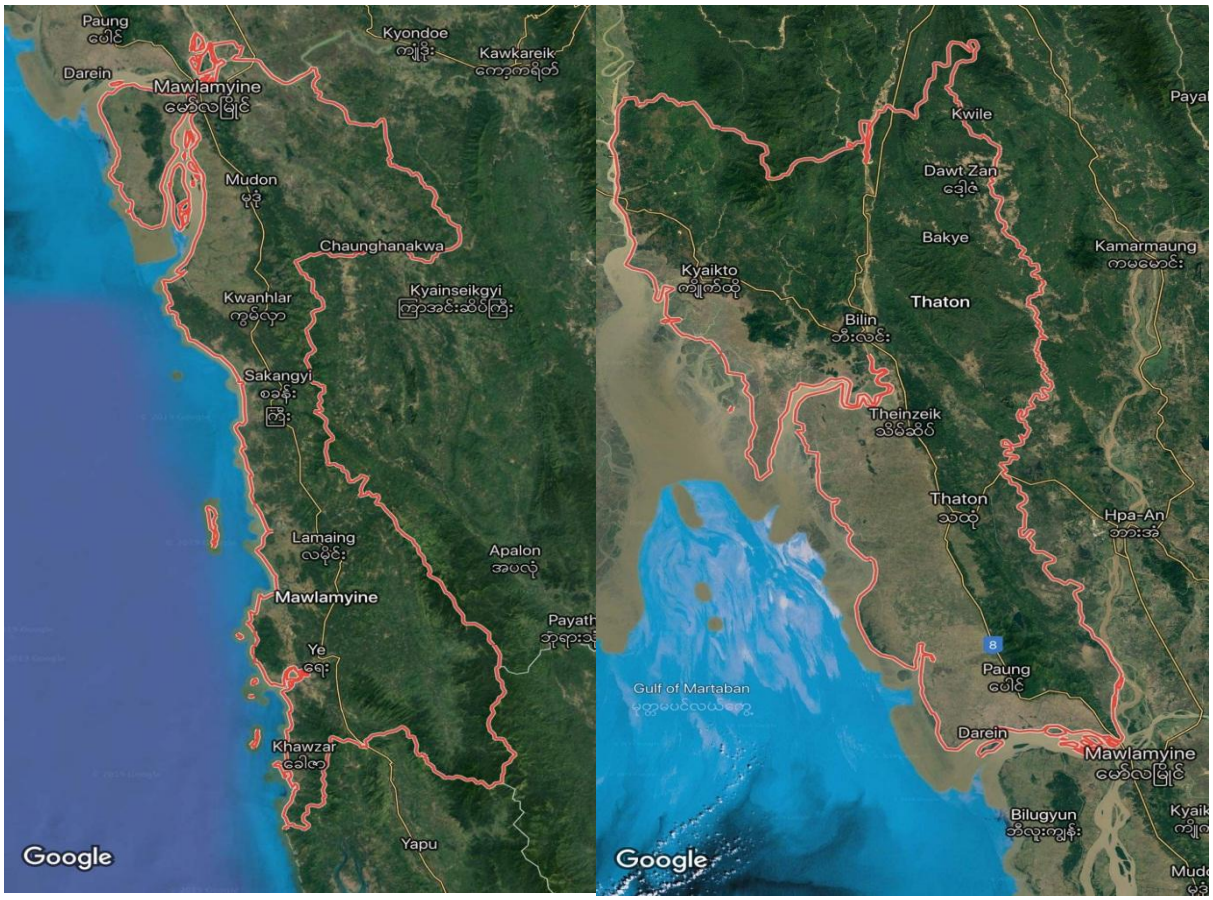

Figure 1 Map of study locations (Mawlamyine and Thaton districts).

(ii) Location of Study Area

Water samples were taken from three different sources:

Sample 1: ThwayThauk village near Mawlamyine university, Mawlamyine district. It has an old antimony mine but production of minerals was stopped since last 7 years.

Sample 2: Mae Wyne village in Hpa Pun township, Thaton district. There is a small gold mine in this village. Now, it is running annually.

Sample 3: Kwinkalay village in Bilin township, Thaton district. There is a gold mine which has production seasonally.

(iii) Climate of Study Area

Mawlamyine and Thaton districts in Mon State have covered a tropical climate. It has temperate weather as it is located in the low latitude zone and near the sea. During summer, the temperature shoots up to 47°C and in winter the temperature may fall to 2°C. Water temperature in summer was high due to low water level, high air temperature and clear atmosphere. This state has only slight changes in temperature. Annual rainfall in Mawlamyine is round about 190 inches (4.8 m).

(iv) Sample Collection

All water samples were collected from three different sources in two districts of Mon State. Samples were collected in clean and dry plastic bottles that were fitted with covers and

then these bottles were put in a box that cannot be entered any effects including sunlight. After that all water samples were brought into laboratory for the measurement of various parameters but water temperature were recorded at the time of sample collection using thermometer. The recorded temperatures of all samples were displayed in table -1.

(v) Analysis of Water Sampling

Selection of appropriate sample container is also utmost important for the analysis of water. Normally, plastic or glass may be preferred for containing and storing of sample water. Before using, sampling plastic (polyethylene) should be washed and rinsed first with tap water and then these bottles were dried under room temperature. For some metal ion, sample containers were used plastic bottles but for mercury ion analysis but now the samples were stored in plastic bottles. Sample preparation is very important step in analytical job. Therefore, collecting ground water and analysis of water samples were prepared very carefully without any mistake or careless.

Parameters to be analyzed: For the analysis of ground water quality of the hand dug wells of selected regions in Mon State, the following water parameters are analyzed (i) pH (ii) electrical conductivity (iii) arsenic (iv) lead (v) cadmium (vi) iron (vii) magnesium (viii) copper and (ix) zinc. The chemical characteristics of water parameters analyzed and their health effects in this paper include:

(i) pH: pH of the solution is defined as negative logarithm of H^+ ions for many practical experiments. The value of pH varies zero to 14 and pH value 7 is neutral. The range of pH from zero to 7 is acidic solution and from 7 to 14 is alkaline. pH usually does not have direct impact on human but it is one of the most important operational water quality parameters. Besides, extreme pH values also increase solubility of elements and compounds making them toxic. Furthermore, temperature has an inverse relationship with pH that is, as temperature increases pH levels decrease and vice versa. In this job, pH of all samples was measured using HANNA HI 98129, 98130 water proof pH tester [Electrode method] in Ecological Laboratory. The measured pH values of ground water samples were described in table-1.

(ii) Electrical conductivity: Conductivity is the capacity of water to carry an electrical current. This conductivity depends on the total concentration of ionized constituents of water, mobility, types of ions and relative concentration and on the temperature of solution. Moreover, conductivity is directly related to salinity that is conductivity improves with high salinity. In this study, conductivity of water samples were also analyzed by HANNA HI 98129,98130 water proof EC tester [Electrode method] in Ecological Laboratory. The obtained results of water samples were shown in table-2.

(iii) Arsenic: Arsenic is highly toxic, contaminated water used for drinking, food preparation and irrigation of food crops poses the greatest threat to public health. In many studies, long term exposure to arsenic in drinking-water is causally related to increased risks of cancer in the skin, lungs, bladder and kidneys. Arsenic is one of WHO's 10 chemicals of major public health concern.[2] In this work, As is analyzed by PinAAcle™ 900H atomic absorption spectrometer instrument in the laboratory of URC at University of Yangon.

(iv) Lead: Exposure to lead is very dangerous for young children compared to an adult because children's growing rate is much higher than that of an adult. Lead can damage brain, kidney,

nerves and blood cells. For infants, large amount of lead can delay physical and mental development. Now, concentration of Pb is also measured by AAS method.

(v) Cadmium: Cd is one of the very heavy metal posing severe risks to human health. Cadmium is biopersistent and, once absorbed by an organism, remains resident for many years. Cadmium can be determined using a high performance atomic absorption spectrometer instrument in URC.

(vi) Copper: Even though copper is an essential element in human diet but the amount of copper eaten by human is nearly 1.0 μg per day. For copper ions is exceeded, the immediate health effects are vomiting, diarrhea, stomach cramps and nausea. Long term exposure of copper can cause serious problems in kidney and liver. Diarrhea are included in top ten leading cause of morbidity in Myanmar and according to Health in Myanmar 2014 published by Ministry of Health and Sports.

(vii) Zinc: Zinc is present approximately 0.05 g/kg in the earth crust. Symptoms of zinc toxicity in human include vomiting, dehydration, electrolyte imbalance, abdominal pain. Concentration of Zn was measured using both methods in this work.

(viii) Iron: Concentration of iron in ground water will usually be 0.5-1 mg/litre.Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, sex range from about 10 to 50 mg/day. Insufficient or excess levels of iron can have negative effect on body functions. Concentration of Fe is determined using AAS method in this paper.

(ix) Magnesium: Magnesium is the fourth most abundant cation in the body and the second most abundant intracellular cation. Magnesium plays important mineral in bone structure, muscle contraction and nerve impulse transmission, blood clotting. Experts in this field tell us that total magnesium intake must be at least 450–500 mg per day, and drinking water should contain a minimum of 25–50 ppm magnesium.

(x) Temperature: Water temperature depends on the season, geographic location, sampling time, temperature of surrounding air and weather condition. Temperature will impact on the acceptability of inorganic constituents and chemical contaminants. High ground water temperature enhances the growth of micro-organisms and may increase physical characteristics of water such as taste, odour, color and corrosion**.**

(vi) Atomic Absorption Spectrometry (AAS)

Atomic Absorption Spectrometry (AAS) is an analytical technique for measuring quantities of chemical elements present in environmental samples by measuring the absorbed radiation by the chemical element of interest. Atomic absorption method measures the amount of energy in the form of photons of light that are absorbed by the sample. Atomic absorption Spectrometer has many uses in different area of research in most of scientific fields. Now, high-performance PinAAcle™ 900H atomic absorption spectrometer is used in this study. It is a combined flame/furnace system with continuum source background correction. The PinAAcle 900H is controlled by the proven WinLab32™ for AA software – whoever the user and whatever the application, WinLab32 software makes it fast and easy to get from sample to results.

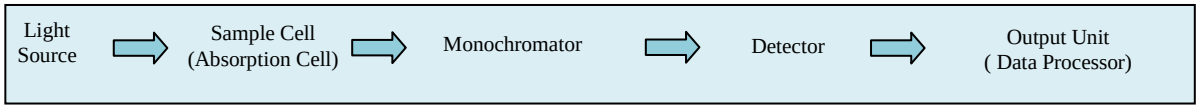

Figure 2 Schematic diagram of an atomic absorption spectrometer.[8]

Figure 3 High-performance PinAAcle™ 900H atomic absorption spectrometer instrument in the laboratory of URC at Yangon University.

(vii) Possible Health Effects of Contaminated Water

There is a greater relation between metal contaminated water and health problem. Some heavy metals are essential for health but in limited concentration, high concentration creates harmful effect on health. Higher concentrations of metal ions result into adverse environment and several types of human health problems. Health risk associated with polluted water includes different diseases such as respiratory disease, cancer, diarrheal disease, neurological disorder and cardiovascular disease. And also, poor quality water destroys the crop production and infects our food which is hazardous for aquatic life and human life. Heavy metals, especially iron affects the respiratory system of fish and aquatic animals. Metal contaminated water leads to hair loss, liver cirrhosis, renal failure and neutral disorder. Bacterial, viral and parasitic diseases are spreading through polluted water and affecting human health.

Results and Discussion

Table1 Physiochemical Properties of water samples from study area in Mon State, Myanmar.

No	Water Samples	pH			Turbidity (FAU)		Temperature (°C)
		Results	Standard Limits WHO (2011)	MEG (2015)	Results	Standard Limits	
1	Sample-1	7.5	6.5-8.5	6.5-9.0	< 5	≤ 10	28
2	Sample-2	7.3	6.5-8.5	6.5-9.0	< 5	≤ 10	25
3	Sample-3	7.1	6.5-8.5	6.5-9.0	< 5	≤ 10	26

MEG (2015) – Myanmar Emission Guideline (2015)

The maximum pH value is 7.5 for sample-1 and minimum value is 7.1 for sample-3. All measured pH values are within the WHO standards. The measured pH values, turbidity values and temperatures of water samples from each of study area are described in table-1 compared with standard limits (WHO). The pH values between 6.5 and 8.5 usually indicate good water quality and this range is typical of most drainage basins of the world. Therefore, the observed pH values for three sources have no deviation from the standard pH range limited by Myanmar Emission Guidelines (2015) and WHO drinking water quality (2011). Turbidity of all water samples are less than 5 and below the standards. Ground water temperature value in study area varies from 25 ºC to 28 ºC with an average value is 26.33 ºC. These results suggest that the ground water temperature is generally ambient and good for consumers in these areas.

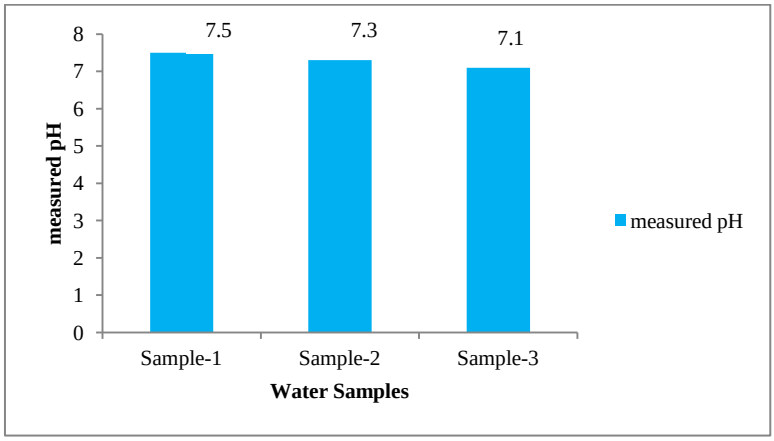

Figure 4 Statistical representation of physiochemical property (pH) of three water samples.

Table 2 Electrical Conductivity of water samples from study area in Mon State, Myanmar.

No	Water Samples	Electrical Conductivity (µS/cm)	
		Results	Standard Limits (WHO)
1	Sample-1	625	1500
2	Sample-2	206	1500
3	Sample-3	43	1500

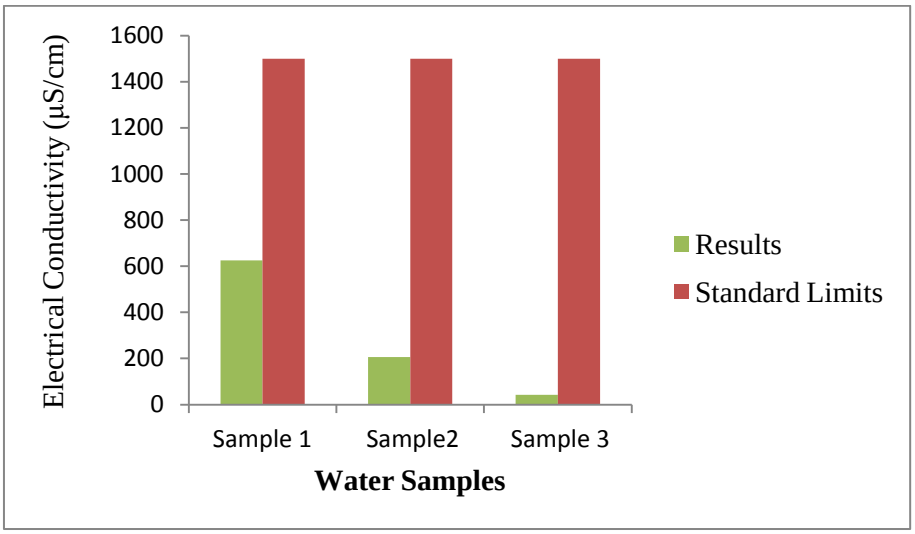

Figure 5 Comparison of results of electrical conductivity and WHO standard limits.

The results of electrical conductivity of three samples were listed in table-2 and displayed in figure (5) compared with WHO standards limits. The most electrical conductivity is 625 µS/cm for sample-1 and the least is 43 µS/cm for sample-3. Conductivity of the ground water for the entire study area stands at an average of 874 µS/cm. By studying this, electrical conductivities of water samples from study area in Mon State were good condition to use for domestic and agriculture.

Table 3 Comparison of some elemental concentration of all ground water samples using AAS method with WHO standards.

Elements	Measured Values (µg/L)			Standard Limit (WHO) (µg/L)
	Sample - 1	Sample - 2	Sample - 3	
As	1.608	1.035	0.735	10
Pb	ND	ND	ND	10
Cd	12	23	25	3
Fe	ND	ND	ND	300
Mg	4500	3170	8400	30000
Cu	ND	ND	ND	2000
Zn	ND	ND	ND	5000

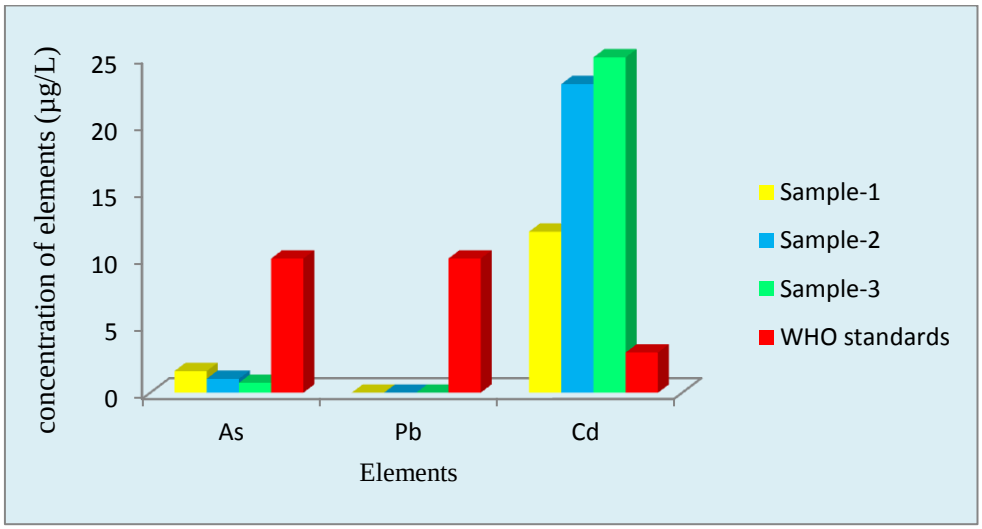

Figure 6 Concentrations of As, Pb and Cd for water samples from study area compared with WHO standards.

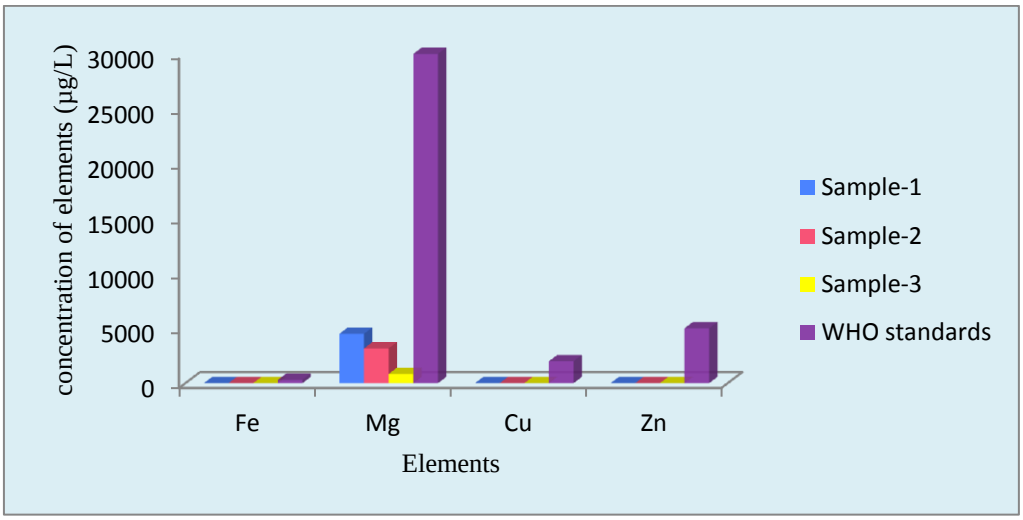

Figure 7 Concentrations of Fe, Mg, Cu and Zn for water samples from study area with reference to WHO standards.

Studying the elemental concentration of all water samples using AAS method, (6) kinds of metals' concentrations are well below the WHO standards except Cd. From this study, the concentrations of cadmium (Cd) for all ground water samples were higher than that of allowed value (WHO). The average daily intake of Cd for humans is estimated as 1µg from water but levels may vary widely. On account of the concentrations of the Cd (heavy metal) studied from this research paper , water samples are not suitable for drinking purposes. Concentrations of magnesium for three water samples were detectable but it is found within allowed limits. In this observation, lead (Pb), iron (Fe), copper (Cu) and zinc (Zn) could not be detected for all ground water samples. Based on the comparison of the achieved data using AAS method, we can conclude that there are no significant differences between the listed drinking water guidelines (WHO) (2011) and measured values in all of water samples in both of the discussed districts except cadmium (Cd). From this observation, results of magnesium content by AAS method were detectable in all samples but it was still within the safe limits.

Conclusion

Water quality is dependent on the type of the pollutant added and the nature of mineral found at particular zone of hand dug wells. From this analysis of water samples in the study area, there was no significant difference in the pH value compared with guidelines for drinking water quality (WHO) 2011 and also electrical conductivity and turbidity for all ground water samples are lower than WHO standards of water quality. The rest of observed values (elemental concentration) were within the WHO standards except Cd. By studying the measured values from AAS method, cadmium concentration is greater than that of highest standard level (WHO) in all samples. This may have a negative impact on human health. There was harmful contamination that causes health hazardous of habitants. Based on the achieved results, we can conclude that the health of the population in selected area has no safety for that ground water to drink and domestic usage. The outcome of this research could be beneficial to local as baseline information on ground water quality in terms of physio-chemical parameters some elemental concentration of ground water in Mawlamyine and Thaton districts. The results obtained from the present investigation shall be useful in future management of the ground water in Mon State, Myanmar.

Acknowledgements

First and foremost, praises and thanks to the Buddha, for his kind throughout my research work to complete the research successfully.

I am extremely grateful to my parents for their love, prayers, nurturing and sacrifices for my future. They are the ultimate role models for me.

I would like to express my gratitude to Professor Dr Khin Khin Win (Head), Department of Physics, Yangon University for her kind permission to give me the opportunity to do research.

I am also grateful to Dr Myo Lwin (Professor), Dr Aye Aye Thant (Professor) and Dr Yin Maung Maung (Professor), Department of Physics, Yangon University for their help and critical suggestions.

Special thanks are due to all my colleagues, friends and students from various fields who actively participated during the process.

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