Comparative Study of Hydrology, Associated Elements and Environmental Aspects of Groundwater from Hinthada Township and Laymyethna Township

Min Min Khaing[1], Aung Than Oo[2], Wathon Chit[3]

Abstract

The research area is situated at the northwestern part of Hinthada Township and eastern part of Laymyethna Township. Its lie between N 17˚ 26′ 24.47″ to N 17˚48′ 12.84″ and E 95˚ 01′ 54.68″ to E 95˚ 26′ 46.83″ of UTM map no. 1795- 01, 02, 03, 05, 06, 07. The research area is mainly composed of sandstone, sandy clay, silty sandstone, mudstone sand gravel and clay stone. Sixteen subsurface deep tube wells data and their water samples were collected and analyzed in the National Health Laboratory (NHL), Yangon. Regionally, the overlaid top soil and alluvial deposits are about 1m to 47m thick. The aquifers are commonly occurred as confined aquifer and semi- confined aquifer. The thickness varies between 5m and 29 m thick and water table is lie between 2m and 37m from different localities. According to the hydro-chemical and groundwater chemistry, chloride water is more abundant than sodium bicarbonate water. The determination of groundwater origin in the research area, water colour, turbidity, total dissolved solids, concentration of chlorine content, concentration of iron content, concentration of zinc content, concentration of sulphate content, concentration of magnesium content, concentration of sodium content, total dissolved solids, total hardness and electrical conductance of Hinthada area is higher than Laymyethna area and lower than WHO guideline values. The concentration of copper content, arsenic content, potassium content, lead content, total suspended solids content, total solids content, total alkalinity and bicarbonate content of Laymyethna area is higher than Hinthada area. The groundwater analyzed results from the research area may be slightly soft and non- hazardous for drinking and domestic uses. The seismic data, underlying rock types and structural geological position of the research area, the most damaging ground failures of landslide and subsidence are closely related to the activities may be caused by excessive withdraws of groundwater, solid materials and weight of urban development. The treatment of polluted waste water, particularly by sewage treatment plants, are classed, and the prevention of flooding hazards by monitoring of the progress of storm, prediction of flooding hazards and combination of flooding plain regulation and engineering techniques. Above these facts are a solution of flooding, landslide, subsidence and damage problems.

Keywords; Aquifers, Semi- confined aquifer, Alkalinity, Turbidity, Electrical conductance

INTRODUCTION

Location, size and accessibility

The research area is situated at the northwestern part of Hinthada Township and eastern part of Laymyethna Township. Its lie between N 17˚ 26′ 24.47″ to N 17˚48′ 12.84″ and E 95˚ 01′ 54.68″ to E 95˚ 26′ 46.83″UTM map no. 1795- 01, 02, 03, 05, 06, 07 and total covering area is about 1778.6 km^2. The research area is very close to Yangon City, Pathein City, Ma-U-bin Township, Ingapu Township and easily accessible by car.

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Physiography, climate and drainage pattern

The research area is situated in the head of Ayeyarwady Embayment and the general elevation lies between 9 m and 11m above sea level. The research area is within the tropical climate with heavy rain fall and the annual rain fall is 2390 m. The annual temperature is 27˚C to 31˚C, but high temperature throughout the whole year. The Ayeyarwady River is the main river in the research area and most of tributaries are flowing into it. Pathein River, Ngawon River and Ngathaing Chaung are flowing in this area. According to this physiographic map, the surface sloping is lies between 3˚ to over 20˚ at Laymyethna area and 1 to 3 at Hinthada area, as shown in Fig. 1. The drainage texture is poor and coarse. Most of the area shows coarse - dendritic to sub -angular pattern.

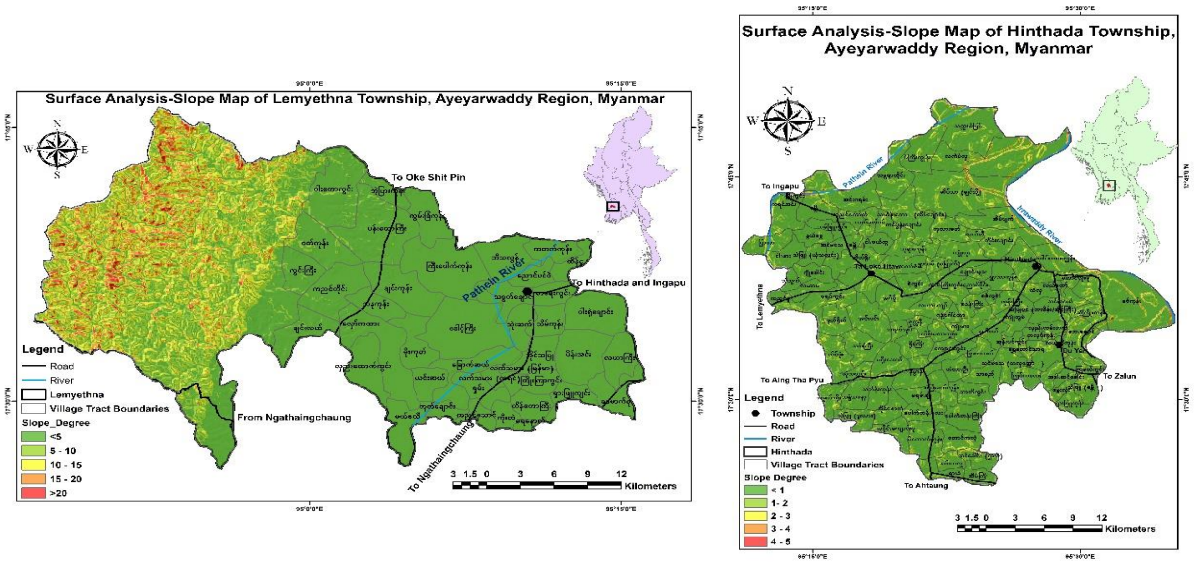

Fig. 1 Physiographic and location map of the research area.

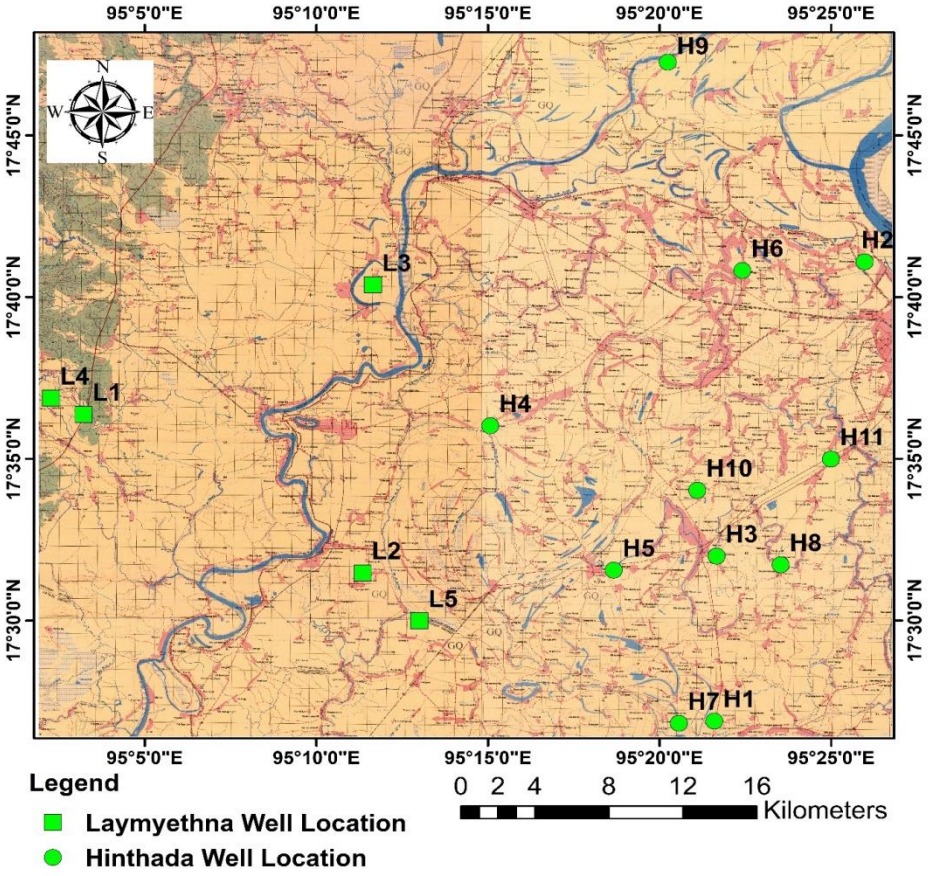

Fig. 2 Sample location map and drainage pattern of the research area.

Purpose of study

The main purpose of the research is to analyze hydro-chemical and groundwater chemical components and associate elements of the groundwater, to study the content and distribution of associated elements in the ground water, to describe the subsurface lithology, to describe the origin of groundwater, to study the related Human - induced hazards and to prevention of natural hazards from environmental points of view.

Materials and Methods

Firstly, UTM map and satellite image are used to study physiography and drainage pattern. Secondly, hydro-chemical and groundwater chemical data were obtained from the government and consulting companies. Sixteen water samples were brought out with the aid of Global Position System (GPS) and to analyze in the National Health Laboratory (NHL), Yangon. The analyze data were interpreted by using Sufer software and computer tools.

Previous Works

Theobald (1873) and Murray Stuart (1912) studied the geology of lower Myanmar and surveyed the geology of Hinthada District. Chhiber (1934) mapped and described the petrography and mineralization. Aung Khin and Kyaw Win (1969) the basins and Burma Tertiary Geosyncline. Lin Thu Aung (2008) studied the geology and sedimentology of the Yenandaung–Letpangwin area, Hinthada District. Thet Thet Lwin (2013) studied a hydrogeochemical analysis in Hinthada Town. Tun Tun Min (2014) describe the geology and structural geology of Laymyethna area.

Regional Geologic Setting

Regional Geology

The research area is situated at the southern part of Central Cenozoic Belt, eastern part of Western Ranges and also lie at the head of Ayeyarwady Delta. Regionally, the research area is mainly composed of Undifferentiated Flysch type sediments (Late Cretaceous - Paleocene), Lower Pegu Group (Paleocene to Late Oligocene), Upper Pegu Group and marine, brackish and terrestrial deposits (Miocene – Pleistocene). The Lacustrine deposits are overlain by the Irrawaddy Formation.

Table 1. Rock sequence of the research area.

Lithostratigraphic Unit	**Geologic Age**
Alluvium	Quaternary
Irrawaddy Formation	Late Miocene - Pliocene
Unconformity	
Upper Pegu Group	
Obogon Formation	Late Miocene
Kyaukkok Formation	Middle Miocene
Pyawbwe Formation	Early Miocene
Unconformity	
Lower Pegu Group	
Okhmindaung Formation	Late Oligocene
Undifferentiated Molassic Unit	Eocene to Early Oligocene
Paunggyi Formation	Paleocene
Unconformity	
Undifferentiated Flysch Unit	Late Cretaceous to Paleocene

Hydrogeology

The water samples location map are shown in Fig. 2 and illustration of the typical profiles of the research were based on tube well data provided by 2015 to 2020 data of Irrigation and Water Utilization Management Department, Pathein City, Ayeyarwady Region. In the research area, the top soil and alluvial deposits are about 12m to 56 m thick. The subsurface is mainly made up of clay, sandstone, sandy clay, mudstone and fine to medium-grained gravel, so semi- confined aquifers are mostly occurred. The water table of the research area is about 3m to 6m in depth, as shown in Fig. 3. The top soil is mainly composed of clay stone and according to subsurface lithology, the groundwater is mainly controlled by underlying rocks. According to subsurface data, two water bearing aquifers are occurred at 84 m to 108 m and 126 m to 176 m depth. These aquifers are mainly composed of medium to coarse –grained, yellowish to gray colour, sand and gravel horizon and water quality is good. Water analyzed data are shown in Table. 2. According to these data, the general water properties of colour is 2.5 Pt-Co to 40 Pt-Co, turbidity is 0.25 NTU to 40 NTU, total dissolved solids is 39.5 mg/l to 280 mg/l, total hardness is 40 mg/l to 300 mg/l, electrical conductance is 75.1 µs /cm to 415 µs /cm and pH is 7.2 to 8.6. The chemical properties of chloride (Cl) is 8.7 mg/l to 40.5 mg/l, sulphate (SO^4-) is 5 to 74.8 mg/l, bicarbonate is up to 48 mg/l, carbonate is 0 mg/l, calcium (Ca^{2+}) is 11.22 mg/l to 80 mg/l, magnesium ($Mg^{2+)}$ is 2.88 mg/l to 5.88 mg/l, iron ($Fe^{2+)}$ is 0.02 mg/l to 2.4 mg/l, potassium (K) is 3.01 mg/l to 3.09 mg/l, sodium is 14.55 mg/l to 16.2 mg/l, zinc is 0.02 mg/l to 2.2 mg/l, lead is up to 0.03 mg/l and arsenic (As3+) is up to 0.03 mg/l respectively. The elements content, their relation with tube well depth and distribution map of the research area are show in Fig. 4. According to the

hydro-chemical and groundwater chemistry, chloride water is more abundant than sodium bicarbonate water. The determination of groundwater origin in the research area, water colour, turbidity, total dissolved solids, concentration of chlorine content, concentration of iron content, concentration of zinc content, concentration of sulphate content, concentration of magnesium content, concentration of sodium content, concentration of copper content, total dissolved solids, total hardness and electrical conductance are lower than WHO guideline values. The concentration of arsenic content, potassium content, lead content, total suspended solids content, total solids content, total alkalinity and bicarbonate content of Laymyethna area is higher than Hinthada area. The concentration of iron content, turbidity and pH value of Hinthada area is higher than Laymyethna area. These water data show no monitoring data and good quality. In the research area, water table is low and varies. Most of aquifers are alluvial aquifers of semi – confined aquifer and confined aquifer. These aquifer are controlled by topographic condition, underlying rock types, hydrological condition and weathering processes. Topographically, the research area is lie on alluvial fan deposits and mainly composed of floodplain deposits which thickness are varies. So the water level and the aquifer thickness are also changes. These changes are good sediments for groundwater storage medium.

ENVIRONMENTAL ASPECTS AND DISCUSSION

Water is essential role in supporting for human life. It contaminated great potential for transmitting a wide variety diseases and illness and act as a vehicle for transmission. Also water transport unwanted chemical to the human body without the knowledge of the consumer. The ideal drinking water should be colourless, odorless, tasteless and should not be harmful bacterial or chemicals. Drinking water may be divided into bacteriological, microbiological, chemical and physical. Bacteriological and chemical qualities especially toxic and other chemicals are harmful of health.

Standard for drinking water are accepted by United State Public Health Service (USPHS), World Health Organization (WHO) and Austrians Department of Health (ADH), shown in Table 3, 4. In the research area, the fundamental characteristics of water samples data were compared with the standard laid down by WHO guideline for drinking water. According to the mineral distribution map of the study area, the water colour and turbidity content are more dominant in the northern part and the concentration of sulphate content is more dominant in the central part of the research area.

Fig. 3 Subsurface lithologic characteristic of water samples from the research area.

Table. 3 Chemical properties and General properties of groundwater analysis data from the research area

No	Loc.(Decimal Degree)		Hold Dep./ Pipe Length(ft)	Pumping Pressure(PSI)		Water Level(ft)		Discharged Water(gph)	Aquifer (ft)	Aquifer Depth(ft)	Colour (TCU)	Turb.	Total Dissolved Solid	Cl-	Cu	TH	Fe2+	pH	SO4-	Zn	Ca2+	Mg2+	Ec	As3+	K	Na+	Pb2+	Salinity	smell	Total Solids	Total Suspended Solid	Total Alkalinity	Bi Carbonate (HCO3-)	Carbonate	Hold Depth
	Lat	Long		Start	During	Starting	Developing				Pt-Co	NTU	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	µs /cm	Ppm	mg/L	mg/L	mg/L	ppt		mg/L	mg/L	mg/L			
H1	17.4483333	95.36	500/470	50	30	15	32	3000	430-485	55	15	5	272	21	0.02	130	1	7.4	57.6	0.01	26	18.2	275	0.001										500
H2	17.685	95.4330556	550/510	50	30	16	72	3000	470-500	30	35	40	210	10.5	0.02	150	2.4	7.2	74.8	0.01	26	23.8	308.5	0										550
H3	17.5333333	95.3611111	590/515	50	30	14	80	2000	480-500	20	25	20	280	16.8	0.03	135	2	8.6	67.2	0.01	28	18.2	320	0										590
H4	17.6005556	95.2511111	560/455	30	20	17	10	3000	305-445	140	40	30	252	16.8	0.03	150	1.95	8.2	74.8	0.01	34	18.2	297	0.001										560
H5	17.5261111	95.3111111	500/431	43	14	18	60	4500	280-300	20	20	5	272	16.8	0	110	0.95	7.5	54.7	0	22	15.4	290.5	0										500
H6	17.6805556	95.3736111	600/540	-	-	15	25	4500	458-552	94	2.5	0	132	13.1	0	130	0.9	7.6	6	0.01	28	16.8	201	0										600
H7	17.4472222	95.3427778	600/580	-	-	15	25	5000	453-480	27	2.5	2.5	156	8.7	0	150	1	8	9	0.04	30	21	239.5	0										600
H8	17.5288889	95.3922222	600/500	70	40	13	18	5000	472-524	48	5	1	114	16.4	0	120	0.3	8.1	5	24	0	16.5	221	0										600
H9	17.7877778	95.3372222	620/600	-	-	10	20	5000	568-620	78	23	15	224	40.5	0	300	1.2	7.7	18	0	80	28	415	0										620
H10	17.5672222	95.3516667	600/590	43	28	15	120	8000	530-570	40	0	0.25	140	21	0	76	0.45	7.3	26.9	0	20.8	5.76	210	0	3.01	16.19	0	0.1	0	142	2	46	46	0	600
H11	17.5833333	95.4166667	500/400	75	65	12	35	4000	307-337	30																									500
L1	17.6063889	95.0536111	580/500	-	-	12	15	4000	289-311, 442-464	22, 22	2	0	154	18.3	45	0	0.3	8.1	7	0.04	9.6	5.88	230	0.001										580
L2	17.5247222	95.1891667	550/530	70	40	7	12	5000	404-473	69	3	1	39.5	35.2	0	80	0.2	6.8	8	0	24	5.6	75.1	0.03										550
L3	17.6730556	95.1941667	600/400	90	80	10	20	4000	360-420	60	0	2.2	160	24	0	124	0.05	7.7	26.9	2.2	28.1	5.76	247	0	1.1	11.49	0.03	0.1	0	164	4	48	48	0	600
L4	17.6147222	95.0377778	600/540	43	23	10	22	5600	440-460	20	0	8.4	95	21	0	40	0.5	7.8	19.2	0	11.2	2.88	140	0	3.09	14.55	0	0.1	0	98	3	22	22	0	600
L5	17.5	95.2166667	600/450	37	68	12	50	4500	292-321	29																									600

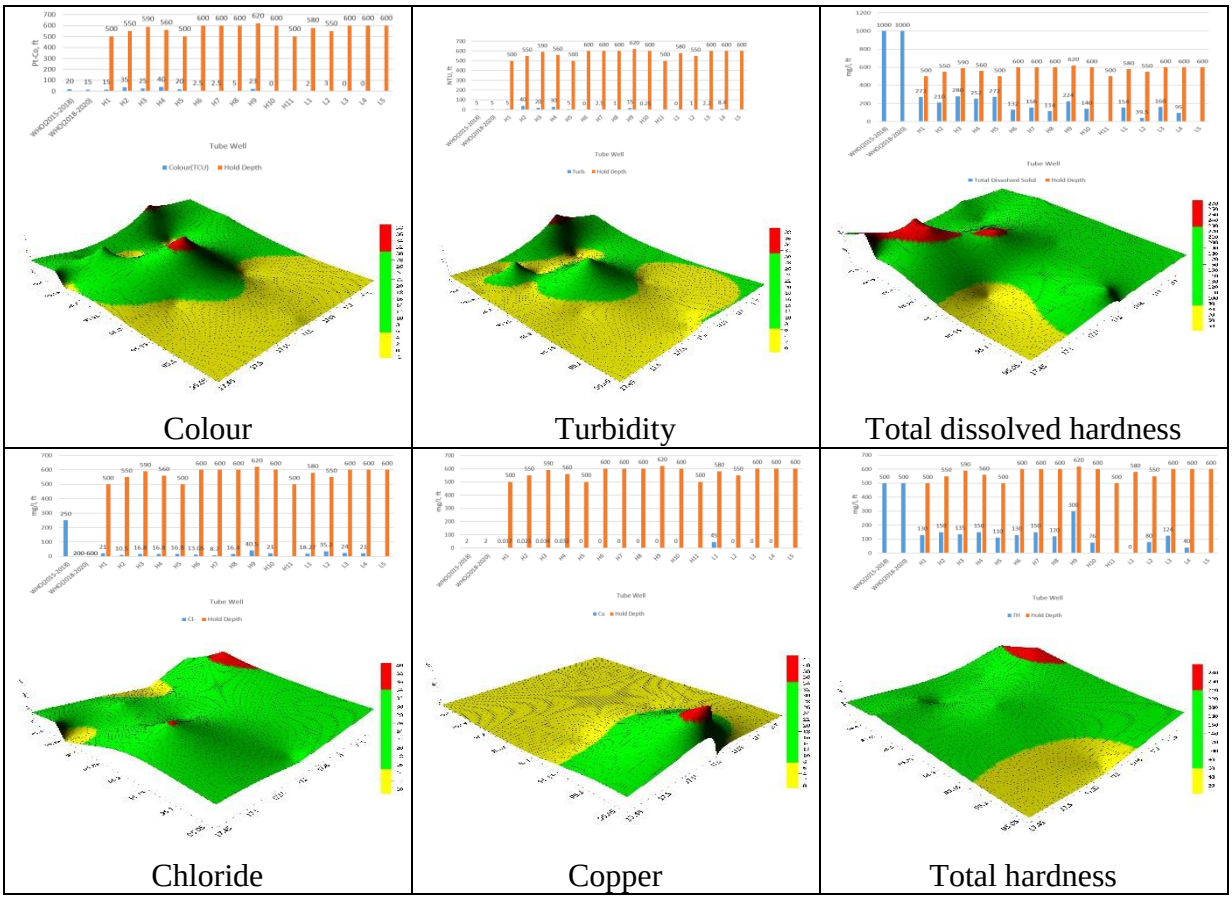

Fig. 4 Relationship between depth and mineral content, and minerals distribution map of the research area

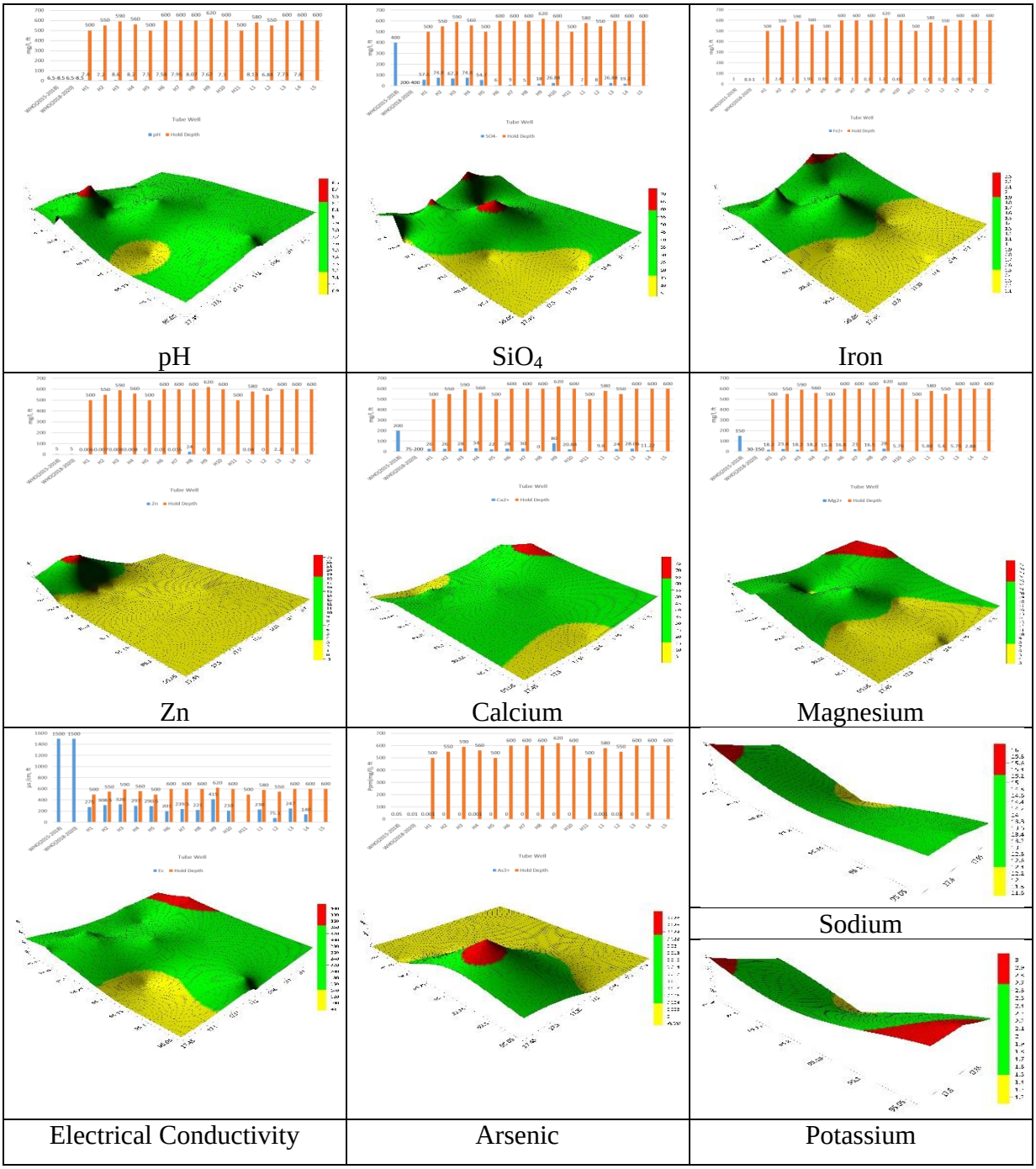

Fig. 4 Relationship between depth and mineral content, and minerals distribution map of the research area (Continue)

Tube well no. H9 has high concentration of chloride content, calcium content and total hardness. The concentration of calcium and iron content increase the taste of beverages becomes slightly bitter and increased electrical conductance. These elements are mostly associated with arsenic. Many different types of material including chemical and heavy metals may contaminate soils. Hazardous wastes may effect soil and water resources.

Table. 3 Standard for drinking water (Suggested Limit that should not be exceeded)

No	**Kind of Metals**	**Guidelines Quality**
1	Aluminum	0.2 mg/1
2	Chloride	250 mg/1
3	Copper	1 mg/1
4	Iron	0.3 mg/1
5	Colour	1.0 mg/1
6	Hardness (as $CACO_3$)	500 mg/1
7	Manganese	0.1 mg/1
8	Chromium	0.05 mg/1
9	Sulphate	400 mg/1
10	Sodium	200 mg/1
11	Turbidity	5 NTU
12	Total dissolved Solid	1000 mg/1
13	Taste & odour	Inoffensive
14	Zinc	0.5 mg/1

Water pollution is caused by toxic substances released from leaking disposal site or underground storage tanks. The most common source of water pollution in well, lake, lagoon and springs is uncertained sewage. It is contaminated water percolate through sand or permeable sandstone, and it can be purified within short distances, in some case, less than 30 m from where pollution occurred.

According to the seismic map of Myanmar (modified after Dr Maung Thein et. al), the research area is situated in the moderate earthquake zone (seismic zone II) with an intensity of VII MM (modified Mercalli) and may be regarded as probable range of ground acceleration due to gravity by vibration as 0.1 to 0.15 g. As the seismic data, its underling rock types and structural geological position of the research area, the most damaging ground failures of landslide and subsidence are closely related to the activities of man. Human – induced subsidence may be caused by excessive withdraws of groundwater, solid materials and weight of urban development. Prevention of landslide and subsidence are very difficult, but engineering practices can do much to minimize hazards. Prevention methods for surface and subsurface damages are removable of unstable slope materials, construction of retaining walls, or some combination of these factors. The concentration of zinc, sodium, potassium, total dissolved solids and pH value of northwestern part of the research area is more distributed than others. Total hardness, electrical conductance, the concentration of chloride, iron, calcium, magnesium and total hardness are widely distributed in northeastern part of the research area. Groundwater from the northern part of the research area is clear. But the smell, colour and turbidity value of groundwater samples from Hinthada area is higher than Laymyethna area. The determination of groundwater origin at tube well no. H_8 has high concentration of Zn content and also tube well no. L_1 has high Cu concentration content. The water table of the research area is low, the top soil is mainly composed of clay stones, low permeability and it lies in heavy rainfall with tropical climate condition, the urban area has increased flood hazards if the storm water to run- off the land rather than filtrate. So we need to control groundwater and soil materials especially in urban development area.

Table. 4 Some disorders associated with deficiency, excess and /or faulty utilization of the minerals (United State Public Health Service (USPHS), World Health Organization (WHO) and Austrians Department of Health (ADH))

Nutrient	Deficiency	Excess	Faulty Utilization
Major Elements			
Potassium	Muscle weakness		Addison's disease; Cushing's disease rickets; osteomalacia;
Calcium	Hypocalcemia; tremor; rickets; osteomalacia; osteoporosis; muscle spasm (tetany); possibly heart disease		Spasm (tetany); possibly heart disease; Paget's disease
Phosphorous	Rickets; osteomalacia; osteoporosis;		Rickets; osteomalacia; osteoporosis; Paget's disease; renal rickes
Sulfur			(Vitamin D- resistant rickets) homocystinuria
Chlorine	Impaired growth in infants		
Trace elements			
Chromium	Impaired glucose tolerance; possibly atherosclerosis		
Zinc	Mental retardation; delayed sexual maturity; dwarfism; sterility; slow wound healing; hypogeusia		Acrodermatitis enteropathica
Iron	Anemia	Hemochromatosis ; Bantu siderosis	hemochromatosis

SUMMARY AND CONCLUSION

The research area is situated at the western part of Ayeyarwady River and the drainage texture is poor, coarse - dendritic to angular pattern. Lithologically, the subsurface is mainly made up of clay, sandstone, silt and fine to medium- grained gravel and semi-confined aquifers are mostly occurred. The top soil and alluvial deposits are about 12m to 56 m thick and water table of the research area is about 3m to 6m in depth. Concentration of magnesium and calcium elements causes vermicelli increase by resumption of bone, renal reabsorption of calcium and absorption of calcium from the industries. Magnesium and chloride concentration are hygienic for drinking water and suitable for domestic and industrial purposes guidelines and it causes colour stained and turbidity in water. Over view of the research area, carbonate content is absent, SiO4 is more concentrated at 165 m to 177m depth and arsenic content is more concentrated in Laymyethna area than Hinthada area. But this arsenic value is lower than WHO guidelines value, so we should not use directly as drinking purposes. The research area is mainly composed of sandstone, silt and gravel. Sand is essential for effective cleaning agent and it promotes purification by mechanically filtering out bacteria, by oxidizing bacteria. So that sandstone are rendered harmless and by bringing bacteria into contact with other organisms that consume them. The treatment of polluted waste water, particularly by sewage treatment plants, are classed as primary, secondary or tertiary. Primary sewage treatment allows suspended particles to settle out, then chloride gas

is added to killed bacteria. Secondary treatment remove more of oxygen demanding wastes and tertiary treatments are sometime used to take out specific pollutants like phosphates. Standard pH value of drinking water are recommended by WHO and ADH, most of water samples from the research area show acidic character and may be regarded as not be suitable for directly using drinking purposes. These groundwater analyzed results from the research area mentioned above may be said to be slightly soft and non- hazardous for drinking and domestic uses. We can make the prevention of flooding hazards by monitoring of the progress of storm, prediction of flooding hazards and combination of flooding plain regulation and engineering techniques. Channelization is straightening, deepening, widening, cleaning or lining of existing, construction of retaining walls and small reservoirs. These facts are a solution to particular flood, landslide, subsidence and damage problems.

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