

## Geographic Assessment on Water Uses in Hinthada Town, Ayeyarwady Region

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### Abstract

The paper highlights the water use of Hinthada Town located on the western bank of Ayeyarwady River. Local people commonly use rain water, tube well water, and river water. The water quality from surface water (rain water and river water) has pH value that is lower than the maximum permissible level of WHO standard. However pH value of rain water result is lower than the highest desirable level but within the maximum permissible level (between 6.5 and 9.2). Thus the water is suitable for potable. Total hardness of tube well is more than the highest desirable level but within the maximum permissible level. Local people lack knowledge of water pollution and they use different sources of water for bathing, drinking, washing, and cooking. But, like other rural areas, most water sources are not suitable for drinking due to low impurity. It causes health problems and affects the hygiene of the local people. The main objectives of this study are to find out existing water uses in Hinthada Town, to explore the consequences of different water uses and to assess the water quality of the area. Primary data were mainly applied to get the detailed information and a field observation was conducted intensively. Assessment on spatial and temporal variation of daily water consumption was done by using quantitative method.

**Keywords:** different water uses, consequences, different sources, water quality

### Introduction

Water is a basic nutrient of the human body and is critical to human life. Water is one of the most abundant and important renewable resources on Earth. Water is one of the most vital of all organisms on the earth. The quality of water has always played an important role for people. There are various kinds of water on the earth. These are surface water (rain water, river water, lakes and ponds water) and ground water (tube-well and hand-dug well).

With the growth of population and extension of the town, the amount of water needed has increased. The water consumption for urban people in the study area is estimated as 20 gallons per person per day. In the study area, the majority of the population use rivers, lakes and tube wells. The research paper focuses on water sources and water quality in the study area from geographical point of view.

### Study area

Hinthada Town is located on the western bank of the Ayeyarwady River. Its total land area is approximately 17.82 square kilometer (5.9 square miles). It is composed of 21 wards. Total population was 92021 in 2019.

### Aim

The main aim is to assess the spatial and temporal variation of water consumption and water quality in study area from geographical point of view.

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**Objectives**

The objectives of this study are;

- to present existing water uses in Hinthada Town,
- to explore the consequences of different water uses and
- to assess the water quality of the area

**Sources of Data and Methodology**

Both primary and secondary data are used. Primary data are collected from field observation and informal talk. This research studied area water consumption of spatial and temporal variation within the period from 2010 to 2019. Test results from water quality are assessed by the WHO water quality standard. It was found that water quality from river water and rain water pH values is lower than the maximum permissible level. Total hardness of tube-well water is more than the highest desirable level but within the maximum permissible level. Secondary data are obtained from Hydrology and Metrology, Immigration and Labour Force Department and Administrative Departments, Water Resources and Water Use Department and City Development Committee of Hinthada Town.

**Results and Findings**

**Geographical Background of Hinthada Town**

Hinthada Town is located on the western bank of the Ayeyarwady River. It is located at north latitudes 17° 15"N and 17° 39" N and east longitudes 95° 13"E and 95° 35"E. Its total land area is approximately 17.82 square kilometer (5.9 square miles). It is bordered by Kaing Chaung village tract on the north, Ayeyarwady River and Gaung Say Kyun on the east, Lel Taw, Kan Hla, and Taung Lone Su village tract on the south, Konegyi village tract on the southeast and Chaung Phyar village tract on the west. It is composed of 21 wards. Hinthada Town is in a rectangular shape (Figs. 1 and 2).



Figure (1) Location of Hinthada Township  
Source: Survey Department, Hinthada

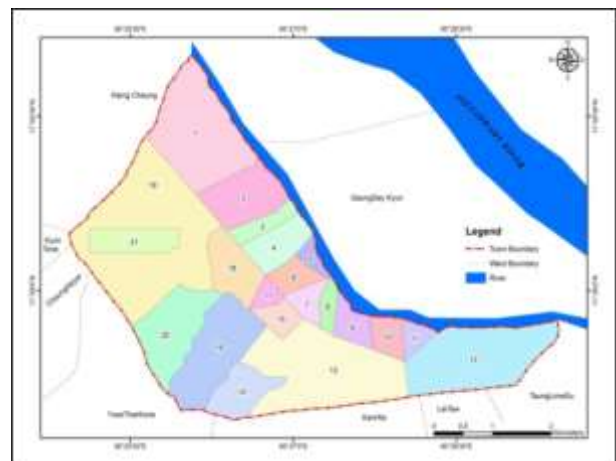


Figure (2) Location of Hinthada Town  
Source: Survey Department, Hinthada

Hinthada Town has a large low-lying plain with the mean elevation of 44.3 feet (13.51 m) above the sea level. The Ayeyarwady River which serves as the eastern boundary is the major drainage of the study area. The Ayeyarwady River is a main river of the town. There are several islands (alluvial lands) in the Ayeyarwady River channel, of which some are submerged under water in the rainy season when the water level rises. The largest and the most well-know island is Gaung Say Kyun (Fig. 3).

**Climate**

The town’s climate generally falls within the tropical zone and experiences tropical Monsoon Climate (Am) which receives heavy rain in June, July and August, according to the Koppens’s climatic classification. But in some years it has the climatic conditions like that of tropical Savanna (Aw). The average maximum temperature is 33.16°C and the average minimum temperature is 20.49°C. The total average rainfall of this region is 2110.34 mm.

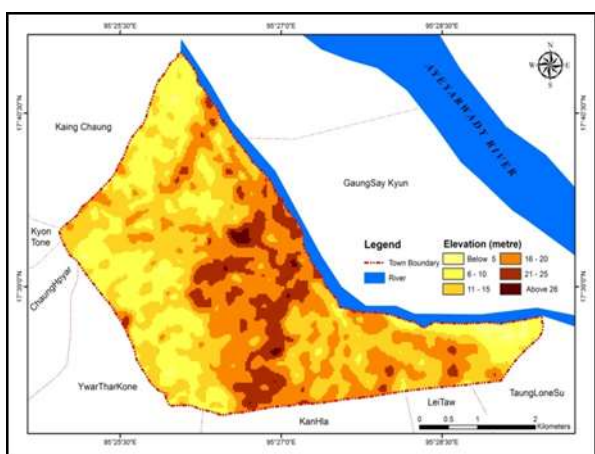


Figure (3) Relief and Drainage of Hinthada Town  
Source: DEM (Digital Elevation Model)

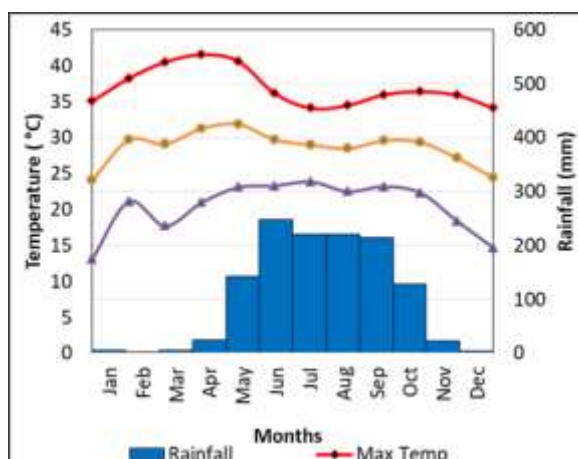


Figure (4) Climograph of Hinthada Township (1999-2019)  
Source: Climatology and Hydrology Department, Yangon

**Geology**

Majority of underlying rocks is composed with grey color and clay minerals. Uppermost layer is the newly alluvium which covers the ground surface. In the geology of the Hinthada District, it can be found as Cretaceous Rocks, Miocene Rocks, Eocene rocks, Irrwaddy Formation, Older Alluvium and Recent deposits. Among them Older alluvium and Recent deposits are found in this region.

**Population Distribution and Density**

According to 2010 records, the total population of Hinthada Town was 78,055 persons and it sharply increased to 92,021 persons in 2019. The town population is increasing year after year from 2010 to 2019. In 2010, Tar Ka Lay ward was the largest population with 12,138 persons. Ka Naung Su Ward was the second largest population with 10,081. Kin ward was the smallest population with 1163.

In 2019, the total population in Ka Naung Su Ward increased to 13,715 persons and it also became the highest population of the town.

Population density is also different from one place to place. In 2010, U Yin (south) ward had the highest population density with 14,424 persons per square kilometer. Pa Khan

Ward had the lowest population density with 619 persons per square kilometer. In 2019 U Yin (south) ward was the highest population density with 17,552 persons per square kilometer. The lowest population density was found in Pa Khan Ward with 786 persons per square kilometer.

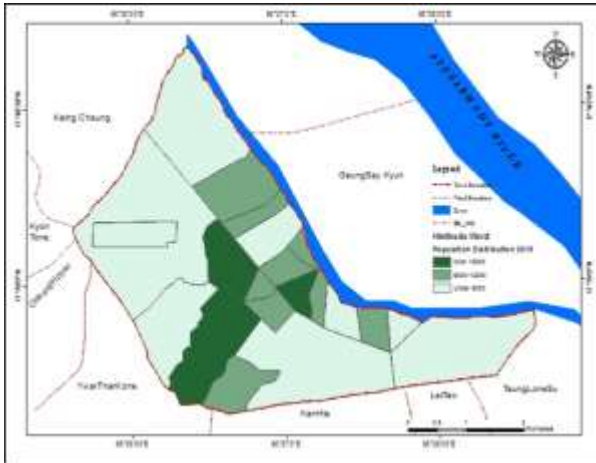


Figure (5) Population Distribution of Hinthada Town (2019)

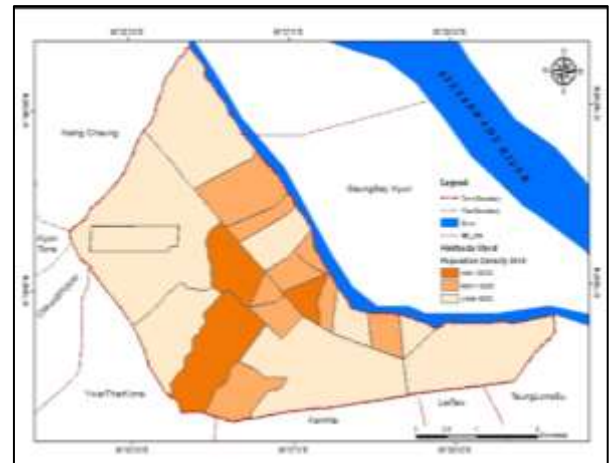


Figure (6) Population Density of Hinthada Town (2019)

### Spatial and Temporal Variation of Water Consumption in the Study Area

Depending upon the specific location of water, the residence time in water consumption vary from one ward to other ward in the study area. The estimate requirement of water per person per day is 20 gallons. Water consumed by each household varies in the study area. By multiplying this amount with the population, the total daily consumption per day can be identified. Therefore, water consumption per day with the population of each ward in Hinthada Town from 2010 to 2019 is shown in the table (1). The total amount of water consumption in the study area in 2010 is found to be over 1.5 million gallons per day and over 1.8 million gallons per day in 2019 respectively (Table 1, and Figs. 7 & 8).

Daily water consumption of Hinthada Town can be divided into three groups; such as

- (1) High daily consumption group
- (2) Moderate daily consumption group
- (3) Low daily consumption group

In Hinthada Town, there are two wards; Ta Ka lay and Ka Naung Su that belong to high daily water consumption group with above 170,000 gallons per day. There are four wards that belong to moderate daily water consumption group with between 90000 and 170000 gallons per day. Other wards included low daily consumption with under 90000 gallons per day. Therefore the largest number of population concerns with high daily consumption group in the study area (Fig. 9).

During the period from 2010 to 2019, the total population had increased from 78055 persons to 92021 persons. There was the temporal change in the of water consumption in study area: 1,561,100 gallons in 2010; whereas in 2019 it is increased to 1,840,420 gallons. Hinthada Town had increased to 15.17 % of total water consumption with temporal change during 10 years' period from 2010 to 2019 (Fig. 10).

Table (1) Spatial Variation of Daily Water Consumption by Wards in Hinthada Town (2010 and 2019)

No.	Wards	Population (2010)	Water consumption (gallons per Day )	Population (2019)	Water consumption (gallons per Day )
1	Pyin Ma Chaung	2530	50600	3330	66600
2	Nyaung Pin	6673	133460	7120	142400
3	Tar Ngar Se (North)	1689	33780	2444	48880
4	Tar Ngar Se (South)	2012	40240	2384	47680
5	Let Tha Mar	1179	23580	1673	33460
6	Yone Gyi	1602	32040	2516	50320
7	U Yin (South)	2452	49040	2984	59680
8	U Yin (North)	1989	39780	3207	64140
9	Shwe Ku	3296	65920	3364	67280
10	Za Kar	2403	48060	3858	77160
11	Kin	1163	23260	1241	24820
12	Pa Khan	1709	34180	2172	43440
13	Tar Ka Lay	12138	242760	12529	250580
14	Pa Be Dan	4699	93980	4999	99980
15	Hpa Yar Gyi	2491	49820	2538	50760
16	Ka Naung Su	10081	201620	13715	274300
17	Pa Da Myar	1294	25880	1378	27560
18	Thone Pin Kwin	7182	143640	8483	169660
19	Let Ti Kwin	4126	82520	4213	84260
20	Mya Wa Di	4536	90720	4715	94300
21	Aye Mya Thar Yar	2811	56220	3158	63160
	<b>Total</b>	<b>78055</b>	<b>1561100</b>	<b>92021</b>	<b>1840420</b>

Source: General Administration Department of Hinthada Township

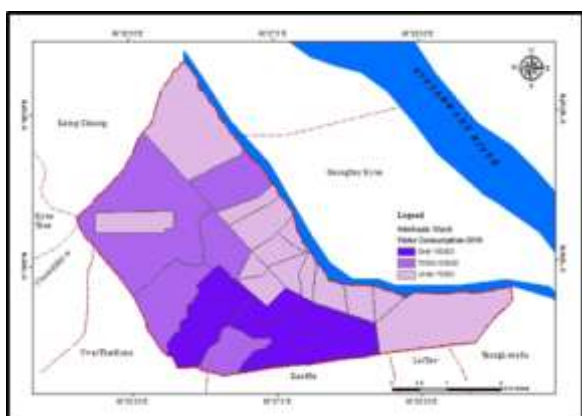


Figure (7) Spatial Variation of Daily Water Consumption by Wards in Hinthada Town (2010)

Source: Interview and Questionnaires' results

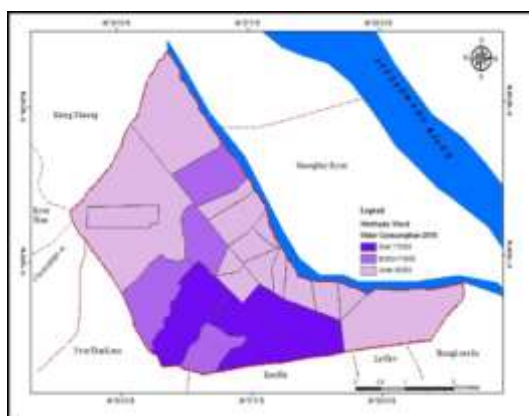


Figure (8) Spatial Variation of Daily Water on Consumption by Wards of Hinthada Town (2019)

Source: Interview and Questionnaires' results



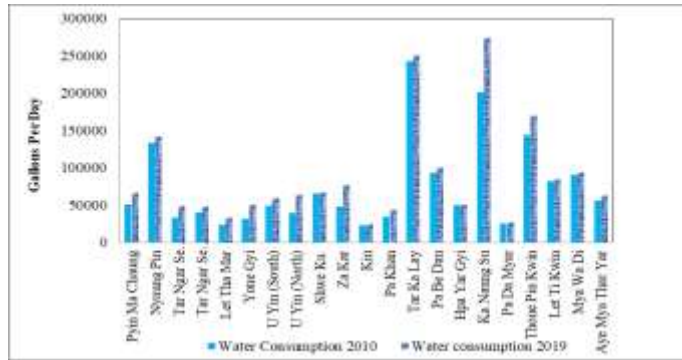


Figure (9) Spatial Variation of Daily Water Consumption by wards in Hinthada Town 2010 and 2019

Source: Interview and Questionnaires’ results

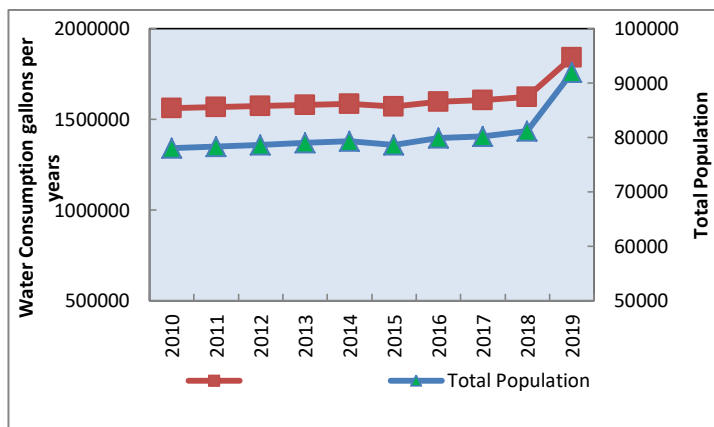


Figure (10) Temporal Changes of Population and Water Consumption of Hinthada Town (2010-2019)

### Assessment on the Tested Results of Water Quality by Sources

Water has unique characteristics that together make it critical for the existence of life and an important factor in many physical and biochemical processes.

To measure quality of water, 3 tests have been done. Physical tests have been done to show detectable properties, chemical test for defining the amount of mineral and organic content affecting water quality, and bacteriological tests explore the existing bacteria and pollution.

Physical Tests measure Colour, turbidity, total solids, dissolved solids, suspended solids, odour and taste of the water. Colour skows presence of minerals and organic origin such as algae and weeds. Turbidity shows suspended and colloidal matter of the water. Odour and taste of water display presence of living microscopic organisms.

Chemical Tests examines pH, hardness of a selected group, biocides and highly toxic elements are explored. pH shows hydrogen ion concentration and acidity or alkalinity of water. pH values 9.5 means high alkalinity while values 3 acidity. Values below 4 generally do not affect living things in the marine environment. Drinking water is pH value between 6.5 and 8.5.

Bacteriological Tests detects harmful organisms. All bacteriological analysis examines contamination that could or could not be revealed in a given sample of water using specified culture methods.

Water quality has an effect on the health of users. Therefore, water quality test is important for living things especially human. Generally, man uses water from two water sources: such as surface water and ground water.

### Quality of Surface Water

In the study area, surface water includes river, water rain water and pond. The Ayeyarwady River is the major drainage of the study area. The ward near the river use river water, such as Pyin Ma Chaung, Nyaung Pin, Sagar, Kin, Shwe Ku and Pa Khan. For laboratory test, river water samples of Kin, Sagar and Shwe ku ward were taken on (29-8- 2017). The results are presented in tables (2) and (3). pH value is at the 6.9 (between 6.9 and 9.2) lower than the highest desirable level, but within the maximum permissible level. Appearance result of rain water is clear. pH value is lower than the Highest Desirable Level, but within the maximum Permissible level. Therefore this water is suitable for drinking water but should be drunk after being boiled.

### Quality of Groundwater

Groundwater (shallow well, deep tube-well, hand-dug wells are found in this area. There are (2508) shallow wells, (6423) deep tube wells and (1186) hand-dug well in 2019-2020. The wells depend on effective use on 14788 households and 92021 persons in 2019-2020. However, increased population also used drinking water sufficiently. There is no difficulty for drinking water before monsoon. They can depend on these wells very efficiently. According to test, deep tube-well is clear and bacteriologically safe. The water quality is tested in five wards, such as Mya Wa Di, Ka Naung Su, Thone Pin Kwin, Pa Da Myar and Yone Gyi ward. pH value is lower than the Maximum Permissible level of WHO Standard between 6.5 and 9.2. Quality of ground water indicates that out of 13 chemical and physical properties, the seven chemical properties, pH, total solid, total hardness, total alkalinity, Calcium, Magnesium, Chloride are less than the highest desirable level of the WHO standard. Therefore the properties are used for ground water sources and these are suitable for home consumption, but it should be treated for use as drinking water (Table 4).

Table (2) Water Quality of "Rain Water" in Hinthada Town

No.	Chemical Properties	Result	Highest Desirable Level	Maximum Permissible Level
1	Appearance	Clear		
2	Odor	Nil		
3	Colour (Platinum, Cobalt Scale)	-	5 Unit	50 Unit
4	Turbidity	-	5 NTU	25NTU
5	pH Value	6.9	7.0 to 8.5	6.5 to 9.2
6	Total Solids ppm (mg/l)	159	500 mg/l	1500 mg/l
7	Total Hardness (as CaCO <sub>3</sub> )	40	100 mg/l	500 mg/l
8	Total Alkalinity (as CaCO <sub>3</sub> )	50		
9	Calcium as Ca	16	75mg/l	200 mg/l
10	Magnesium as Mg	2.8	30 mg/l	150 mg/l
11	Chloride as Cl	40	200 mg/l	600 mg/l
12	Sulphate as SO <sub>4</sub>	Nil	200 mg/l	400 mg/l
13	Total Iron as Fe	Nil	0.3 mg/l	1.0 mg/l

REMARKS: pH value is lower than the Highest Desirable Level, but within the maximum permissible level  
Source: YCDC, Health Department, Chemical Water Analysis Report (29.8.2017)

Table (3) Water Quality of "River Water" in Hinthada Town

No.	Chemical Properties	Result	Highest Desirable Level	Maximum Permissible Level
1	Appearance	Turbid		
2	Odor	Soil		
3	Colour (Platinum, Cobalt Scale)	-	5 Unit	50 Unit
4	Turbidity	-	5NTU	25NTU
5	pH Value	6.4	7.0 to 8.5	6.5 to 9.2
6	Total Solids ppm (mg/l)	207	500 mg/l	1500 mg/l
7	Total Hardness (as CaCO <sub>3</sub> )	70	100 mg/l	500 mg/l
8	Total Alkalinity (as CaCO <sub>3</sub> )	50		
9	Calcium as Ca	24	75mg/l	200 mg/l
10	Magnesium as Mg	2.8	30 mg/l	150 mg/l
11	Chloride as Cl	40	200 mg/l	600 mg/l
12	Sulphate as SO <sub>4</sub>	Nil	200 mg/l	400 mg/l
13	Total Iron as Fe	Nil	0.3 mg/l	1.0 mg/l

REMARKS: pH value is lower than the Maximum Permissible level

Source: YCDC, Health Department, Chemical Water Analysis Report (29-8-2017)

Table (4) Water Quality of "Tube Well Water" in Hinthada Town

No.	Chemical Properties	Result	Highest Desirable Level	Maximum Permissible Level
1	Appearance	Clear		
2	Odor	Nil		
3	Colour (Platinum, Cobalt Scale)	-	5 Unit	50 Unit
4	Turbidity	-	5NTU	25NTU
5	pH Value	7.1	7.0 to 8.5	6.5 to 9.2
6	Total Solids ppm (mg/l)	273	500 mg/l	1500 mg/l
7	Total Hardness (as CaCO <sub>3</sub> )	110	100 mg/l	500 mg/l
8	Total Alkalinity (as CaCO <sub>3</sub> )	60		
9	Calcium as Ca	40	75mg/l	200 mg/l
10	Magnesium as Mg	2.8	30 mg/l	150 mg/l
11	Chloride as Cl	60	200 mg/l	600 mg/l
12	Sulphate as SO <sub>4</sub>	Nil	200 mg/l	400 mg/l
13	Total Iron as Fe	Nil	0.3 mg/l	1.0 mg/l

REMARKS: Total Hardness is more than the Highest Desirable, but within the Maximum Permissible level

Source: YCDC, Health Department, Chemical Water Analysis Report (29.8.2017)

For laboratory test result, five water sample from Mya Wa Di, Thone Pin Kwin, Ka Naung Su and Pa Da Myar, Yone Gyi are taken. In the study area, tested results are total solids in highest of the three water sources, total hardness in second step, total alkalinity in the third step, chloride in the fourth step and calcium in the fifth step respectively.

Water causes health problems and hygiene on local people. According to the WHO, about 80% of diseases are related with water. Thus, water use and supply should be promote each household level in this area. The rich mineral ground water especially water containing dangerous elements such as arsenic, lead, etc., affecting human health. Table (6) shows that a



little antimony is found in soils, waters and air. The animals such as, rats, rabbits and dogs suffer diseases. Arsenic is a poisonous and arsenic causes nerve injury and skin damage. Lead is a metal having negative effects on human health. Lead can enter into drinking water through deterioration of pipes. Mercury has an effect on animals' kidney damage. Thallium is a toxic and causes hair loss and kidney damage.

Table (5) Compare Water Quality of "River Water", "Tube Well Water and Rain Water" in Hinthada Town

No.	Chemical Properties	River water	Tube well water	Rain water
1	Appearance	Turbid	Clear	Clear
2	Odor	Soil	Nil	Nil
3	Colour (Platinum, Cobalt Scale)	-	-	-
4	Turbidity	-	-	-
5	pH Value	6.4	7.1	6.9
6	Total Solids ppm (mg/l)	207	273	159
7	Total Hardness (as CaCO <sub>3</sub> )	70	110	40
8	Total Alkalinity (as CaCO <sub>3</sub> )	50	60	50
9	Calcium as Ca	24	40	16
10	Magnesium as Mg	2.8	2.8	2.8
11	Chloride as Cl	40	60	40
12	Sulphate as SO <sub>4</sub>	Nil	Nil	Nil
13	Total Iron as Fe	Nil	Nil	Nil

Source: YCDC, Health Department, Chemical Water Analysis Report (29.8.2017)

Table (6) Water Related to Health Effects

No.	Chemical Properties	Health Effects	No.	Chemical Properties	Health Effects
1	Bromated	Cancer	11	Chromium	Allergic dermatitis
2	Chlorite	Anaemia,* CNS effects	12	Copper	Short term -*** GI
3	HAAS	Cancer	13	Cyanide	Nerve damage, thyroid
4	TTHMs	Liver, kidney,** CNS, Cancer	14	Fluoride	Bone diseases, mottled teeth
5	Antimony	increased cholesterol	15	Lead	Delayed physical, mental development
6	Arsenic	Skin Damage, CVS, Cancer	16	Mercury	Kidney damage
7	Asbestos	being intestinal polyps	17	Nitrites	Infants shortness of breath, blue baby syndrome, death
8	Barium	Increased blood pressure	18	Selenium	Hair loss, finger nail loss, numbness, CVS
9	Beryllium	Intestinal lesions	19	Thallium	Hair loss, changed in blend, kidney, G.I, Liver etc.
10	Cadmium	Kidney damage			

\* Central Nervous System

\*\* Central Vascular System

\*\*\* Gastro Intestinal

Source: National Health Laboratory

## Conclusion

Hinthada Town is located on the western bank of the Ayeyarwady River. Hinthada Town has a large low-lying plain with the mean elevation of 44.3 feet (13.51 m) above sea level. The Ayeyarwady River which serves as the eastern boundary is the major drainage of the study area. The Ayeyarwady River is the main river of the town. The total average rainfall of this region is 2110.34 mm. In Hinthada Town, there is no great problem in water sources and water supply due to abundant rainfall in monsoon period. In Hinthada Town, there are two wards: Ta Ka lay and Ka Naung Su that belong to high daily water consumption group with above 170,000 gallons per day. There are four wards: Nyaung Pin, Pa Be Dan, Thone Pin Kwin and Mya Wa Di wards that belong to moderate daily water consumption group with between 90000 and 170000 gallons per day. Other wards included low daily consumption with less than 90000 gallons per day. Therefore the largest number of population concerns with high consumption daily group in the study area. There was the temporal change in the of water consumption in study area, 1,561,100 gallons in 2010, whereas in 2019 it increased to 1,840,420 gallons. Hinthada Town had increased 15.17 % of total water consumption with temporal change during 10 years period from 2010 to 2019. Water quality from river water and rain water (pH values) are lower than the maximum permissible level. Total hardness of tube-wells is more than the highest desirable level but within the maximum permissible level. In the study area, test results are total solids in the three water sources, total hardness in second step, total alkalinity in the third step, chloride in the fourth step and calcium in the fifth step respectively. To assess the water use and water quality in the urban area of Hinthada Town, river water, rain water and tube well water samples were examined and found to be of generally good quality. At present, water can be used sufficiently for local people. Tube-wells can be found in all the wards. Rain water is used for drinking in the rainy season. Awareness program on water use should be carried out in houses, at schools and town health department of the study area.

## Acknowledgements

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