Analysis and Treatment Studies of Agricultural Drainage Water

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Abstract- In this research, it was preferred to investigate the extent of environmental contamination by water from agricultural sites; the water sample was collected from drainage near paddy fields in Taw-ma village, Singaing Township, Mandalay Region. The sampling, analyzing and treatment process were carried out from 19 July to 5 November 2017 by using Standard analytical methods. Physicochemical properties of water sample such as pH, conductivity, total dissolved solids (TDS), total alkalinity, total hardness and organic pollutants parameters such as dissolved oxygen (DO), chemical oxygen demand (COD) and biochemical oxygen demand (BOD) were analyzed. Determinations of ammonia-nitrogen, nitrate-nitrogen and total phosphate contents were also performed. Moreover, bacteriological examination of collected water sample was done. Some trace elements were screened by using Atomic Absorption Spectrophotometer (AAS). The treatment study was carried out by using adsorbents prepared from biomass waste material (Terminalia chebula Retz.). The effects of adsorbent dosage and contact time on removal of pollutants by adsorption method were investigated after treatment. The removal percent was also calculated. Finding results were compared with water quality standard values that prescribed by WHO and USEPA. The present study results may provide some information on water quality in the drainage of that agricultural environ and also may be a simple solution especially to reduce level of contamination occurred by that agricultural sites.

Indexed Terms- activated charcoal powder, biomass waste products, adsorption, contaminated agricultural water, physicochemical parameters

I. INTRODUCTION

Nowadays, water problems have been one of the focuses of great international concern and debate. Environmental pollution is mainly due to rapid industrialization. It is a matter of great importance due to their toxicity and after effects. In Myanmar, agriculture is the backbone of the national economy. A large amount of fresh water is required in agriculture, but in turn, it contributes to groundwater pollution.

Myanmar Water Vision was formulated in 2003 in cooperation with UNESCAP, FAO and Irrigation Department with the participation of all the stakeholders. It stated that: “By the year 2030, the country will have an attainment of sustainability of water resources to ensure sufficient water quantity of acceptable quality to meet the needs of people of country in terms of health, food security, economy and environment”. It is a demanding problem for maintaining the quality and cleanness of water.

The discharges of industrial and agricultural wastes into aquatic bodies are a great threat to the aquatic life as well as for human health also. Water is a prime natural resource, a basic human need and a precious national asset. All water and water resources, and the beds and banks of watercourses and water bodies, wet lands are vested in the world. Drainage basins and aquifers are the fundamental units of water resources management, because these are where water naturally collects and flows. Water as a resource is one and indivisible: rainfall, river waters, surface ponds and lakes and ground water are all part of one system. Fresh water is a finite and vulnerable resource, essential to sustain all live, human development and the environment, where it is naturally available people have the right to sufficient water for drinking, hygiene, and growing their food. Planning, development and management of water resources need to be cared.

By reducing the ability of water infiltration within soils, severe compaction can increase the amount of run-off of pollutants and synthetic fertilizers. So, agricultural pollution becomes the major concern.

Removal of heavy metal contents and inorganic pollutants from effluents can be achieved by several methods. The recent technologies in use for waste water treatment have many major problems. High cost for construction of waste water treatment plants are highly uneconomical, space wastage, and they are commercially not pleasing in nature, with a much of disposal problems.

These technologies are divided mainly into three major types specifically biological, physical and chemical. Some methods like ion exchange and membrane process are quiet expensive. An alternative method is needed to overcome all these kinds of problems and to treat the waste water in more efficient way.

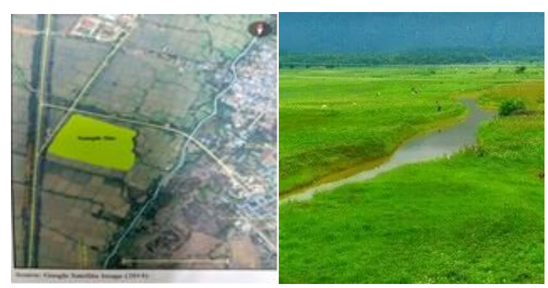
Adsorption is an eco-friendly technique used to treat the agricultural contaminated water. The major advantage of using adsorption technique is that it gives the relevant level of energy saving from much efficient wastewater treatment system that is operating for little hours which is widely attractive because the biomass waste is inexpensive and is widely available. Adsorption process also works at low cost, and there is no need of an additional advanced things requirement. Different adsorbents have been recently used for the removal of heavy metal contents. Few of them are rice straw, wood and bark, tamarind seed, sawdust and rice husk, etc.

This study reveals the significance of using pollution free outlook of low cost adsorbents by adsorption to treat contaminated water sample from selected area.

II. MATERIALS AND METHODS

Study Area: Taw-ma is a village located at Singaing Township, Mandalay Region. Paddy fields are located besides the Yangon-Mandalay high way road. The Zawgyi River passes through from southeast to north direction. Minye canal passes through the eastern side of Kyaukse town. Zeedaw dam is found in Kyaukse town. Water is distributed from this dam for the growing of agriculture products to the fields using canals. The people lives in villages around are predominantly farmers.

(A) Location map of study area



(B) (C)

Figure 1. (A) Location map of study area (B) Google Satellite Image of sample site (C) Photograph of water drainage near paddy field

III. BOTANICAL DESCRIPTION

Figure 2. Terminalia chebula Retz. (Hpan-hka seed)

Botanical name - Terminalia chebula Retz.
Family name - Combretaceae
English name - Myrobalan; Chebulic Myrobalan
Myanmar name - hpan-hka (Phanga)
Parts used - seeds.

The tree of Hpan-hka (Phanga) was found in North India abundantly and throughout Myanmar. The seed was used as a coagulant to purify water (Razia M.et al., 2014).Then it was also used for various medicinal properties in India traditional medicine (Kumar, et al., 2012).

IV. COLLECTION OF WATER SAMPLE

For the purpose of treatment, contaminated water sample was collected from water drainage near paddy field in October, 2017 that is situated at Taw-ma village, Singaing Township, Mandalay Region by using clean new plastic container which was covered with black polyethene bag to prevent growth of Algae. The guidelines for water sampling is based on the document "Guide Manual: Water and Wastewater Analysis" and analyzing methods used for various parameters were applied by using appropriate Standard methods (APHA, 21st Edition, 2005). The DO (dissolved oxygen) and BOD (biochemical oxygen demand) were determined immediately after sampling and the sample was stored and used throughout the research.

V. COLLECTION OF TERMINALIA CHEBULA RETZ. (HPAN-HKA SEED)

The seeds were collected from Kalay University Campus, Kalay Township, Sagaing Region to use as adsorbents for water treatment.

a. Preparation of Adsorbents

Seed Powder: The Seeds were dried and grounded to a fine dried and grounded to a fine powder using electric blender. The resulting powder was sieved by using 80-100 mesh size sieves. The obtained seed powder was placed in the plastic bottle and used throughout the experiment.

b. Charcoal Powder of T.chebula Seed (hpan-hka):

The seeds were dried and placed in dried and placed into the crock pot. The charcoal powder was made by heating in anaerobic condition until the charcoal was obtained and crushed to form powder. The resulting charcoal powder was sieved by using 80-100 mesh size sieves. Then obtained charcoal powder was placed in the plastic bottle and used throughout the experiment.

c. Activation of T.chebula Charcoal:

Charcoal powder was treated with dil.H_2SO_4 (acid: H_2O is 1:2 v/v) at 90˚C for 1hr and then the product was cooled at room temperature. It was filtered then washed with distilled water and 1% $NaHCO_3$ solution until the neutral colorless solution was obtained. It was filtered then dried under sunlight for 24hr and then sieved by 80-100 mesh size sieves. The obtained activated charcoal powder was placed in the plastic bottle and used throughout the experiment.

d. Physicochemical Analysis before Treatment

Some physicochemical parameters were analyzed and calculated in this research including pH by the use of a pH meter, Electrical conductivity (EC) by the use of a conductivity meter, total dissolved solids (TDS) by using oven drying method, total alkalinity (TA) and total hardness (TH) by using titration methods, dissolved oxygen (DO) by Winkler's method and biochemical oxygen demand (BOD) by Incubation method(Hooda and Kaur,1999) and chemical oxygen demand (COD) value by using method of permanganate titrimetric analysis(APHA, 1998). Ammonia-nitrogen, nitrate-nitrogen and total phosphate contents were measured by MD 600

(Lovibond) at Amtt Co., Ltd in Yangon. Moreover, bacteriological examination was also made to assess the bacteriological quality of collected water sample. Some trace elements were screened by using Atomic Absorption Spectrophotometer (AA-6300 SHIMADZU). The results are shown in Tables (1, 2, 3 and 4).

VI. TREATMENT OF CONTAMINATED WATER BY ADSORPTION METHOD

The treatment of contaminated water was done based on the effect of adsorbent dose and the effect of contact time.

a. Effect of Adsorbent Dose

The seed powder, charcoal powder and activated charcoal powder adsorbents of various masses (3, 5, 7and 9) g/L were placed in the flasks and 100 ml of contaminated water sample was added to each flask. And then the flasks were shaken at 300 rpm for one hour and then the solution was filtered. Treated water sample was measured for parameters such as TDS, nitrate nitrogen and total phosphate contents, BOD and COD, potassium content and for bacteriological examination. And then the data were calculated to obtain percent removal results. The resulting data were presented in Tables (5, 6, 7, 8, 9 and 10).

b. Effect of Contact Time

The seed powder, charcoal powder and activated charcoal powder adsorbents 5 g/L were placed in the separate flasks and 100 ml of the water sample was added to each flask. And then the flasks were shaken at 300rpm for varied contact time intervals of 1hour, 2 hour and 3 hour then the solution was filtered. Treated water sample was measured for parameters such as TDS, nitrate nitrogen and total phosphate contents, BOD and COD, potassium content and for bacteriological examination. And then the data were calculated to obtain percent reducing results. The resulting data were presented in Tables (11, 12, 13, 14, 15, 16 and 17).

VII. RESULTS AND DISCUSSION

a. Physicochemical Properties of Water Sample before Treatment

The water sample was collected from selected area of agricultural drainage near paddy field. The physicochemical properties of water sample such as pH, conductivity, total dissolved solids (TDS), total alkalinity, total hardness and ammonia-nitrogen, nitrate-nitrogen and total phosphate contents were examined. The results were tabulated in Table (1).

Table (1) Physicochemical Properties of Water Sample before Treatment

No	Parameters (units)	Water Sample	WHO Std.*	EPAStd**
1.	pH	7.6	6.5-8.5	6.5-8.5
2.	Conductivity(µS/cm)	487	400	-
3.	TDS (mg/L)	840	500-1500	500
4.	Total alkalinity(mg/L)	350	200-500	-
5.	Total hardness(mg/L)	340	200	-
6.	Ammonia nitrogen(mg/l)	0.5	0.5	0.5
7.	Nitrate-nitrogen(mg/L)	7.6	1.0	1.0
8.	Total Phosphate(mg/L)	3.1	0.02	0.12

*World Health Organization drinking water standard limits of maximum acceptable concentration to maximum allowable concentration

**Environmental Protection Agency standard limits of maximum allowable concentration

According to these data, total dissolved solids, nitrate-nitrogen and phosphate content were found to be higher values than the standard safe limits.

b. Organic Pollutants of Water Sample before Treatment

The organic constituents of water sample such as dissolved oxygen, biochemical oxygen demand and chemical oxygen demand were also determined. The results are shown in Table (2).

Table (2) Organic Pollutants of Water Sample before Treatment

Parameters	Water Sample	WHO Std.*	EPA Std.**
DO (mg/L)	3.1	$\geq$ 5	4 - 6
BOD (mg/L)	10.5	< 5	-
COD (mg/L)	23.8	< 10	-

According to this table, the lower value of DO was observed. DO values show that the water is fresh or not. There are many disadvantages of lower value in dissolved oxygen. The DO value of water sample has not good match with standard limit. Also from the determination of BOD and COD results, the values were above standard limit.

c. Bacteriological Examination of Water Sample before Treatment

The bacteriological examination of waste water sample was examined and the result was shown in Table (3). The bacteriological analysis of water is to determine its portability. E-coli can thus serve as very good indicator organisms and tests are practically run to determine their presence. By looking for their presence, it may be interpreted a margin of safety or not. The bacteriological analysis involves the following tests (1) A quantitative test for all coli-form bacilli (probable count) (2) A differential E-coli test. In the present examination, the counts of coli form organisms and E-coli of the sample were determined.

Table (3) Bacteriological Examination of Water Sample before Treatment

Parameters	Water Sample	WHO std*.	EPA std**.
E-coli	isolated	ND	ND
Probable Coli form Count	5/5	0	0

According to these data, E-coli were isolated .Therefore, from the point of view of bacteria, it was found to be unsatisfactory. This water sample should be treated with appropriate technique before use (ND= not detected).

d. Trace Elements of Water Sample before Treatment by AAS analysis

Table (4) Trace Elements of Water Sample before Treatment

Element	Symbol	Water Sample (mg/L)	US.EPAMCL* (mg/L)
Potassium	K	7.92	0.05
Copper	Cu	0.02	1.00
Iron	Fe	Nil	-

*US.EPA (MCL) = United States Environmental Protection Agency (Maximum Contaminant level)

From these results, potassium content was found to be higher in agricultural contaminated water sample collected from water drainage near paddy field. These are recognized as nutrients required for animal and plant life and are also essential at low levels but toxic at higher levels.

e. Treatment by Adsorption Method

According to the results obtained from various parameters of water analysis, the water sample collected from water drainage near paddy field located at Taw-ma village, Singaing Township was found to be contaminated. Treatment of this agricultural water sample was carried out by adsorption method with adsorbents such as seed powder, charcoal powder and activated charcoal powder based on the effect of adsorbent dose and the effect of contact time.

f. Effect of Adsorbent Dose

As presented in the experimental works, the prepared adsorbents were used for the determination of percent removal of contaminants such as TDS, nitrate nitrogen, total phosphate, BOD, COD and potassium content from water on the effect of adsorbent dose.

Calculation of percent removal

% removal =A- B/ A x 100

Where, A = before treatment result, B = after treatment result

Table (5) Percent Removal of TDS

Dosage amount (g/L)	Before treatment= 840 (mg/L)			% removal of TDS		
	After treatment (mg/L)					
	Seed powder	Charcoal	Activated charc	Seed po	Charcoal	Activated

		powder	oal powder	wder	powder	charcoal powder
3	674	608	540	19.76	27.61	35.71
5	659	586	534	21.54	30.23	36.42
7	659	586	534	21.54	30.23	36.42
9	659	586	534	21.54	30.23	36.42

Table (5) shows the % removal of TDS by adsorbents with various doses at shaking time 1 hour. The removal percent was increased from 19% to 21%, 27% to 30% and 35% to 36% with increase in dose of seed powder, charcoal powder and activated charcoal powder from 3g/L to 9g/L, respectively.

Table (6) Percent Removal of nitrate-nitrogen

Dosage amount (g/L)	Before treatment= 7.6 (mg/L)			% removal of NO_3^{2-} N		
	After treatment (mg/L)					
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
3	5.58	4.54	4.43	26.57	40.26	41.71
5	5.47	4.50	4.30	28.02	40.78	43.42
7	5.48	4.49	4.30	27.89	40.80	43.42
9	5.48	4.49	4.30	27.89	40.80	43.42

Table (6) shows the % removal of nitrate-nitrogen by adsorbents with various doses at shaking time 1 hour. The removal percent was increased from 27% to 28%, 40% to 41% and 42% to 43% with increase in dose of seed powder, charcoal powder and activated charcoal powder from 3g/L to 9g/L, respectively.

Table (7) Percent Removal of Phosphate

Dosage amount (g/L)	Before treatment= 3.1(mg/L)			% removal of PO_4^{3-}		
	After treatment (mg/L)					
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
3	2.74	2.61	2.60	11.61	15.80	16.12
5	2.70	2.41	2.39	12.90	22.25	22.90
7	2.71	2.42	2.40	12.58	21.93	22.58
9	2.71	2.42	2.40	12.58	21.93	22.58

Table (7) shows the % removal of Phosphate by adsorbents with various doses at shaking time 1 hour. The removal percent was increased from 12% to 13%, 16% to 22% and 16% to 23% with increase in dose of seed powder, charcoal powder and activated charcoal powder from 3g/L to 9g/L, respectively.

Table (8) Reduction Percentage of BOD

Dosage amount (g/L)	Before treatment= 10.5(mg/L)			% reduction of BOD		
	After treatment (mg/L)					
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
3	8.70	6.95	5.96	17.14	33.80	43.23
5	8.69	6.85	5.80	17.23	34.76	44.76
7	8.70	6.86	5.80	17.14	34.66	44.76
9	8.70	6.86	5.80	17.14	34.66	44.76

Table (8) shows the % reduction of BOD by adsorbents with various doses at shaking time 1 hour. The reducing percent was increased from 17.14% to 17.23%, 34% to 35% and 43% to 45% with increase in dose of seed powder, charcoal powder and activated charcoal powder from 3g/L to 9g/L, respectively.

Table (9) Reduction Percentage of COD

Dosage amount (g/L)	Before treatment= 23.8(mg/L)			% reduction of COD		
	After treatment (mg/L)					
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
3	19.61	17.97	16.39	17.60	24.49	31.13
5	19.50	17.88	16.27	18.06	24.87	31.63
7	19.58	17.89	16.27	17.73	24.83	31.63
9	19.58	17.89	16.27	17.73	24.83	31.63

Table (9) shows the % reduction of COD by adsorbents with various doses at shaking time 1 hour.

The reducing percent was increased from 17% to 18%, 24% to 25% and 31% to 32% with increase in dose of seed powder, charcoal powder and activated charcoal powder from 3g/L to 9g/L, respectively.

Table (10) Percent Removal of Potassium

Dosage amount (g/L)	Before treatment= 7.92 (mg/L) After treatment (mg/L)			% removal of Potassium		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
3	5.86	3.59	3.37	26.01	54.67	57.44
5	5.79	3.47	3.26	26.89	56.18	58.83
7	5.80	3.50	3.26	26.76	55.80	58.83
9	5.80	3.50	3.29	26.76	55.80	58.45

Table (10) shows the % removal of Potassium by adsorbents with various doses at shaking time 1 hour. The removal percent was increased from 26% to 27%, 54% to 56% and 57% to 59% with increase in dose of seed powder, charcoal powder and activated charcoal powder from 3g/L to 9g/L, respectively.

According to these results, it can be attributed that activated charcoal powder can effectively reduce and remove pollutants than charcoal and seed powder from agricultural waste water at optimum adsorbent dosage of 5g/L.

e. Effect of Contact Time

The prepared adsorbents were used for the determination of percent removal of pollutants such as TDS, nitrate nitrogen, total phosphate, BOD, COD and potassium content from waste water on the effect of contact time.

Table (11) Percent Removal of TDS

Time (hr)	Before treatment= 840(mg/L) After treatment (mg/L)			% removal of TDS		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
1	659	586	534	21.54	30.23	36.42
2	654	579	529	22.14	31.07	37.02
3	654	579	530	22.14	31.07	36.90

Table (12) Percent Removal of nitrate-nitrogen

Time (hr)	Before treatment= 7.6(mg/L) After treatment (mg/L)			% removal of nitrate-nitrogen		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
1	5.47	4.50	4.30	28.02	40.78	43.42
2	5.39	4.43	4.20	29.07	41.71	44.73
3	5.40	4.43	4.21	28.94	41.71	44.60

Table (13) Percent Removal of Phosphate

Time (hr)	Before treatment= 3.1(mg/L) After treatment (mg/L)			% removal of Phosphate		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
1	2.70	2.41	2.30	12.90	22.25	22.90
2	2.65	2.35	2.24	14.51	24.19	27.74
3	2.67	2.36	2.24	13.87	23.87	27.74

Table (14) Reduction Percentage of BOD

Time (hr)	Before treatment= 10.5(mg/L) After treatment (mg/L)			% reduction of BOD		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
1	8.69	6.85	5.80	17.23	34.76	44.76
2	8.67	6.82	5.77	17.42	35.04	45.04
3	8.67	6.82	5.77	17.42	35.04	45.04

Table (15) Reduction Percentage of COD

Time (hr)	Before treatment= 23.8(mg/L) After treatment (mg/L)			% reduction of COD		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
1	19.50	17.88	16.27	18.06	24.87	31.63
2	19.39	17.70	16.10	18.52	25.63	32.35
3	19.39	17.70	16.11	18.52	25.63	32.31

Table (16) Percent Removal of Potassium

Time (hr)	Before treatment= 7.92(mg/L) After treatment (mg/L)			% removal of Potassium		
	Seed powder	Charcoal powder	Activated charcoal powder	Seed powder	Charcoal powder	Activated charcoal powder
1	5.79	3.47	3.26	26.89	56.18	58.83
2	5.60	3.32	3.12	29.29	58.08	60.60
3	5.61	3.33	3.12	29.16	57.95	60.60

Tables of (11, 12, 13, 14, 15 and 16) show the percent removal of TDS, nitrate nitrogen, Phosphate, BOD, COD and Potassium by adsorbents with various contact time from 1 hour to 2 hour to 3 hour. According to these results, the maximum percent removals by adsorbents were reached within 2 hour to 3 hour. After 2 hour shaking, the reducing percents were nearly constant. And then it observed that percent removal pollutants for 2 hour by activated charcoal were found to be higher than other two adsorbents of optimum dosage 5g/L.

h.Bacteriological Examination of treated water sample

Bacteriological examination of treated water samples of optimum adsorbent dose 5g/L at contact time for 2 hr were examined. The results were shown in Table (17).

Table (17) Bacteriological Examination

Parameter	Seed powder	Charcoal powder	Activated charcoal powder	WHO std*.	EPA std**.
E-coli	isolated	isolated	isolated	ND	ND
Probable Coli form Count	4/5	3/5	3/5	0	0

ND=not detect

According to these data, E-coli were isolated in all treated water samples. Therefore, it was found to be further treatment by using more effective adsorbents.

VIII. CONCLUSION

In this research work, the physicochemical characteristic properties of agricultural drainage water collected from paddy field drainage were analyzed. The water treatment process was performed by using adsorption method. The quality of agricultural drainage water sample was observed to be changed after the treatment with adsorbents such as seed powder, charcoal powder and activated charcoal powder of the Terminalia chebula Retz. (hpan-hka seed). Before treating, the results of total dissolved solids, nitrate-nitrogen content, phosphate content and organic pollutant parameters such as biochemical oxygen demand and chemical oxygen demand were found to be higher than the standard safe limits. The result of bacteriological examination was also unsatisfactory remark. The potassium content was also higher than the maximum contamination limit level. From the studies on the effect of dosage and effect of contact time with adsorbents, it can be seen that the optimal reducing percent of contaminants in dosage amount was 5g/L and contact time was 2hr. Among three prepared adsorbents, the acid activated charcoal powder of Terminalia chebula Retz.seed was found to be effectively reduced contaminants followed by charcoal and seed powder respectively. Therefore, adsorbent of activated charcoal seed powder can adsorb more than charcoal and seed powder adsorbents. The present study revealed that the adsorption increases with increase in contact time and is dependent on the dosage of adsorbents. From the experimental data, the conclusion can be drawn that the prepared low cost adsorbents from biomass waste material like hpan-hka seed are suitable for the removal of contaminants in agricultural drainage. These research finding may be an answer to solve the problem related to the agricultural wastewater pollution in rural area.

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REFERENCES

[1] American Public Health Association (APHA), (1998), "Standard Methods for the Examination a of Water and Wastewater", American Water Works Association, 20th Edn., Washington, 12-96

[2] United States Environmental Protection Agency (USEPA) (2005), "National Mauna gem Measures to Control Non-point Source Pollution from Urban Areas."Chapters 7 and 8. Document No. EPA 841-B-05-004. November, 128-154

[3] WHO Geneva, (2008), Guidelines for drinking-water quality (electronic resource), 3rd edition incorporating 1st and 2nd addenda, Volume 1, Recommendations.

[4] Ademorati. M. A. (1996). Standard Methods for water and effluent analysis. Foludex Press Ltd, Ibadan. 1st ed. Pp 80-83.

[5] (USEPA) (2005) "Protecting Water Quality from Agricultural Runoff". Fact sheet No.EPA-841-F-05-001.March, 4-8.

[6] Zaw Moe Oo, Win Aung, Thida and Kyaw Naing (2015). ``Investigation of Sea Water Quality around the Kyaikkhami Coastal Area, Myanmar", Chemical Bulletin, Issue No., March 2015, Department of Chemistry, University of Yangon.

[7] Arthur Coterell (1980). The Encyclopedia of Ancient Civilllisations. Rainbird Publishen.pp.176-178.

[8] United States Geological Survey, Denver, C.O. (USGS) (1998). Ground Water and Surface Water: A Single Resource." Circular 1139.

[9] V. Simonov, J.A. Straits, C. Smarted al, (2003), "Assessment of the Surface Water Quality in Northern Greece," Water Research, vol.37, no.17, pp. 4119-4124

[10] Online materials

http://www.freedrinkingwater.com/watereducation

http://www.google.com

http://www.Sciencedirect.com/science

http://en.wikipedia.org/wiki