Available online at **www.joac.info**

ISSN: 2278-1862

Journal of Applicable Chemistry

2019, 8 (4): 1586-1591

(International Peer Reviewed Journal)

Hydro Chemical Characterization and Study of Underground Contamination of Different Water Sources of Warf Road East Godavari Area-AP, India

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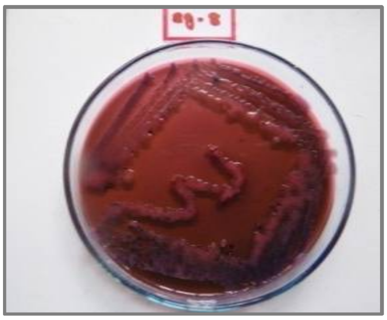
ABSTRACT

he present study of physicochemical characteristics and heavy metal levels in water samples obtained from different sample locations. People on globe are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of air, water and soil. Due to increased human population, industrialization, use of fertilizers and man-made activity water is highly polluted with different harmful contaminants. Natural water contaminates due to weathering of rocks and leaching of soils, mining processing etc. The availability of suitable quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different physico-chemical parameters such. The evaluation was done by the hydro chemical metals characterization by measure of contamination levels with the ground waters. The purposes of this study are, specifying spatial distribution of groundwater quality parameters such as Temperature, pH, Electrical conductivity, TDS, TA, pH, Hardness, chloride, nitrate and sulphate. The research results reveals that their common origin, especially from industrial effluents and municipal wastes that are responsible for the enhancement of chemical components moving together in groundwater higher values of physicochemical parameters reveal the anthropogenic sources of these variables. The high concentration of parameters in groundwater water may cause serious threat to public health as well as the aquatic environment.

Graphical Abstract



Enterobacter, Klebsilla

Keywords: Suitability, Tremendous Chemical, Toxicity, Characterization, Environment.

INTRODUCTION

Groundwater is also termed as subsurface water. Water is a wonder of the nature. *"No life without water"* is a common saying depending upon the fact that water is the one of the naturally occurring essential requirement of all life supporting activities. All living organisms on the earth need water for their survival and growth subsurface waters have long been considered as the purest form of water available in nature which can meet the overall demand of rural and semi urban people. Water is essential for all dimensions of life. Over the past few decades, utilization of water has increased and in many places water availability is falling to crisis levels. More than 50% of the world population depends on groundwater for drinking.

More than 80 countries with 40% of world's population are already facing water shortages. The quality of water in rivers and underground has deteriorated, due to pollution by waste and contaminants generated from cities, industry and agricultural and aqua cultural activities. Ecosystems are also being destroyed. Over one billion people lack of safe water while 3 billion lack sanitation and 80% of infectious diseases are water borne and killing millions of children each year. Ground water accounts for half of the drinking water. This resource is susceptible to contamination from many sources which include septic system, infiltration of industrial run off, landfills and irrigation return flows and among which agriculture is a major source of pollution. Agricultural activities contribute many pollutants to the environment such as phosphates, herbicides, pesticides, nitrates and bacteria. Nitrates and pesticides are common contaminants of ground water derived from agricultural runoffs and irrigation return flows. Once undesirable constituents enter the ground, it is difficult to control their dissolution. The chemical characteristics of ground water play an important role in assessing the water quality. Water has always been a very precious resource. Water resources are sources of water that are potentially useful. 97 percent of the water on the Earth is salt water and only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps [1]. The remaining unfrozen fresh water is found mainly as groundwater or subsurface water with only a small fraction present above ground or in the air [2].

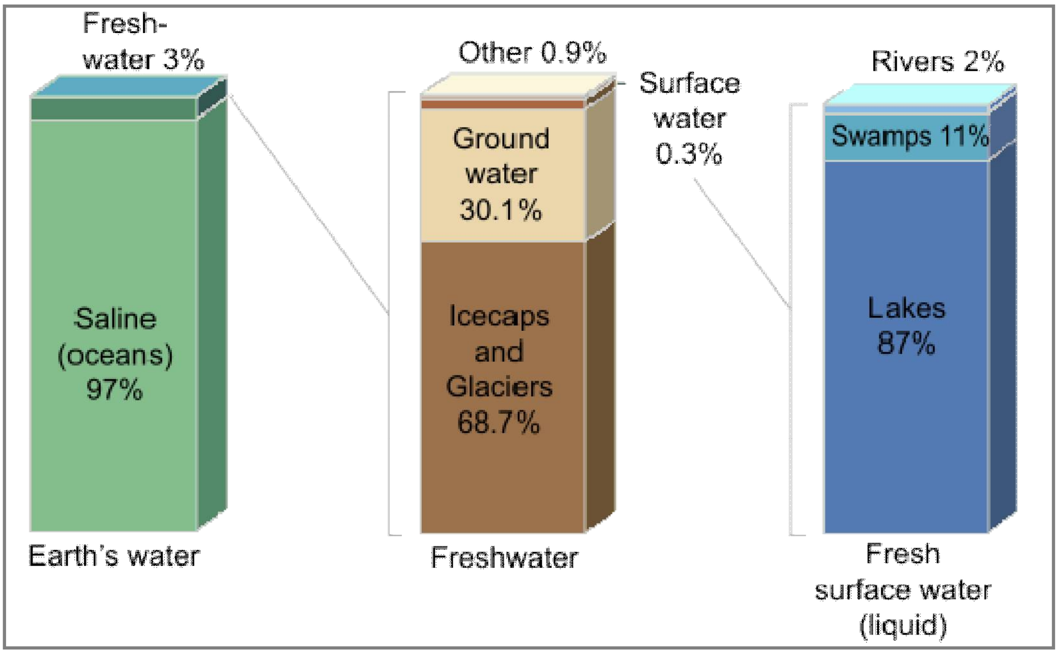


Figure 1. Earth's water distribution, 2009 [1] and Scientific Facts on Water, 2008 [2].

Fresh water is a renewable resource, yet the world's supply of groundwater is steadily decreasing, with depletion occurring most prominently in Asia and North America, though it is still unclear how much natural renewal balances this usage and whether ecosystems are threatened [3]. Sub-surface water can be thought of in the same terms as surface water: inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, subsurface water storage is generally much larger compared to inputs than it is for surface water. This difference makes it easy for humans to use sub-surface water unsustainably for a long time without severe consequences. It is estimated that 8% of worldwide water use is for household purposes, 22% of worldwide water is used in industry and 70% of worldwide water use is for irrigation, with 15-35% of irrigation withdrawals being unsustainable [4]. It takes around 2000-3000 litres of water to produce enough food to satisfy one person's daily dietary need [5]. Ground water is of major importance in providing the mains water supply, and is intensively exploited for private, domestic and industrial use in many urban centers of the developing world. At the same time, the subsurface waters have come to serve as the receptor for much urban and industrial wastewater and for solid waste disposal [6]. It is estimated that more than 1 billion urban dwellers in Asia and 150 million in Latin America probably depend directly or indirectly upon well, spring and borehole sources [6].

Subsurface or ground water's quality will be affected by several factors like discharge of agricultural, domestic and industrial wastes, land use patterns, geological formation, rainfall pattern and infiltration rate in an area [7]. As subsurface water moves along flow lines from recharge to discharge areas, its chemistry is altered by the effect of a variety of geochemical processes [8]. Twenty representative ground water samples were collected from 20 locations around selected study area in East Godavari reason respectively following the standard procedures of sampling and the details of Sample code, location and source type presented in table 1.

MATERIALS AND METHODS

Polythene containers were employed for sampling and preserved for analysis by following the standard procedures [9]. The samples were analysed for physicochemical parameters which include pH, Electrical conductivity (EC), Total Dissolved solids (TDS), Total Alkalinity (TA), Total hardness (TH), Chloride, Sulphate and Nitrate. pH determined by pH meter (Global-DPH 505, India-Model) and Conductivity measured by the digital Conductivity meter (Global-DCM-900-Model). TDS is determined from the relation TDS=Electrical conductivity (EC)×0.64. Chloride, TH, TA and Chloride are estimated by titrimetry. Sulphate, nitrate by Spectrophotometer (Model-167, Systronics), Na^+ and K^+ by Flame Photometer (Model-125, Systronics).

Twenty representative ground water samples were collected from 20 locations around selected study area in East Godavari reason respectively following the standard procedures of sampling and the details of sample code, location and source type presented in table 1.

Table 1. Sampling Locations and from the source

S.No	Sample locations	Sample sources	S.No	Sample locations	Sample sources
GW-1	GGH Canteen	BW	GW-11	Warf road street No.2	BW
GW-2	Sub-Jail office	BW	GW-12	Vempati street	BW
GW-3	Warf road street No.8	OW	GW-13	Near old bus stand backside	BW
GW-4	Prezarupeta street No.1	BW	GW-14	Old bus stand backside	BW
GW-5	Zillah parishad	BW	GW-15	GGH backside	OW
GW-6	Warf road street No.7	BW	GW-16	Rangayya Naidu street	BW
GW-7	Warf road street No.6	BW	GW-17	Gandhinagar	BW
GW-8	Old bus stop	OW	GW-18	Ramaraopet	OW
GW-9	Temple street	BW	GW-19	Sub-Jail backside	BW
GW-10	Prezanupeta street No.3	OW	GW-20	AmbedkarBhavan	BW

OW=Open well BW= Bore well

Microbial Analysis: The ground water samples collected in sterilized containers (E.K. Lipp., *et al.*, 2001) are immediately processed for analysis for determining the MPN count and for detecting the bacterial species [10]. The Most Probable Number (MPN) technique has been employed for the

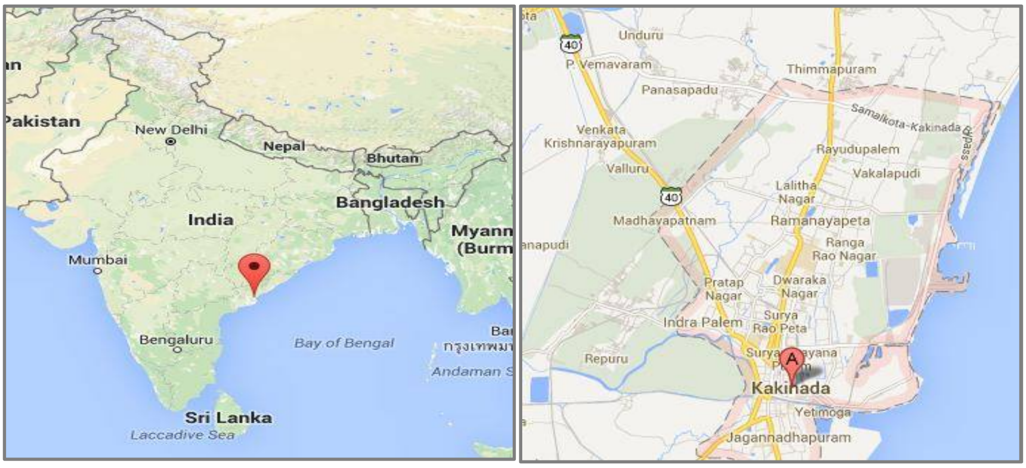


Figure 2. Satellite pictures of the study area.

enumeration for the *Coliform* count in water samples [**11, 12**], which involved the presumptive test using lactose broth and Nutrient Agar, confirmatory test using Eosin Methylene Blue (EMB) agar. Pure colonies isolated were subjected to grams stain, motility, Indole, Methyl red, Voges-Proskuer tests, Citrate utilization test, Urease test, Catalase and Oxidase test [**13**].

RESULTS AND DISCUSSION

pH: pH of ground waters range from 6.47-8.95 it indicates the slight alanine nature and it majority of water is in the range of drinking water standards (Table 2).

EC: EC of ground waters ranges from 416-5983 µmhos cm^{-1}. EC of Samples GW-2, 8, 9, 13, 17 and GW-19 respectively found to be higher. Higher EC indicates the saline nature of waters in the study area and the solid content impact on ground water in enhancing the EC value in the respected study area locations.

TDS: TDS of sample locations it ranges from 223-3829 mg L^{-1}. TDS is higher in GW-2, 8, 9, 13, 14, 17 and GW-19 indicating the presence of soluble solid matter in ground water. Higher TDS indicate the depletion of ground water.

TA: Total alkalinity of waters its ranges from170-550 mg L^{-1}. TA is higher in GW-1, 8, 9 and 19 indicating the change of taste of waters in the study area location and basic components has impact only in locations GW-1, 8, 9 and in the remaining locations it is absent.

TH: TH of ground waters ranges from 182-975 mg L^{-1} in ground waters. All the values crossed the permissible limit of 300 mg L^{-1} except in water of sample -6, 9, 10, 14, 15 and 19. Higher values of Total Hardness indicate the encrustation nature of water in the study area.

Chloride: Chloride ion concentration in study area locations ranges from 141.8-737.05 mg L^{-1}. Chloride levels are higher in all samples of ground water indicating the corrosive nature of waters. Influence of pollutants on ground waters is present on water samples of GW-2, 4, 8, 14 and 19 sampling locations.

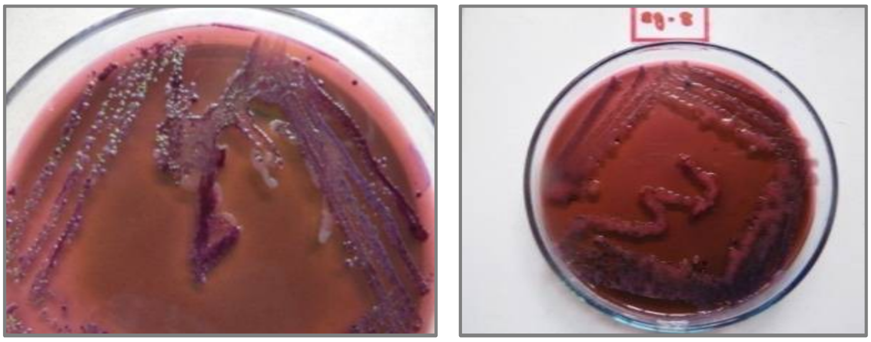
Nitrate: Nitrate levels in ground water samples ranges from 10-100 mg L^{-1} nitrate levels crossed the permissible limit (45 mg L^{-1}) of drinking waters only in sample 3, 8, 12 and 15 in other water samples it is within the permissible limit. Higher levels indicate the possibility of discharge of agriculture runoff in to the waters source in 3, 8, 12 and 15 sample locations.

Table 2. Hydro chemical parameters of Sampling Locations from the study area

S.No	pH	EC	TDS	TA	TH	Chloride	Nitrate	Sulphate
GW-1	7.13	890	570	430	403	141.8	10	107
GW-2	7.10	3872	1198	370	813	319.05	20	241
GW-3	7.08	1520	973	420	605	212.7	50	193
GW-4	6.99	1727	1105	440	520	248.15	40	186
GW-5	7.29	646	413	380	975	177.25	20	53
GW-6	7.41	416	266	190	182	177.25	10	163
GW-7	7.34	1076	689	330	338	212.7	05	86
GW-8	8.41	2637	1048	580	650	283.6	100	417
GW-9	8.47	3480	223	460	215	248.15	30	124
GW-10	7.10	988	632	360	715	177.25	05	130
GW-11	7.28	1506	964	320	830	248.15	05	143
GW-12	6.47	864	553	210	780	283.6	50	215
GW-13	7.10	5983	3829	290	445	737.05	05	449
GW-14	7.05	1650	1056	310	280	319.05	10	116
GW-15	7.17	1403	898	170	307	283.6	50	183
GW-16	7.44	921	589	360	500	283.6	05	195
GW-17	6.54	2180	1395	390	255	177.25	05	180
GW-18	7.03	1046	669	260	406	42.54	10	56
GW-19	8.95	3850	2464	550	848	248.15	20	387
GW-20	7.7	1032	660	287	534	198.23	30	58

Sulphate: Sulphate ion concentration levels in ground waters ranges from 56-449 mg L^{-1}. All the values are within the permissible limit of drinking water standard (350 mg L^{-1}) indicating the non discharge of effluent in to water sources. Higher value of Sulphate ion concentration in sample locations GW-8, 13 and 19 revealed the discharge of contaminated water from municipal waste.

Microbial species: The waters are observed with *E.coli* which indicates the microbial contamination of eaters in the study area. The waters are further analyzed for bacterial species and the presence of the pathogenic Bacteria Viz., *E.coli*, *Enterobacter*, *Klebsilla*, can cause water borne diseases and show impacts on human health. The images of *bacterial species* identified in water samples are represented in figure 3a and 3b.



3a . *E.coli, Enterobacter, Klebsilla* **3b.** *Enterobacter, Klebsilla*

Figure 3. Images of bacterial observations in ground water samples.

APPLICATION

The results of the chemical analysis indicate chemical contamination of ground water of sampling sites conforming the waters unsuitability of these waters are drinking are domestic purposes. The results of microbial analysis are clearly indicating the bacterial contamination of waters with pathogenic bacteria species like *E.coli. Proteus*, *Enterobacter*, *Klebsilla*, which can cause water borne disease.

CONCLUSION

pH values of waters are within the permissible limit of drinking water standards. Higher values of EC and Chloride in majority of samples indicate the saline nature of waters. Higher values of TDS in majority water samples indicate the presence of soluble solids in ground waters. Higher values of TA in water samples can change the taste of the waters. Higher values of Chloride concentration in water samples is due to the bleaching process of effluent during treatment and its impact on ground waters of very nearby locations to the industrial unit. The parametric values of Sulphate are within the permissible value of drinking water standards higher values of Sulphate indicate the discharge of municipal waste in to waters. Higher levels nitrate indicate the possibility of discharge of agriculture runoff in to the waters source in the study area. The presence of MPN count indicate the microbial contamination of waters and the presence of pathogenic bacteria species viz., *Klebsilla, Enterobacter* cause water borne diseases, if these waters are consumed for drinking purposes. The research results revealed that the ground waters in the study area are chemically and microbially contaminated. Hence the waters are to be treated properly before considering the waters for use for drinking or domestic purposes.

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