PalArch's Journal of Archaeology of Egypt / Egyptology

GROUND WATER QUALITY ASSESSMENT OF CUDDALORE DISTRICT, TAMILNADU, INDIA

GUNASELVI SHUNMUGAM [1]* MOHAMMED SALEH NUSARI [2] VASANTHY MUTHUNARAYANAN [3]

[1]*Post Doctoral Fellowship in Civil Engineering, Lincoln University College, Malaysia.
[2]Lincoln University College, Malaysia.
[3]Department of Environmental Biotechnology School of Environmental Sciences, Bharathidasan University, Tiruchirapalli – 620 024, Tamil Nadu, India

GUNASELVI SHUNMUGAM [1]* MOHAMMED SALEH NUSARI [2] VASANTHY MUTHUNARAYANAN [3]. GROUND WATER QUALITY ASSESSMENT OF CUDDALORE DISTRICT, TAMILNADU, INDIA– Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(12). ISSN 1567-214x

Key words: Water quality, Cuddalore District.

ABSTRACT

Water covers 70.9% of the Earth's surface, and is vital for all known forms of life. On Earth, 96.5% of the planet's water is found mostly in oceans; 1.7% in groundwater; 1.7% in glaciers and the ice caps of Antarctica and Greenland; a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds formed of solid and liquid water particles suspended in air, and precipitation. Only 2.5% of the Earth's water is fresh water, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products.

INTRODUCTION

Water is an important condition, in fact a sign for the tolerance of the human race. Adequate supply of fresh and certain water is essential for the development of popular well-being. The well-being risks added by the very sparsely formed parts of the arena, and especially by tropical areas and using large, contaminated water components, are more diverse and more honest than regions created from light and additional arenas. Water for home use should be clear, pale, ascented, palatable to drink and free from significant cold and hazardous impurities for well-being. It is so great that human well-being and sustainability are based on the use of clean, uncontrolled water for drinking and various local jobs. But, our fashionable masses continue to have access to this precious asset. The helpless water supply structure has affected human health in special areas from the beginning. Water is the regular name for applying the conditions of liquid composition of a combination of hydrogen and oxygen H2O. Pure water is odorless, stupid and pure. Water is nature's greatest benefit

to mankind. Essential for life, male or female resistance depends on water consumption. Exceptions Water is the most essential additive for well-being.

Food combinations and take-offs continue to oxygenate legitimate muscle tone resources, and cell supplements are crucial to freeing up the accumulation of spenders and filling it with a unique cooling frame. The welfare government emphasizes the importance of consuming eight glasses of fresh water every day to maintain incredible health.

This water particle carries one oxygen molecule and two hydrogen molecules connected by covalent bonds. Water is a fluid in the surrounding conditions, but it often coincides with its strong state, ice, and volatile nation (water smoke or steam) on this planet. Water is similarly present in a liquid value stone state near hydrophilic surfaces. Henniker, (1949). Beneath the terminology used to name mixtures of substances, dihydrogen monoxide is the logical name for water, although it is my in the way Bramer, (2011) is used.

Water is a substance compound with a synthetic equation of H2O. The water molecule carries oxygen and hydrogen atoms connected by covalent bonds. Water is a liquid in the surrounding temperature and pressure factor, but it is regularly combined with its dominant nation, ice and volatile country (water smoke or steam). Water is additionally found to be a liquid close to hydrophilic surfaces (Manju et.al., 2000, Sundar et.al., 2000, Anandan et.al., 2019, Ashok et.al., 2018 & 2019, Vasanthy and Jeganathan 2008 & 2009).

Water covers 70% of the surface, and is essential for all recognized forms of lifestyle. On this planet, 86% of the planet's water is concentrated in the oceans, 1.7% in groundwater, 1.7% in the icy loads of Antarctica and Greenland, and a small component and 0.001% significant in other large body of water. In the form of smoke all around, signs (the size of debris suspended in the air and fast water) and rain. Only 2.5% of the earth's water is freshwater, and 98.8% of that water is in ice and groundwater. 0.3 Stream of all freshwater is in canals, lakes and the climate, and a small fraction of the earth's freshwater (minus-003%) is present in our bodies and manufactured goods.

Earth's water is invisible and evaporates, condensation, precipitation and overflow that normally occur at sea are constantly circulating through the hydrological method. Disappearances and events contribute to soil rainfall.

Cuddalore District

The southern region of the Indian peninsula, Tamil Nadu, covers an area of more than 1,30,058 km2, with latitudes between 805 'and 13035' N and longitude 76015 '- 80020' E, and about 4 per cent of the country's land area. Makes a percentage. Tamil Nadu has 32 regions, 13 of which are located along the coast. The Kadurwar area (ID 1) is located 160 km south of the national capital Chennai.

Site location is 3706 km2. One of the most valuable landmarks in the Cuddalore area is Cuddalore (11044'45"N and 79045'56"E), a large mechanical metropolis with experience preparing beaches for an instant fee. The Cuddalore region is bounded on the north by the areas of Walipuram and Puducherry Union, on the west by Permambloor and Arivalur areas, on the south by Nagpatnam, Trevor and Thanjavur areas, and on the east by the middle of the Bay of Bengal.

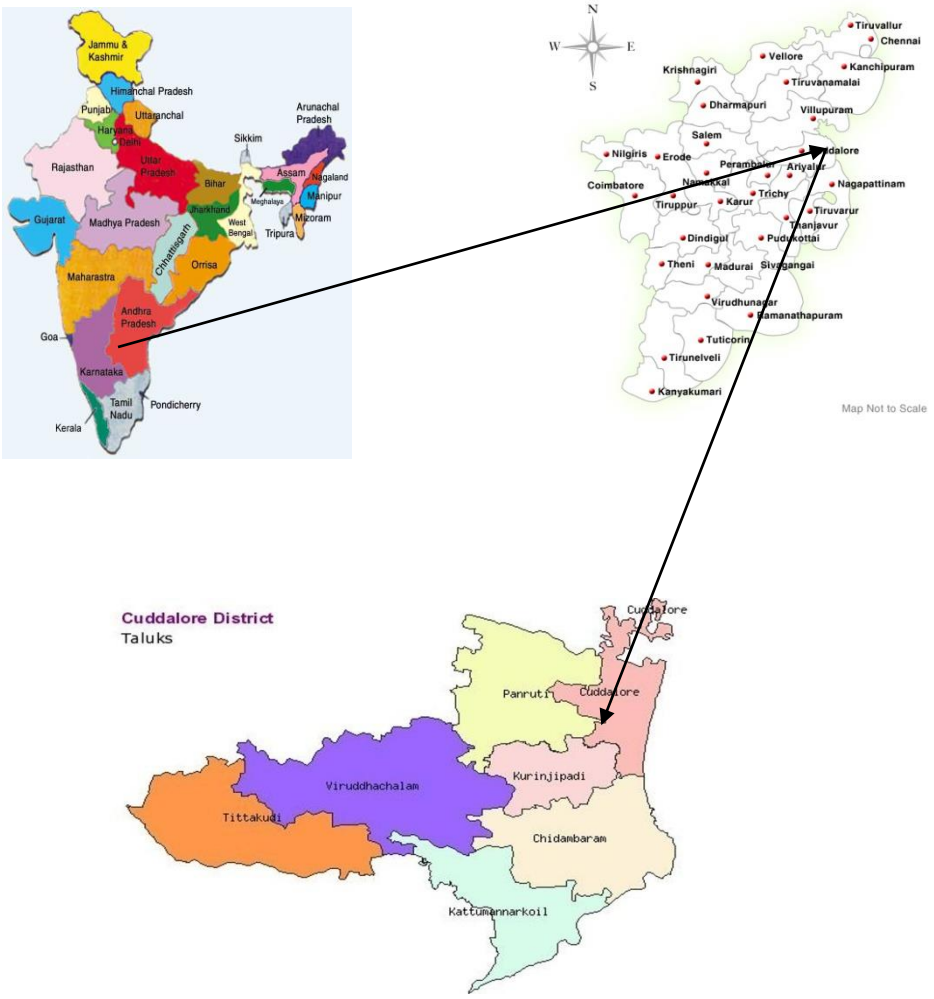

Fig .1Study Area

Sampling Places

The following areas have been selected for the intensive studies.

1. Neyveli (North)
2. Virddhachalam (West)
3. Chidambaram (South)
4. Cuddalore (East)

Materials and Methods

Physico-chemical examination of water samples

In a modern study, 16 cases from the lake (at some point during the summer and winter seasons) were stored in pre-wipe clean 1 L polyten bottles with the necessary guards (Brown et al. , 1974). Physicochemical inhibition, ie pH, EC, TDS, turbidity, TA, CH, MH, TH, DO, BOD, COD, Fe, nitrate, sulfate, phosphate, Na, k, nitrate, Cl and F For estimation. The evaluation was performed according to the conventional method (APHA, 1998). The boundaries within the desk are extended.

Table.1. Parameters and methods employed in the physico-chemical examination of water samples

S. No.	Parameter		Methods	Reference
1	Temp^{o} C	Temperature		
2	p^{H}	p^{H}	Electrometric Methods	APHA (1998)
3	EC mmho/cm	Electrical Conductivity	Electrical Conductivity Method	APHA (1998)
4	TDS mg/L	Total Dissolved Solids	Dessicator method	APHA (1998)
5	TA mg/L	Total Alkalinity	Volumetric method	APHA (1998)
6	Cl^{-} mg/L	Chloride	Argentometric Method	APHA (1998)
7	SO_4^{-2} mg/L	Sulphate	Colorimetric Method	APHA (1998)
8	DO mg/L	Dissolved Oxygen	Winkler's Mayer Method	APHA (1998)
9	BOD mg/L	Biological Oxygen Demand	Closed Reflux Method	APHA (1998)
10	COD mg/L	Chemical Oxygen Demand	Volumetric Method	APHA (1998)
11	TH as $CaCo_3$ mg/L	Total Hardness	Volumetric Method	APHA (1998)
12	CaH as $CaCo_3$ mg/L	Calcium Hardness	Volumetric Method	APHA (1998)
13	MgH as $CaCo_3$ mg/L	Magnesium Hardness	Volumetric Method	APHA (1998)
14	NO_3^{-} mg/L	Nitrate	Colorimetric Method	APHA (1998)
15	NO_2^{-} mg/L	Nitrite	Colorimetric Method	APHA (1998)
16	PO_4^{-3} mg/L	Phosphate	Colorimetric Method	APHA (1998)
17	F^{-} mg/L	Fluoride	Colorimetric Method	APHA (1998)
18	Na mg/L	Sodium	Flame Photometric Method	APHA (1998)
19	Turbidity NTU	Turbidity	Nepleoturbidity meter	APHA (1998)
20	K mg/L	Potassium	Flame Photometric Method	APHA (1998)
21	Fe mg/L	Iron	Colorimetric method	CPCB (2007)

RESULTS AND DISCUSSIONS

Table.1. Ground Water Quality in selected places of Cuddalore District

Parameters	Neyveli		Chidhambaram		Virudhachalam		Cuddalore	
	Pre Monsoon	Post monsoon	Pre Monsoon	Post monsoon	Pre Monsoon	Post monsoon	Pre Monsoon	Post monsoon
pH	7.27	7.84	7.34	7.57	8.11	7.11	9	8.2
TS	2500±0.84	4000±0.02	2200±0.01	3000±0.06	2500±0.04	2500±0.08	5000±0.81	3500±0.44
TDS	2000±0.02	2000±0.01	1500±0.02	2000±0.06	2000±0.02	1000±0.08	4500±0.08	2000±0.48
TSS	500±0.02	2000±0.01	700±0.04	1000±0.02	500±0.01	1500±0.01	500±0.28	1500±0.81
Alkalinity	600±1.63	210±0.02	200±0.04	359±0.02	400±0.01	450±0.08	526±0.01	294±0.01
Hardness	400±0.84	120±0.76	100±0.48	124±0.01	234±0.02	350±0.72	349±0.49	350±0.48
Ca	231±0.08	100±0.08	85±0.81	100±0.42	125±0.01	238±0.18	310±0.44	225±0.78
Mg	41.06±0.06	4.86±0.02	3.64±0.01	5.83±0.79	26.48±0.06	27.21±0.07	9.47±0.80	30.37±0.43
Chloride	89.15±0.06	100.28±0.002	70.35±0.04	250.13±0.22	115.89±0.64	120.19±0.82	45.84±0.14	200.15±0.07
Do	3.32±0.09	6.32±0.001	6.08±0.001	3.25±0.04	4.05±0.06	4.33±0.02	6.02±0.004	6.08±0.001
Bod	1.02±0.02	2.28±0.84	2.62±0.36	1.24±0.42	1.26±0.01	3.54±0.08	2.25±0.81	2.92±0.08
Cod	120±0.06	95±0.01	100±0.06	220±0.72	115±0.49	100±0.63	85±0.01	78±0.02
Sulphate	9.25±0.01	8.36±0.02	10.28±0.01	6.59±0.62	32.25±0.09	25.64±0.04	10.59±0.13	12.24±0.06
Silicate	12.38±0.01	10.29±0.04	33.85±0.07	22.34±0.81	10.89±1.42	15.68±0.81	20.29±0.08	22.76±0.08
Nitrate	9.5±0.01	12.24±0.04	17.58±0.01	7.36±0.08	8.34±0.06	6.48±0.01	2.24±0.004	21.95±0.02
Phosphate	0.075±0.002	0.052±0.008	0.025±0.004	0.055±0.04	0.015±0.002	0.035±0.001	0.018±0.001	0.057±0.004

pH

pH is a term used to increase the energy of corrosive or alkaline water. For most factors, the pH of water depends on the topography of the region and the limits of water buffering (Weber and Stun, 1963). pH in the Cuddalore district study area varies from 7.01 to 8.64, As per ISI (1995) standards eighty percentages of the samples in irrespective seasons respectively are within the recommended limits (6.5 – 9.2) for human consumption. The pH values were within the permissible limit in total area according to the (WHO, 1991). Chemical changes such as reduction and $o_2$idation, decomposition of organic matter may cause variations in pH. For these reasons it is desirable to determine the pH of water immediately after collection (Karanth, 1987).

As in the case of BIS (1991), a good pH for drinking water is 6.5 to 8.5. Term, 1985, was designed to regulate pH-restricted fluids using hydrogen particles to create or react with ingested substances. Deviation from this range produced varied effects (Banerjee *et al*., 1999 and Purandara *et al*., 2003). Alkaline range of pH may be explained on the basis of occurrence of lime stone rocks in the surrounding of the sampling stations. Limestone decomposes into calcium oxide and carbon di oxide and on addition of water makes calcium hydro$_2$ide. The corrosive base concord is also a control limit for example pH exchange.

Ph is also influenced by a variety of water treatment processes, such as water rest, rainfall, freezing, disinfection, and so on. In the absence of the risk that the pH is at some viable distance, it affects the mucous membrane of the cells. pH is used in the estimation of alkalinity and CO2, as well as in various combinations of corrosive and base materials (Garg, 2008). A pH value of less than 4–0 tastes intense, while a pH value of more than 8.5 makes water taste intense (Mahesh et al., 2004). A pH of less than 6.5 can destroy metal strains (Suvarnakumari et al., 1997; Indirabai et al., 2005).

Alkalinity

Water alkalinity is defined by its ability to kill the acidic form and the presence of hydroxyl particles. The alkalinity in water rating is essentially a matter of carbonate, bicarbonate and hydro 2 side content. The total alkalinity range from 60mg/l to 120mg/l, 100mg/l to 600mg/l Cuddalore district .

The alkalinity values were within permissible limit in total area according to the standard values of WHO (200 mg/L). Ball, 1994 have been reported An alkalinity of about 150 mg / L has been found to lead to a greater return on our body's water. Alkalinity values serve as an index of productive potential of the water (Jain, R. 1996). Lenin Sundar and Saseetharan, 2008 It is calculated that a high degree of salinity in the water is unfavorable for a water machine that activates soil damage and reduces crop yields.

Hardness

Hard water often starts in areas where thick topsoil and limestone grow (Sawyer and McCarthy 1967). The hardness of the water fluctuates all around. After all, groundwater is lighter than groundwater. The hardness of the water reflects the idea of improving the land with which it has come into contact. (Garage.com, 2007) Within modern testing, the absolute rigidity of the water test is assumed 74mg/l to 181mg/l, 250mg/l to 400mg/l, 99mg/l to 197mg/l, 65mg/l to 246mg/l in Cuddalore district.

As the step with the degree of hardness of water, delicate water (0-75 mg / L) is assigned to slightly harder water (75-150 mg / L), hard water [150-300 mg / L] And hard water [over 300 mg / L] Gupta and Shukla, 2004). Hardness makes water unsatisfactory for some local needs such as washing, cooking etc. as it keeps the water cleaner with foam management and further increases the water limit (Mahesh et al., 2004 et al. Kumar 2008).

Small Scale et al., 2003, found that the increased water hardness explains the extremely maximum use of detergents. It scales water heaters and utensils while it is used for cooking, and customers a larger cleaner when washing appliances (Singh and Kumar 2004).

Calcium

The main source of calcium is the rocks from which it is leached. Calcium is the central cation in first-rate water studies. Many earth springs can be made from calcium. Although calcium bicarbonate comes in direct contact with water hardness, it can be added to groundwater as a suspension fabric.

Normally calcium is not problematic but higher concentration of it leads to an increase in total hardness of water (Devi *et al.*, 2008). The awareness of calcium ions varies from 50 mg / L to 220 mg / L in the Caddalol region. Calcium is an essential component of a type of surgery in the human body and low substances cause damage to the teeth (Meenakumari, 2008).

Magnesium

The antacid principle found in ground water is calcium and magnesium, which gives the hardness of the earth. Both calcium and magnesium charge for the improvement of the volume in the boiler, skin and containers. Magnesium content range is > 25 mg/l can produce some cathartic (purifying and cleaning) and diuretic effects (Sharma and Bhattacharya, 2001).

The magnesium ions are ranged from 2mg/l to 35.96mg/l in Cuddalore district. High amount of magnesium leads to a condition called hyper – magnesemia. It is a well known cause of hypotension, cardiac dysfunction and induces paralytic illus (Suthar *et al.*, 2008).

4.6.6. Dissolved oxygen

Probably the main obstacle to checking for great water. The presence of o2ygen is essential for amphibian survival in water. The dough level of water depends on the physical, composition, and natural sport of the body of water. Generally variation in concentration of DO is largely governed by photosynthesis, respiration, mineralization and decomposition activities in water (Chanu and Devi, 2008).

Given the fact that most living beings, other than aerobic organisms, die quickly, they are a major functional variable in marine biological systems. O_2 level falls to zero. In the present study the Cuddalore district water sample dissolved $o_2$ygen values were in ranges from 2.45mg/l to 8.43mg/l. According to the BIS standard value all the sampling places werewithin the permissible limit.

high-quality consumable water have to have the diploma of soaked DO at 7 – 9 mg/l at 30^0C. As the DO level falls, undesirable odour, taste and colour appear which reduce the acceptability of water (Garg *et al,* 2007). Increase in Do is related to decrease in temperature or decrease in DO is related to higher temperature as solubility of O_2 decrease with increase in temperature (Dwivedi and Sonar, 2004).

Total solids

All solid matter problems are interrupted or damaged in water. Total solids include volatile and unpredictable solids. Due to the presence of dry leaves, muddy sand particles, and scattered salt, there are absolute solids in certain bodies of water. Excessive fragility in the water indicates pollution that promotes a cleansing effect. Damaged solids begin with rocks, soil, limestone melts, agricultural activity, and special properties (Manimegali and Muthuleshmi, 2006). Basically, all solids remain in the container after being destroyed in a broiler at 103-105 ° C and are a buildup of dough after drying. Within the research site, there is an increasing number of solids that excel at reaching 500 mg / l to 5000 mg / l in the Cuddalore area.

Total dissolved solids

Total dissolved solids in water are composed of inorganic salts, mainly chlorides, sulphates, and carbonates of calcium, magnesium, potassium and sodium. The water samples have been classified based on the concentration of TDS (ICMR, 1975). According to ICMR classification majority of the study area water samples were in desirable for drinking. The decomposed solids in the water come from conventional resources and wastewater. In the Cuddalore region, the TDS was between a minimum of 300 mg / L and a minimum of 4300 mg / L.

TDS indicates the general nature of salinity of water. The desirable limit of TDS is 500mg/l (BIS ,1991). Presence of dissolved solids in water affects the taste of water. Higher TDS may even cause corrosion and unpalatable mineral taste since it contains inorganic salts such as Ca, Mg, Na, k cations and Chloride and nitrate anions (Saradhi *et al,* 2003). The higher concentration of dissolved solids imparts a peculiar taste to water and reduces its portability (Garg *et al.,* 2008). Excess TDS may cause gastrointestinal irritation when consumed. It elevates the density of water and reduces solubility of oxygen that may prove lethal to aquatic life (Chennakrishnan *et al*., 2008).

Total suspended solids

Suspended solids are those that can be hung from the water channel and are not equipped to be installed in the base. These include sediment, soil, micro fish, grass waste and inorganic seams. Improved aggregation of suspended solids can cause serious problems for the welfare of waterways and the lives of amphibians. In the current research all areas of the TSS estimate were opposite and the old BIS estimates were the same. High absolute suspended solids can also justify the selection of surface water temperatures, given that suspended debris controls heat during daylight hours. Excess of TSS in the body of water can lead to high conversion of microorganisms, pesticides and metals into water. This pollution can also be associated with residual particles on the ground and can be transported from typhoons to bodies with water. Waters rich in suspended solids are probably elegant for laundry tasks.

Chloride

Chloride is invariably present in small amounts in almost all natural waters. This ink is usually transported naturally in the form of sodium, potassium and calcium

salts. As a result of aging, chlorides are transferred to the soil and water by a type of stone. The chloride content of rocks is generally small because it is so readily solubilised and leached by water. The highest concentrations of naturally occurring chlorides are found in deposits after the evaporation of sea water, and these occur throughout the globe.

The chloride level was minimum in 25mg/l maximum 200mg/l in Cuddalore district. The chloride values were in permissible limit in total study area. The concentration of chloride in natural water varies from few mg/l to several hundred mg/l (Sivakumar and Jaganathan, 2002). Das and Malik, 1998, found that chloride in groundwater can be generated by minerals such as apatite, mica, and hornblende, as well as by the incorporation of liquids into molten rock. Source of chloride in groundwater due to the hardiness of phosphate minerals and domestic wastewater (Karanth, 1987; Bhanja and Patra, 2000).

Phosphate

Phosphates occur in specific waters and in wastewater and are classified into orthophosphates, dense phosphates and apparently bound phosphates. They occur in systems, in particles or waste or in groups of oceanic survival forms. Phosphorus is an aspect commonly found in soil. Phosphorus in soils is formed from solid and union boundaries in solid fractions, which are strong (> 99%).

Most of the phosphorus binds to and through large amounts of insoluble water, and for that reason, the phosphorus content of new water is low. The giant phosphorus pits are domestic sewage, cleaners, compost-containing horticultural waste, and ordinary sewage. Phosphate overexpression triggers an increase in green growth and eutrophication reform (Kalivani et al., 2006). The phosphate ranges in the Cuddalore area are in contrast and are a general estimate of BIS (0.005 mg / L). Natural phosphates can also appear due to the breakdown of herbal pesticides that contain phosphates. They exist in company, in unincorporated sections, or in collections of marine organisms. Inorganic phosphate can be a phosphate that is not associated with natural ingredients.

Nitrate

Nitrate is a type of nitrogen that normally occurs and is an important part of the nitrogen cycle in meteorological conditions. Nitrate is composed of compost, rotten flora, fertilizers and other natural deposits. It is very often observed throughout the soil, water and diet (especially vegetables) and is commonly introduced into the human body.

In the present study the nitrate level in the range of minimum and maximum were 12mg/l(min) and 47 mg/l (max) in Cuddalore district. And the values were compared with the USEPA (Unites States Environmental Protection Agency). The range of Drinking water standard is within the level 10mg/l (USEPA).

Plant improvement is easy because nitrogen is a phase of protein, chlorophyll, and various natural compounds (Chambers et al. 2001). N is abundant in the world, but less than 2% have access to the existing bureaucratic structure (Galloway 1998). Nitrogen, produced as a carbon, oxygen, or hydrogen-binding N, is usually made by the attachment of the herb nitrogen, a non-creative nitrogen that is a triple-enhanced N (Wetzel2001). Litch and Schnoor (1933) have effectively demonstrated the potential of

phytoremediation for nitrate removal.

When compared with standards, the Magnesium values of all samples are very low and the samples can be recommended to drinking water purposes.

PH also calming of water, rain, coagulation, sterilization and similarly Kule Nishtha et al. Similar to 2012, it affects specific water treatment measures. In 2012 it was specified that there could be no abnormal differences in pH in groundwater investigations. With the closed danger that the pH is determined to be past, it affects the mucous film of the cells. The pH is applied in the estimation of alkalinity and CO2 and differentially corrosive balance - base (Garg, 2008). A low pH relative to 4.0 produces a spicy taste and an excessive stimulus above 8.5 gives the water an unpleasant taste (Mahesha et al., 2004). Five erodes steel deformations at low pH (Suvarnakumari et al., 1997; Indirabai et al., 2005).

As indicated by the hardness level, water sensitive water (0–75 mg / L) is decently hard water (75–150 mg / L), hard water [150–300 mg / L], and exceptionally hard water. [Above 300 mg / l]. Shukla, 2004). The hardness makes the water neglected for some homegrown requirements, for example washing, cooking and like the fact that the water continues from the association of the water with the cleaner and furthermore the limitation of the water. (Mahesha et.al.), 2004 and Singh and Kumar 2008).

Smaller than the standard, 2003 observed that better hardness of water is the biggest cause of sanitation use. A great time for cooking and washing clothes for consumers is applied to clean water heaters and utensils (Singh and Kumar 2008).

Conclusion

Tourism potential of Cuddalore district can be further developed if the study areas adopt Ecotourism as a clean and green environment can always attract tourists to a maximum. Always the eco-tourism targets the enjoyment in a sustainable manner. The travel industry is a significant type of revenue and occupations, and assists with improving thankfulness for the common magnificence of the Cuddalore area. As a small, isolated archipelagic ecosystem, these area are susceptible to degradation from human impacts. The base line study makes us understand that the study area namely the Pitchavaram is one of the most favoured destinations for Ecotourism. Promoting Ecotourism not only facilitates long term jobs and incomes for local communities but also will help preserve and conserve the environment minimizing the ecological impact which could be otherwise caused by the tourism. Calcium and magnesium are the main earth metals found in ground water and increase water hardness. Each calcium and magnesium contributes to the formation of quantities in cauldrons, traces and dishes. An area with magnesium content> 25 mg / L may have a soothing (cleansing and cleansing) and diuretic effect. Magnesium residues went from 2 mg / l to 35.96 mg / l in the area around Cadalore. High amounts of magnesium are called hypermagnesemia. It is far from a good target for high blood pressure, cardiovascular diseases and causes motionless delusions.

References

1. Anandan, V., Senthamilkumar, S., Sundararajulu, V., Gunaselvi, S., Jeganathan, M. 2019. Comparative study on the behavior of conventional ferrocement and modified ferrocement wrapped columns. International Journal of Advanced Research in Engineering and Technology, 2019, 10(6), pp. 22–29.
2. Anandan, V., Senthamilkumar, S., Sundararajulu, V., Gunaselvi, S., Jeganathan, M. 2019. Comparative study on the behavior of modified ferrocement wrapped columns and cfrp wrapped columns. International Journal of Advanced Research in Engineering and Technology, 2019, 10(6), pp. 41–48.
3. APHA., 1998."Standard method for the examination of water and waste water"(20thedn.).American Public Health Association. Washington.
4. Ashok, J., Senthamilkumar, S., Satheesh Kumar, P., Jeganathan, M. 2018. Air quality assessment of Neyveli in Cuddalore district, Tamilnadu, India. International Journal of Civil Engineering and Technology, 2018, 9(12), pp. 729–735.
5. Ashok, J., Senthamil Kumar, S., Satheesh Kumar, P., Jeganathan, M. 2019. Estimation of cement kiln exhaust on air quality of ariyalur in terms of suspended particulate matter-a case study. International Journal of Civil Engineering and Technology, 2019, 10(1), pp. 498–508.
6. Bramer S.K. 2011.Diversity benthic macro invertebrates as measures of pollution in the Damodar and the Ganagarivers in India. Poll Res., Vol. 26 (4), 579-586.
7. Brown, J and Sobsey.M 1974. Independent Appraisal of Ceramic Water Filtration Interventions in Cambodia: Final Report, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina, USA.
8. Garg. D., Singh. R.V and Mehla.S.K (2008).Physico-chemical assessment of ground water quality of Bharatpur district during the pre monsoon season 2007. *Indian.J.Environand Ecoplan*41: 55-96.
9. Gupta.G.K and Shukla.R (2004).Physico-chemical and bacteriological quality in various sources of drinking water from Auriya district [UP] industrial area.*Indian.J.Environ and Ecoplan*12: 15- 32.
10. Henniker, R.M. 1949.Nitrogen and sulphur compounds. In Handbook of air pollution analysis (2nd edn). Ed.R.M. Harrison and R.Perry.Chapman and Hall. London.
11. Indirabai, W.P.S and George, S 2005.Assessment of drinking water quality in selected areas of Tiruchirappalli town after floods.Poll. Res., 21(3): 243-248.
12. ISI., 1983.Indian standard specification for drinking water. IS:10500, New Delhi.
13. Koul mishtha, S., Bronstert, A and Zehe, E 2012. Groundwater-surface water interactions in a North German lowland floodplain – implications for the river discharge dynamics and riparian water balance, J. Hydrol., (347), 404–417.
14. Mahesha, Nagaraja Naik and Rajendra Prasad N.R. 2004. Physico – Chemical characteristics of bore well water in Arsikere taluk, Hussan. IJEP., 24 (12), 897-904.
15. Manju, M., Nagarajan, R.V., Satheesh Kumar, P., Jeganathan, M. 2020.Environmental quality and economical study on electrical and electronic industry - A case study.International Journal of Advanced Research in Engineering and Technology, 2020, 11(2), pp. 266–275.
16. Manju, M., Nagarajan, R.V., Satheesh Kumar, P., Jeganathan, M. 2020.Determination of heat resistant in building structures - A case study.International Journal of Advanced Research in Engineering and Technology, 2020, 11(2), pp. 94–105.
17. Manju, M., Nagarajan, R.V., Satheesh Kumar, P., Jeganathan, M. 2020. Analysis of quantity and quality of light in schools and residential area of Chennai city, Tamilnadu, India. International Journal of Advanced Research in Engineering and Technology, 2020, 11(2), pp. 259–265.

18. Mini.P.B., Rajanna.L.N., Seetharam.Y.N and Sharanabasappa.G.K. 2003.Phytochemical studies of *StrychnosPotatorum* – A medicinal plant. 4(4): pp 510-518.
19. Sing N and Kumar. P.L. 2008.Chemistry for sanitary engineers,McGraw Hill, New York.*Indian journal of Environmental protection*.16:15-25.
20. Sundar, S., Stella Mary, S., Jeganathan, M., Satheesh Kumar, P.2020. Evaluation of building construction water quality and removal of total hardness using low cost methods. International Journal of Advanced Research in Engineering and Technology, 2020, 11(2), pp. 27–35
21. Suvaranakumari and Saseetharan, M.K., 1997. Dye house waste colourremoval – Adsorption studies. M.E. Thesis.Govt. College of technology. BharathiarUniversity. CoimbatoreTechnol., (42): 927- 933.
22. Vasanthy, M., Geetha, A., Jeganathan, M., Anitha, A. 2009. A study on drinking water quality in ariyalur area, Tamil Nadu, India.Nature Environment and Pollution Technology, 2009, 8(2), pp. 253–256.
23. Vasanthy, M., Jeganathan, M. 2008. Monitoring of air quality in terms of respirable particulate matter - A case study. Journal of Industrial Pollution control, 2008, 24(1), pp. 53–55.
24. WHO.,1992.Environment health criteria-36; Fluoride and fluorides. World Health Organization, Finland. 136.