**ANALYSIS AND EVALUATION OF WATER QUALITY CHARACTERISTICS IN A WATER RESOURCE AT TIRUCHIRAPALLI**

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**Abstract**

Water is one of the most vital natural resources for all life on Earth. The availability and quality of water always have played an important part in determining not only where people can live, but also their quality of life. Total utilizable water resource in the country has been estimated to be about 1123 BCM (690 BCM from surface and 433 BCM from ground), which is just 28% of the water derived from precipitation. About 85% (688 BCM) of water usage is being diverted for irrigation. This may increase to 1072 BCM by 2050. Major source for irrigation is groundwater. Water use can mean the amount of water used by a household or a country [1].Water is essential for achieving sustainable development and the millennium development goals. Properly managing water resources is an essential component of growth, social and economic development, poverty reduction and equity. Water is one of the renewable resources essential for sustaining all forms of life, food production, economic development, and for general wellbeing. It is impossible to substitute for most of its uses, difficult and it is truly a unique gift to mankind from nature. Due to poor water quality, risk occurs in the industrial areas which damage the whole environment and causes an economical loss. This study focuses on the physico - chemical parameters and heavy metal analysis of the Uyyakondan canal water from ten different stations in and around Tiruchirapalli district, Tamilnadu, India and reports the evaluation of characteristics for its suitability for drinking purpose.

INTRODUCTION

Water is one of the most manageable natural resources as it is capable of diversion, transport, storage, and recycling. All these properties impart to water its great utility for human beings. The surface water and groundwater resources of the country play a major role in agriculture, hydropower generation, live stock production, industrial activities, forestry, fisheries, navigation, recreational activities etc. [2]. Water plays a vital role in everyone’s life and is observed everywhere and in every form [3]. In today’s world, due to climatic changes and pollution the water quality has been affected in urban areas and various experiments are done to test the quality of water [4]. Due to poor water quality, risk occurs in the industrial areas which damage the whole environment and causes an economical loss [5]. The root cause for many Diseases such as typhoid, diarrhea, cholera is the usage of contaminated water caused by increased industrialization and urbanization in India [6].

According to reports form WHO, it is estimated that about 77 million people are affected by contaminated water in India and 21% of diseases are caused due to this [7]. Due to insufficient rainfall and drying up of main reservoirs that supply water, India faces water crisis frequently, hence making water one of the most precious and limited land resources.

Many Organizations including WHO and BIS have framed standards for water quality parameters that can be used to efficiently analyze the quality of water. For checking the quality of water, conventionally it is required to collect water samples and send it to the lab for testing which is a tedious process [8]. With IOT and Machine Learning algorithms it is easy to obtain the sensor values from a water sample, monitor and predict the quality of water at the comfort of our home. IOT is a buzzing technology that allows sensors to transfer data between them or to the cloud without the intervention of humans [9]. Water quality index of the water, which helps in determining the quality of water, can be predicted by the extensive use of machine learning regression.

Water is the most important natural resource for the existence of life on earth. It is a medium in which all living processes take place. Water supports all forms of biological resources including plant and animal life. A complete assessment of a water body is however based on appropriate monitoring of its hydrology, Physico - chemistry and biology [10]. However, the quest for technological advancement and increasing industrial activities to satisfy the growing need of human and improve on civilization has created unexpected damages to our environment . These damages are potential threats to the water quality and several biological activities of the ecosystem.

All water masses are transformed from one form to another in the course of the hydrological cycle, a continual shift of water on the Earth (in the atmosphere, hydrosphere and the Earth’s crust) that occurs under the influence of solar radiation and gravity. This planetary process includes evaporation of water from the Earth’s surface, its transfer with the help of air currents from the place of evaporation, condensation of water vapor and precipitation (transfer of water masses in water bodies onto the

Earth’s surface and inside its crust). The quantity of precipitation annually falling on the Earth’s surface is equal to the quantity of water evaporated from the surface of the landmasses and oceans.

#### Water resource

Water resources are natural resources of water that are potentially useful as a source of water supply. 97% 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. The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air. Natural sources of fresh water include surface water, under river flow, ground water and frozen water. Artificial sources of fresh water can include treated wastewater (reclaimed water) and desalinated seawater.

#### Surface Water

Important source of water for human being comes from the surface water bodies which is now under severe environmental stress due to developmental activities. Most of the water bodies disappeared due to encroachment and pollution . The surface water quality in a region largely depends on the nature and extent of the industrial, agricultural, and other anthropogenic activities in the catchments [11].

Interactions between groundwater and surface water play a fundamental role in the functioning of riparian ecosystems. In the context of sustainable river basin management, it is crucial to understand and quantify exchange processes between groundwater and surface water. Numerous well-known methods exist for parameter estimation and process identification in aquifers and surface waters. Only in recent years has the transition zone become a subject of major research interest; thus, the need has evolved for appropriate methods applicable in this zone. This article provides an overview of the methods that are currently applied and described in the literature for estimating fluxes at the groundwater – surface water interface. Considerations for choosing appropriate methods are given including spatial and temporal scales, uncertainties, and limitations in application. A multi-scale approach combining multiple measuring methods may considerably constrain estimates of fluxes between groundwater and surface water [12]. The total evaporation from the ocean surface and continents amounts to 577,000 km3 per year (a mean layer of 1.13m over the earth) .It consumes on an average 88W/m3 of heat, wh ich amounts to more than a third of the solar energy supply of the earth. Through the operation of the water circulation on the Earth, the entire 577,000 km3 falls on the Earth each year. Meridional water vapor transfer is a significant peculiarity of water circulation. Water vapor (H2O) is the most variable of the atmosphere components. Its volumetric content can change by a factor of 100,000 depending on the season and place.

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### Oceans, inland seas, coastal zones, and estuaries

The seas are classified as interior (inland), or inter-insular according to their geographic position and degree of isolation. An inland sea is one almost completely surrounded by land and joining the ocean or adjacent seas only through relatively narrow channels. Interior seas are assumed to be subdivided into continental and intercontinental types.

The World Ocean is the body of water with a continuous water surface, occupying the largest depressive geomorphologic feature of the Earth. It surrounds the continents and islands and has a composition dominated by common salt. The total area of the World Ocean is 361.26 million km2; this is about 70.8% of the Earth’s surface (61% of the surface in the northern hemisphere, and 81% in the southern hemisphere). The average depth is 3711 m, and the maximum depth is 11 022 m in the Mariana Trench in the Pacific Ocean. The total volume is around 1340.7 million km3.

Inland seas are landlocked seas that are only connected to the ocean through narrow channels. They usually contain many islands, channels, sounds, and straits. Inland sea was first defined for the Seto Inland Sea, separating the three main islands of Japan and connected to the Pacific Ocean through narrow channels. It is one of the world's largest inland seas, encompassing 400 islands, 7,500 km of coastline, water depths to 650 m in the coastal areas, and an overall marine area of 17,000 km2.

The coastal zone is a region where land, ocean and atmosphere interact and hence it is dynamic in nature. India has a long coastline which was not adequately monitored until the advent of the satellite remote sensing era in the 70s. India has a very robust remote sensing program that the Indian Remote Sensing Satellite (IRS) series of satellites were effectively used to monitor coastal habitats, landforms, shoreline, water quality, etc., and changes were identified during the last 40 years. The classification system for coastal habitats and the classification and geometric accuracies of products were standardized. Detailed information for mangroves communities and characteristics of coral reefs were generated. The high and low tide lines were delineated seamlessly for the entire coastline using satellite data. All these data were organized in a GIS and the coastal data base for the entire country was created. Impacts of various hazards such as cyclones, tsunami and sea level changes on coastal habitats were documented. Based on topography, shoreline changes and tides, coastal multi-hazard vulnerability maps were characterized by employing the elevation data derived from satellite data and were prepared for the coastline of India. The information on ocean color and sea surface temperature was used to generate potential fishery advisories, which are provided daily to fishermen. The coastal database was utilized effectively to identify coastal regulation zones, marine protected areas, vulnerable zones, etc. Various services for tsunami, fishery and coral reef bleaching were generated for societal benefits. It is planned to develop models for the coastal

zone, so that impeding dangers and likely changes in the coastal zone

can be predicted and suitable actions can be undertaken.

An estuary is a partially enclosed body of water formed where fresh water from land meets and mixes with salt water from the ocean. Estuaries are unique environments to which plants and animals have specially adapted. Estuaries are protected from ocean forces by reefs, barrier islands, head lands and deltas. They transport and trap nutrients and sediment through the combined action of freshwater flow, wind, waves and tidal action.

Sea level has slowly risen over the last 15 000 years remaining stable over the last 6000 years. As the sea rose it drowned river valleys and filled glacial troughs. Once formed, estuaries make good sediment traps, filling with sediment from both the land and the sea. Sediment from the land include muds and clays delivered by rivers while sediments from the sea are usually clean sands pushed into the estuary by waves and tidal currents. Sediment can also come from shoreline erosion, windblown sediment and shell production [14].

#### River, reservoirs, lakes and wetland

Large river systems constitute one of the most important continental geomorphic systems that have sustained civilizations for more than 5000 years. Large rivers are generally defined by one or more of the following criteria: drainage area (A) = 800000 km2, river length (Lr) = 2500 km, average discharge (Q) = 7500 m3/s, and suspended and dissolved load = 100 mt/yr . The subject of large rivers can be approached from different perspectives. A modern perspective emphasizes the hydrological, sediment transport and network organization of large rivers. This perspective also includes the process-based understanding of the rivers and river management in the backdrop of future sustenance of human civilizations. From a geological or stratigraphic perspective, the reconstruction of ancient large river systems through the methods of sedimentary basin analysis and long-term development of alluvial architecture has been highlighted. Most large rivers ‘have large, long-lived deltas which have played major role in both deep and shallow waters’. Alluvial stratigraphic records preserved in most large rivers and their valleys have enabled an understanding of the development of large rivers on different time scales –century, millennial, tens of thousands of years, million and tens of millions of years.

A river is a water course flowing in a self-developed bed augmented by surface and groundwater. With all its tributaries it forms a river system whose character and development is related to climate, relief, geologic structure, and the dimensions of the basin.

Rivers can be subdivided into Mountain rivers- usually flowing rapidly in narrow valleys- and the plain ones, which flow more slowly in wide terracing valleys. The water regime depends mainly on the character of river augmentation and the climate conditions in the region. Total annual river run off into the world ocean is about 47,000 km3. A lake is a natural reservoir filled with water within a lake basin not directly linked with the sea. Basins are subdivide d according to their origin into tectonic, glacial, fluvial, coastal, sinkhole (in karsts and thermokarsts), volcanic, and dammed.

Within the global hydrologic cycle, freshwater lakes play a very small quantitative role, constituting only about 0.009 percent of all free water, which amounts to less than 0.4 percent of all continental fresh water. Saline lakes and inland seas contain another 0.0075 percent of all free water. Freshwater lakes, however, contain well over 98 percent of the important surface waters available for use. Apart from that contained in saline bodies, most other continental waters are tied up in glaciers and ice sheets and the remainder is in groundwater. Although lakes are to be found throughout the world, the continents of North America, Africa, and Asia contain about 70 percent of the total lake water, the other continents being less generously endowed. Lakes also occur far beneath the ice sheets of Antarctica; however, surveys of the volume and other features of those discovered so far remain incomplete. One-fourth of the total volume of lake water is spread throughout the world in uncounted numbers of small lakes.

Commercial fisheries and other food industries reap great harvests from the major lakes of the world. The quality of the fish catch has steadily decreased, however, as a result of pollution in many lakes, with the more desirable species becoming less plentiful and the less desirable species gradually dominating the total.

In other parts of the world too, faulting has played an important role in basin formation. Lake Baikal and Lake Tanganyika, the two deepest lakes in the world, occupy basins formed by complexes of grabens (down dropped faulted blocks). These lakes are among the oldest of modern lakes, as are other graben lakes, particularly those within the East African Rift System, which extends through the East African lake system and includes the Red Sea. Depending on the nature of the lake bed, three main types of lakes can be distinguished:

* Dammed lakes: fluvial, valley, and coastal ( including reservoirs)
* Hollow lakes: moraine, karsts, thermokarsts, deflation, volcanic, tectonic.
* Lakes of mixed origin.

India has a wealth of wetland ecosystems that support diverse and unique habitats. These wetlands provide numerous ecological goods and services but are under tremendous stress due to rapid urbanization, industrialization and agricultural intensification, manifested by the shrinkage in their areal extent, and decline in the hydrological, economic and ecological functions they perform. Wetlands are amongst the most productive ecosystems on the Earth and provide many important services to human society . However, they are also ecologically sensitive and adaptive systems (Turner et al., 2000). Wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant species, and soil and sediment characteristics . Globally, the areal extent of wetland ecosystems range from 917 million hectares (m ha) to more than 1275 m ha.

The water spread area of wetlands varies greatly. Overall, inland wetlands have a water spread area of 7.4 m ha in post monsoon and 4.8 m ha in pre-monsoon; and coastal wetlands have 1.2 m ha and 1 m ha in post monsoon and pre monsoon, respectively . Across all categories of wetlands, the water spread area from post monsoon to the peak of summer reduces significantly indicating the uses and losses the wetlands go through. This has major implications for the total water availability of these wetlands and the various functions that they can perform in different seasons. Overall, reduction in water spread area of in land wetlands is highest (35%) followed by that of coastal wetlands (16%). Within inland wetlands, reduction is significantly higher in man-made types (49.5%), such as surface reservoirs and tanks, in comparison to natural types (24%), such as lakes and ponds, as they are under pressure to meet various irrigational and non-irrigational needs and are also subjected to higher evaporation losses. In terms of average water spread area for each category of wetland, man-made coastal wetlands have the highest area.

#### Ground Water

This term refers to water in the Earth’s crust in all physical states, in the sedimentary rock layers and massive-crystallized rock features. Ground water is the most preferred source of water in various user sectors in India on account of its near universal availability, dependability and low capital cost. The increasing dependence on ground water as a reliable source of water has resulted in indiscriminate extraction in various parts of the country without due regard to the recharging capacities of aquifers and other environmental factors. On the other hand, there are areas in the country, where ground water development is sub-optimal in spite of the availability of sufficient resources, and canal command areas suffering from problems of water logging and soil salinity due to the gradual rise in ground water levels. As per the latest assessment, the annual replenishable ground water resource of country has been estimated as 433 billion cubic meter (bcm), out of which 399 bcm is considered to be available for development for various uses.

The irrigation sector remains the major consumer of ground water, accounting for 92% of its annual withdrawal. The development of ground water in the country is highly uneven and shows considerable variations from place to place. Though the overall stage of ground water development is about 58%, the average stage of ground water development in North Western Plain States is much higher (98%) when compared to the Eastern Plain States (43%) and Central Plain States (42%). Management of ground water resources in the Indian context is an extremely complex proposition. The highly uneven distribution and its utilization make it impossible to have single management strategy for the country as a whole.

Groundwater has emerged as the primary democratic water source and poverty reduction tool in India’s rural areas. On account of its near universal availability, dependability and low capital cost, it is the most preferred source of water to meet the requirements of various user sectors in India. Ground water has made significant contributions to the growth of India’s Economy and has been an important catalyst for its socio economic development. Its importance as a precious natural resource in the Indian context can be gauged from the fact that more than 85 percent of India’s rural domestic water requirements, 50 percent of its urban water requirements and more than 50 percent of its irrigation requirements are being met from ground water resources. The increasing dependence on ground water asa reliable source of water has resulted in its large-scale and often indiscriminate development in various parts of the country, without due regard to the recharging capacities of aquifers and other environmental factors.

The chemical composition of groundwater includes a mixture of many chemical elements in the form of different ion types, neutral molecules, organic-mineral complexes, colloids, and isotopes. A complex of climatic, physical-geographical, soil vegetation, structural-geologic and hydrogeological factors, etc.

#### Glaciers, icebergs, and ground ice

Ice is the most abundant solid substance on Earth. It can exist in a great range of temperatures and pressures. The total ice mass contained in glaciers, icebergs, ground ice, snow cover and the atmosphere is 2423 х 1022 tons. As a consequence of climate, more than 96.6% of ice area and 90% of ice volume is concentrated in the Greenland and Antarctic ice sheets. Outside the ice sheet area there are several isolated ice domes. Large slabs of floating ice, called ice shelves surround much of the Antarctic continent. The ice shelf is considered in relation to the ice sheet that feeds it. There are several types of icebergs: tabular, domelike, pyramidal and destroyed. There are 28 types of fresh ice, which can be divided into three groups: congelation ice (all ice of fresh water reservoirs and streams), ground ice

(sedimentation ice) and metamorphic (glacier) ice. Floating ice can be distinguished by its origins into marine, river, lake and land.

Ground ice is a general term used to refer to all types of ice formed in freezing and frozen ground. Sediments that contain excess ice are often referred as “ice rich” or “icy” sediments. Various types of buried ice (glacier ice, sea, lake or river ice) fall under this classification, which results in ten mutually exclusive ground ice forms. The terms massive ice or massive ice bodies are usually reserved for relatively pure ground ice where the ice content averages at least 250% for a thickness of several meters.Segregated ice is a broad term for soil with a high ice content [15].

Ice covers more than 16.3 x 106 km2, i.e. 11% of the Earth surface. The total ice volume of modern glaciers ranges from 26.8 x 106 km3 to 30.3 x 106 km3. If this ice layer were to cover the Earth uniformly, its thickness would be approximately 55–60 m). However, ice is distributed unevenly throughout the Earth. Due to climatic features, more than 96.6% of ice area and 90% of ice volume is concentrated in the Greenland and Antarctic ice sheets.

Glaciers are divided into several types according to their morphology and location:

* Summit glaciers (cone summit, flat summit and caldera glaciers).
* Slope glaciers (slope glaciers, hanging glaciers, corrie glaciers and corrie-valley glaciers).
* Valley glaciers (valley glaciers, dendrite glaciers, expanded–foot or bulb glaciers, piedmont glaciers and basin glaciers).
* Plateau glaciers, diffluent glaciers, recemented glaciers and others.

Mountain glaciers in many dry areas of the Earth provide a considerable part of the water used for irrigation in those places. Snow line location is responsible for glacier formation in otherwise arid geography. Above the snow line the accumulation of solid precipitation is greater than the loss of mass to thawing, evaporation, or run off. The snow line level widely oscillates, depending on moisture and heat balance and local climatic conditions from sea level in the Antarctic Continent to 6000 – 6500 m above sea level on the Tibetan Plateau.

#### Soil water

The term “soil water” usually refers to the water localized in soil pore space (i.e in the surficial part of the land) in the form of liquid moisture. Water supply through soils is vital for both plants and soil organisms—they need water to survive. Soil water contains nutrients that move into the plant roots when plants take in water. Water enters the soil through large pores (macrospores) and is stored in many small

pores (micro pores). Porous soils have a balance between macro and micro pores.

The soil water content is the amount of water held in the soil at any given time and can be expressed as volumetric or gravimetric water content. Volumetric water content is the volume of water per unit volume of dry soil and is the most useful way of expressing water content for developing a water budget, which is discussed in the next section. Gravimetric water content is the mass of water per unit mass of dry soil. The volumetric water content (percent, unit less) is equal to the gravimetric water content (in cm3 per gram) multiplied by the soil’s bulk density (in grams per cm3).

Infiltration and permeability describe the manner by which water moves into and through soil. Water held in a soil is described by the term water content. Water content can be quantified on both a gravimetric (g water/g soil) and volumetric (ml water/ml soil) basis. The volumetric expression of water content is used most often. Since 1 gram of water is equal to 1 milliliter of water, we can easily determine the weight of water and immediately know its volume. The following discussion will consider water content on a volumetric basis.

Saturation is the soil water content when all pores are filled with water. The water content in the soil at saturation is equal to the percent porosity. Field capacity is the soil water content after the soil has been saturated and allowed to drain freely for about 24 to 48 hours. Free drainage occurs because of the force of gravity pulling on the water. When water stops draining, we know that the remaining water is held in the soil with a force greater than that of gravity. Permanent wilting point is the soil water content when plants have extracted all the water they can. At the permanent wilting point, a plant will wilt and not recover. Unavailable water is the soil water content that is strongly attached to soil particles and aggregates, and cannot be extracted by plants. This water is held as films coating soil particles. These terms illustrate soil from its wettest condition to its driest condition.

Several terms are used to describe the water held between these different water contents. Gravitational water refers to the amount of water held by the soil between saturation and field capacity. Water holding capacity refers to the amount of water held in the soil against gravity, or the total volume of water in the soil at field capacity. Plant available water or available water capacity is that portion of the water holding capacity that can be absorbed by the plant, and is the amount of water held between field capacity and wilting point.

The volumetric water content measured is the total amount of water held in a given soil volume at a given time. It includes all water that may be present including gravitational, available and unavailable water. The relationship between these different physical states of water in soil can be easily illustrated using a

sponge. A sponge is just like the soil because it has solid and pore space. Obtain a sponge about 6 x 3 x 1/2 inch in size. Place it under water in a dishpan, and allow it to soak up as much water as possible. At this point, the sponge is at saturation. Now, carefully support the sponge with both hands and lift it out of the water. When the sponge stops draining, it is at field capacity, and the water that has freely drained out is gravitational water. Now, squeeze the sponge until no more water comes out. The sponge is now at permanent wilting point, and the water that was squeezed out of the sponge is the water holding capacity. About half of this water can be considered as plant available water. You may notice that you can still feel water in the sponge. This is the unavailable water.

Water in the form of precipitation or irrigation infiltrates the soil surface. All pores at the soil surface are filled with water before water can begin to move downward. During infiltration, water moves downward from the saturated zone to the unsaturated zone. The interface between these two zones is called the wetting front. When precipitation or irrigation cease, gravitational water will continue to percolate until field capacity is reached. Water first percolates through the large pores between soil particles and aggregates and then into the smaller pores.

Available water is held in soil pores by forces that depend on the size of the pore and the surface tension of water. The closer together soil particles or aggregates are, the smaller the pores and the stronger the force holding water in the soil. Because the water in large pores is held with little force, it drains most readily. Likewise, plants absorb soil water from the larger pores first because it takes less energy to pull water from large pores than from small pores.

Use of soil water estimates on a percentage volume basis does not allow for any practical interpretation. Therefore, water is usually converted from a percentage volume basis to a depth basis of inches of water/foot of soil .

#### BASIC TYPES OF WATER

1. **Tap water:** The water that we get directly from our faucet is tap water. Tap water is generally taken from a dam or river and supplied to our home through pipelines. Tap water is ideal for household purposes, such as cleaning, gardening, cooking and washing clothes. Tap water, however needs to meet the standards set by the local municipal bodies. Tap water may always not be suitable for drinking purposes, especially if the pipelines are old and have leakages.
2. **Spring Water:** Spring water comes from natural springs formed from an underground source. What makes spring water different is the water is not recycled and you get it directly from the source.

Though natural spring water is not supplied by the common community water system, it is suitable for drinking as it comes from the underground.

1. **Mineral water:** This type of water naturally contains essential minerals. The reason is mineral water is obtained from underground sources which are the reason why it is rich in minerals such as calcium, magnesium, and manganese. Any further minerals can’t be added in the water and it can’t be subjected to any further treatment. However, mineral water can be subjected to limited processes such as carbonation or iron removal before packaging.
2. **Well water:** Well- water is not very common in urban areas, however, it is the main source of water supply in rural areas. Water trickles down and travels into the cervices of the soil when it rains. The main feature of well water is it directly taps the water source and is available on the surface via a drilled-well. Well-water may also be contaminated which is the reason why it is necessary to follow a purification process before using well water.
3. **Hard water:** Most of the homes in India get hard water. Plain water contains only two hydrogen atoms and one oxygen atom. However, when water is supplied to our home, it passes through limestone and picks up unwanted minerals to water, thereby making it hard. The presence of an excessive amount of calcium and magnesium increases the hardness of the water. In some regions, hard water may contain iron, aluminum, and manganese. Hard water is the reason for a number of problems such as dry skin, dull hair, and corrosion of plumbing fixtures.
4. **Alkaline water:** Drinking water with the right pH level is necessary to stay healthy. Drinking water that is too acidic has a negative impact on our health. The pH level of alkaline water is less than normal water and contains alkaline minerals and negative oxidative reduction potential (ORP). The right pH level in water can help us to neutralize excessive acid present in the body. Water with the right pH level slows down the aging process and even prevents cancer.
5. **Distilled water:** Distilled water or demineralized water is one where the water has been subjected to a treatment that removes all its minerals and salt by the process of distillation. It is an absolutely pure form of water but it is not typically recommended for drinking. It can cause mineral deficiencies because it is devoid of all salts and most of the natural minerals in the water are gone as a result of this process. Drinking this water may cause rapid sodium, potassium, chloride, and magnesium loss.
6. **Ground water:** Groundwater, which makes up around 22% of the water we use, is the water beneath the earth’s surface filling cracks and other openings in beds of rock and sand. It exists in

soils and sands that are able to retain water. The water table is the line between unsaturated soil and saturated soil. Below the water table is where rocks and soil are full of water. A study in 2008 showed private house hold wells constitute the largest share of all well water in the United States, with over 13 million occupied households having their own well.

1. **Rain water:** This has been condensed from the clouds. Rainwater is naturally designed to water plants, and it can easily be used for our indoor and outdoor gardens. We can use rainwater in watering cans to water plants by hand. You can also attach any rainwater storage tanks directly to an automatic irrigation system.
2. **Snow water:** This is frozen rain. Freezing does not eliminate any germs. All snow flakes have hardened mineral deposits. If the cleanest snow is melted we can find it saturated with dirt, inorganic minerals, germs and viruses.

#### WATER POLLUTION

The planet keeps nudging us with increasingly extreme droughts, reminding us that water is life. It is an essential resource upon which all living beings depend and it is crucial to all social and economic development, as well as energy production and adaptation to climate change. Nevertheless, we are now facing a gigantic challenge. The waters of the River Ganges flow clear and clean through the Indian city of Rishikesh at the gateway to the Himalayas. In these mountains, nobody would guess that this water will be transformed into one of the most heavily polluted rivers in the world, with fecal bacteria levels up to

31 million per 100 milliliters. This is according to reports from Sankat Mochan Foundation, an organisation struggling to restore the Ganges to its former glory. These levels mean that the sacred river has become synonymous with water pollution, a worldwide problem affecting one in every three people on the planet, according to the United Nations (UN).

The World Health Organization (WHO) says that polluted water is water whose composition has been changed to the extent that it is unusable. In other words, it is toxic water that cannot be drunk or used for essential purposes like agriculture, and which also causes diseases like diarrhea, cholera, dysentery, typhoid and poliomyelitis that kill more than 500,000 people worldwide every year.

The main water pollutants include bacteria, viruses, parasites, fertilizers, pesticides, pharmaceutical products, nitrates, phosphates, plastics, fecal waste and even radioactive substances. These substances

do not always change the colour of the water, meaning that they are often invisible pollutants. That's why small amounts of water and aquatic organisms are tested to determine water quality.

#### CAUSES OF WATER POLLUTION

It is sometimes caused by nature, such as when mercury filters from the Earth's crust, polluting oceans, rivers, lakes, canals and reservoirs. However, the most common cause of poor quality water is human activity and its consequences, which may be listed as follows:

* Global warming: Rising global temperatures caused by CO2 emissions heat the water, reducing its oxygen content.
* Deforestation: Felling forests can exhaust water resources and generate organic residue which becomes a breeding ground for harmful bacteria.
* Industry, agriculture and livestock farming: Chemical dumping from these sectors is one of the main causes of eutrophication of water.
* Rubbish and fecal water dump: The UN says that more than 80% of the world's sewage finds its way into seas and rivers untreated.
* Maritime traffic: Much of the plastic pollution in the ocean comes from fishing boats, tankers and cargo shipping.
* Fuel spillages: The transportation and storage of oil and its derivatives is subject to leakage that pollutes our water resources.

#### Ground water pollution:

Ground water contamination is nearly always the result of human activity. In areas where population density is high and human use of the land is intensive, ground water is especially vulnerable. Virtually any activity whereby chemicals or wastes may be released to the environment, either intentionally or accidentally, has the potential to pollute ground water. When ground water becomes contaminated, it is difficult and expensive to clean up.

Ground water and contaminants can move rapidly through fractures in rocks. Fractured rock presents a unique problem in locating and controlling contaminants because the fractures are generally randomly spaced and do not follow the contours of the land surface or the hydraulic gradient. Contaminants can also move into the ground water system through macro pores root systems, animal burrows, abandoned wells, and other systems of holes and cracks that supply pathways for contaminants. In areas surrounding pumping wells, the potential for contamination increases because water from the zone of contribution, a land area

larger than the original recharge area, is drawn into the well and the surrounding aquifer. Some drinking water wells actually draw water from nearby streams, lakes, or rivers. Contaminants present in these surface waters can contribute contamination to the ground water system. Some wells rely on artificial recharge to increase the amount of water infiltrating an aquifer, often using water from storm runoff, irrigation, industrial processes, or treated sewage. In several cases, this practice has resulted in increased concentrations of nitrates, metals, microbes, or synthetic chemicals in the water.

#### MAJOR WATER POLLUTANTS

**Improper Disposal of Hazardous Waste**

Hazardous waste should always be disposed of properly, that is to say, by a licensed hazardous waste handler or through municipal hazardous waste collection system. Many chemicals should not be disposed of in household septic systems, including oils (e.g., cooking, motor), lawn and garden chemicals, paints and paint thinners, disinfectants, medicines, photographic chemicals, and swimming pool chemicals. Similarly, many substances used in industrial processes should not be disposed of in drains at the workplace because they could contaminate a drinking water source. Companies should train employees in the proper use and disposal of all chemicals used on site. The many different types and the large quantities of chemicals used at industrial locations make proper disposal of wastes especially important for ground water protection.

#### Releases and Spills from Stored Chemicals and Petroleum Products

Underground and above ground storage tanks are commonly used to store petroleum products and other chemical substances. For example, many homes have underground heating oil tanks. Many businesses and municipal highway departments also store gasoline, diesel fuel, fuel oil, or chemicals in on-site tanks. Industries use storage tanks to hold chemicals used in industrial processes or to store hazardous wastes for pickup by a licensed hauler. Approximately 4 million underground storage tanks exist in the United States and, over the years, the contents of many of these tanks have leaked and spilled into the environment. If an underground storage tank develops a leak, which commonly occurs as the tank ages and corrodes, its contents can migrate through the soil and reach the ground water.

#### Landfills : Solid waste is disposed of in thousands of municipal and industrial landfills throughout the country.Chemicals that should be disposed of in hazardous waste landfills sometimes end up in municipal landfills. In addition, the disposal of many household wastes is not regulated.

As a result, chemicals can leach into the ground water by means of precipitation and surface runoff. New landfills are required to have clay or synthetic liners and leachate (liquid from a landfill containing contaminants) collection systems to protect ground water. Older landfills, however, do not have these safeguards. Older landfills were often sited over aquifers or close to surface waters and in permeable soils with shallow water tables, enhancing the potential for leachate to contaminate ground water. Closed landfills can continue to pose a ground water contamination threat if they are not capped with an impermeable material (such as clay) before closure to prevent the leaching of contaminants by precipitation.

#### Improperly Abandoned Wells

These wells can act as a conduit through which contaminants can reach an aquifer if the well casing has been removed, as is often done, or if the casing is corroded. In addition, some people use abandoned wells to dispose of wastes such as used motor oil. These wells may reach into an aquifer that serves drinking supply wells. Abandoned exploratory wells (e.g., for gas, oil, or coal) or test hole wells are usually uncovered and are also a potential conduit for contaminants.

#### Water pollution-Control measures

**pH Control**

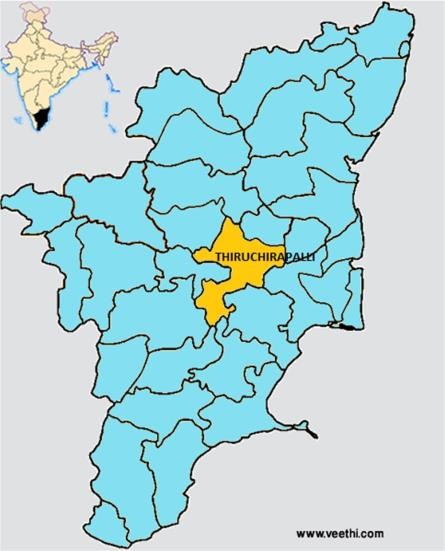
The pH of the waste waters can vary significantly depending on the cleaning strategy employed. The pH of wastewater also needs to be altered first because the efficient coagulation will exclusively work only in certain pH conditions . For acidic wastes (low pH): NaOH, Na2CO3, CaCO3 or Ca(OH)2 are used. For alkali wastes (high pH): H2SO4 and HCl are used.

#### Coagulation

Coagulation refers to the way of collecting small particles dispersed in a liquid form into bigger aggregates or become flocs by adding chemical or natural coagulant . These particulates (flocs) will adsorb dissolved organic matter. An important design and control parameter during coagulation- flocculation is the size distribution of floc aggregates. Aggregation size distribution as well as aggregate structure and density are of great importance in solid-liquid separation processes such as sedimentation . This whole process reduces turbidity and dissolved chemical species in liquids. Coagulation is one of the most widely used physicochemical operations used in water, and wastewater treatment, as it is efficient and

simple to operate and can be achieved by chemical and electrical means . Coagulation reduces the suspended/ dissolved (especially non-settleable solids and colour), organic matter and colloidal materials responsible for turbidity of the wastewater for removal from the water being treated.

# STUDY AREA



Tiruchirappalli, situated on the banks of the river Cauvery is the fourth largest city in Tamil Nadu. It was a citadel of the early Cholas which later fell to the Pallavas. Trichy is a fine blend of tradition and modernity built around the Rock Fort. Apart from the Fort, there are several Temples dating back to the 1760s. The town and its fort, now in Trichy were built by the Nayaks of Madurai. This District has given great scholars and leaders whose contributions to the society have been very significant.

Woraiyur, a part of present day Tiruchirappalli, was the capital city of Cholas from 300 B.C. onwards. This is supported by archaeological evidences and ancient literatures. There are also literary sources which tell that Woraiyur continued to be under the control of Cholas even during the days of Kalabhra interregnum (A.D. 300 - 575).

Tiruchirappalli district lies almost at the exact centre of Tamil Nadu. The district has an area of 4,404 square kilometers. It is bounded in the north by Perambalur district, northwest by Namakkal district, in the northeast by Ariyalur District, east by Thanjavur district in the southeast by Pudukkottai district and Sivagangai district, in the south by Madurai district, in the southwest by Dindigul district and, in the west by Karur district. The district shares its borders with 10 other districts, the highest for any district in the state. The Kaveri river flows through the length of the district and is the principal source of irrigation and drinking water.

Trichy district is situated almost at the geographic central point of the state Tamil Nadu. The district lies between 10° 48' 18o of northern latitude and 78° 41' 8.16o eastern longitude.

Approximating the statistical norm, the elevation of the area is indicated at 88 metres. The topographic study of Trichy considering history of the place as indicated by its topography is virtually having a surface without slope, tilt in which no part is higher or lower than another.

Trichy spread over an area of 146.7 square kilometres bordered on the north by Salem District, on the northeast by Perambalur District, on the east by Thanjavur District, on the southeast by Pudukkottai District, on the south by Sivaganga and Madurai districts, on the southwest by Dindigul District, on the west by Karur District, and on the northwest by Namakkal District.

There is a relief from the hot summer for people in Trichy during August-October, where the district experiences moderate climate followed by heavy rainfalls. During November-February period, there is cool and pleasant climate which normally excites the local population. Fog and mist are very rare occurrences in the district. But one may be lucky enough to enjoy them during winter season. North-East monsoon season in Trichy district occurs during November-December. During this period, the district receives intermittent rainfall. The district receives an average rainfall of **722.6 mm**. The maximum temperature can go up to **37.2**

**?C** and minimum temperature can go down to **20.6oC**.

Tiruchirappalli experiences a dry-summer tropical savanna climate (Köppen climate classification: As), with no major change in temperature between summer and winter. The climate is generally characterized by high temperature and low humidity. With an annual mean temperature of 28.9 °C (84.0 °F)and monthly average temperatures ranging between 25 °C (77 °F) and 32 °C (90 °F), the city is the hottestin the state.[105] The warmest months are from April to June, when the city experiences frequent dust storms. As of November 2013, the highest temperature ever recorded in Tiruchirappalli was 43.9 °C (111.0

°F), which occurred on 2 May 1896; the lowest was observed on 6 February 1884 at 13.9 °C (57.0 °F). The high temperatures in the city have been attributed to the presence of two rivers—Kaveri and Kollidam and

the absence of greenery around the city. As Tiruchirappalli is on the Deccan Plateau the days are extremely warm and dry; evenings are cooler because of cold winds that blow from the south-east.From June to September, the city experiences a moderate climate tempered by heavy rain and thundershowers. Rainfall is heaviest between October and December because of the north-east monsoon winds, and from December to February the climate is cool and moist.The average annual rainfall is 841.9 mm (33.15 in), slightly lower than the state's average of 945 mm (37.2 in).Fog and dew are rare and occur only during the winter season.

**MATERIALS AND METHODS**

Sample Collection:

The samples were collected in polyethylene bottles (1 liter capacity) which were thoroughly washed, filled with distilled water and then taken to the sampling site. The bottles were emptied and rinsed several times to collect water. Also, the sample bottles were partially filled with the collected water and vigorously shaken to note the odour. The sample bottles were tightly covered immediately after collection and the temperature is noted. They were then stored in a refrigerator at 4°C to slow down bacterial and chemical reaction rates. All the parameters were analyzed using standard procedures .

#### Quantity of Sample

Generally 2.5 liters of samples are sufficient for most of the physical and chemical examinations. For certain special determinations, however, larger volumes of sample were taken.

#### Sample Container

The samples were collected in 2.5 L plastic cans. Prior to use, the cans were cleaned thoroughly rinsing with tap water, then with 1% nitric acid and finally with distilled water. Then the bottles were dried, cooled and labelled. For the estimation of DO, BOD and COD, well sterilized BOD bottles were used. The same was carried for the analysis.

#### Time Interval between Collection and Analysis

In general, shorter the time between collection and analysis, the more accurate will be the results. No specific time interval between collection and analysis can be generalized. This depends upon the nature of the sample, constituents to be determined and conditions of storage. The samples were kept out of light (to retard the growth of organisms) at low temperature (4°C). The samples for DO analysis were fixed at the field itself. The physico- chemical parameters and heavy metals were determined in the laboratory.

#### Preservation of Samples

Preservatives were added to the samples used for COD and heavy metal estimations.

The preservatives/conditions are:

* 1. COD: Con. H2SO4
  2. Heavy Metals: Con. HCl

1. BOD estimation: the samples were stored at 4°C for 24 hrs.

#### Methodology

1. **pH**

#### pH is the negative log10 of the hydrogen ion concentration in a solution. It can be

measured by colorimetric methods using various indicators or paper strips. However, the use of colorimetric methods is less convenient and less accurate. For accurate measurement of pH electrometric methods are used, employing the hydrogen ion sensitive electrodes.

There are a number of models available for pH meters. Potable pH meters operated

by battery can also be obtained. The accuracy of pH can vary from 0.01 to 0.1 depending on the make. Some pH meters employ two electrodes, an indicator glass electrode, and a calomel reference electrode, while others may have a combined glass and reference electrodes. Most pH meters also have a temperature compensation system to avoid the differences arising due to the different temperature.

* 1. An essential aspect to use all the pH meters (Elico-Model CM - 180) is to calibrate it with suitable buffers. Buffers of pH values are also available in the market. Set the pH meter with a buffer whose value is near to the expected pH of the sample.
  2. Buffers of different pH values can also be made in the laboratory in the following

manner:

#### Potassium hydrogen phthalate buffer

10.2 g of potassium hydrogen phthalate was dissolved in water for the preparation of 1000 ml potassium hydrogen phthalate buffer.

#### Phosphate buffer

3.40 g of KH2PO4 and 4.45 g of NaHPO4.2H2O were dissolved in 1000 ml of water for the preparation of phosphate buffer.

#### Borax buffer

1000 ml of borax buffer was prepared by dissolving 3.81 g of Na2B4O7.10H2O crystals with water.

#### Electrical Conductivity

water.

Electrical conductance is the ability of a substance to conduct the electric current in

Electrical Conductivity was measured using Digital Conductivity Meter (Elico-Model

CM-180).

#### Total Dissolved Solids (TDS)

Total dissolved solids were determined as the residue left after evaporation of the filtered

sample.

* 1. The samples was taken in an evaporating dish and ignited at 550°C ± 500 °C muffle furnace for about an hour and kept in a desiccator and weighed.
  2. The sample was filtered through glass fiber filter paper.100 ml of this filtered sample was evaporated (or more in case the solids are less than 25 mg / L) in the pre weighed evaporating dish on a water bath or a hot plate having a temperature not more than 98°C
  3. The residue was heated at 103-105°C in an oven for one hour and the final weight was taken after cooling in desiccators.

#### Calculation

TDS (mg/l) = A-B × 1000 × 1000/V

Where A = Final weight of the dish in g B = Initial weight of the dish in g

V = Volume of the sample taken in ml

#### Total Hardness

In alkaline condition, EDTA reacts with Ca and Mg to form a soluble chelated

complex. Ca and Mg ions develop wine red colour with Eriochrome black T under alkaline conditions. When EDTA is added as a titration, Ca and Mg divalent ions get complexed resulting in a sharp change from wine red to blue colour which indicates end-point of the titration. The pH of this titration has to be maintained at 10.0 ± 0.1. At a higher pH, (about 12.0), Mg2+ ion precipitates and only Ca2+ ion remains in solution. At this pH, Murexide indicator forms a pink colour with Ca2+. When EDTA is added to it, Ca2+ gets complexed resulting a change from pink to purple, which indicates the end point of the reaction. Metal ions do interfere, but can be overcome by the addition of inhibitors.

Total hardness, calcium hardness, Magnesium hardness, DO, Biochemical Oxygen

Demand and Chemical Oxygen Demand were analysed using standard procedures.

#### Heavy Metals

The heavy metals elemental analysis of water samples have been determined by Atomic Absorption Spectroscopy. The elements like Iron, Nickel, Zinc, Lead and Copper have been analyzed. Flame Spectroscopy is an analytical technique used for the qualitative and quantitative determination of the element in a sample. In this method the sample, in the form of a homogenous liquid, is introduced into a flame where thermal and chemical reactions create

„free‟ atoms capable of absorbing, emitting or fluorescing at characteristic wavelengths. In atomic absorption spectroscopy the majority of free atoms in the commonly used flames is in the ground state. A light source emitting a narrow spectral line of the 37 characteristic energy is used to excite the free atoms formed in the flame. The decrease in energy (absorption) of the light is then measured. The absorption is proportional to the concentration of free atoms in the flame, given by the Lambert - Beer law. Absorbance = log I0 (I0 / It) = k c l

Where I0 = Intensity of incident radiation emitted by the light source It = Intensity of transmitted radiation (amount not absorbed) c = Concentration of sample (free atom)

k = Constant (can be determined experimentally) l = Path length.

This is the most common method where interference effects are known to be absent. Usually at least three standards and a blank are used to cover the range of 0.1 to 0.8 absorbance. The calibration blank solution is used to calibrate the instrument.

**RESULTS AND DISCUSSION**

1. **pH**

pH, quantitative measure of the acidity or basicity of aqueous or other liquid solutions.

The term, widely used in chemistry, biology, and agronomy, translates the values of the concentration of the hydrogen ion-which ordinarily ranges between about 1 and 10−14 gram- equivalents per litre-into numbers between 0 and 14. The pH were in the range of 7.2-

7.6 The ideal pH for drinking water is 6.5-8.5.



**Sampling variation of pH**

7.8

7.6

7.4

7.2

7

1

2

3

4

5

6

7

8

9

10

**Sampling stations**

#### Electrical conductivity

**pH**

Electrical conductivity is the measure of the amount of electrical current a material can carry or its ability to carry a current. The electrical conductance were in the range of 1140-5080 micro ohms/cm.in the presence study of the EC values in all the water sample are found above the permissible limits set by WHO values (600 micro ohms/cm).



40

**sampling variations in electrical**

**conductivity**

30

20

10

0

1

2

3

4

**sam**5**pling sta**6**tions**

7

8

9

10

**electrical conductivity**

#### Salinity



5000

**sampling variations in TDS**

4000

3000

2000

1000

0

1

2

3

4

5

6

7

8

9

10

**sampling stations**

The term "salinity" refers to the concentrations of salts in water or soils. Salinity can take three forms, classified by their causes: primary salinity (also called natural salinity); secondary salinity (also called dry land salinity), and tertiary salinity (also called irrigation salinity). Salinity for drinking water can range between1-2.

#### TDS



4

**sampling variations in salinity**

3

2

1

0

1

2

3

4 **sam**5**pling stat**6**ions** 7

8

9

10

**salinity**

Total dissolved solid (TDS) are the total amount of mobile charged ions,

including minerals, salts or metals dissolved in a given volume of water, expressed in units of mg per units volume of water (mg/L), also referred to as parts per million (ppm).TDS is directly related to the purity of water and the quality of water purification systems and affect everything that consumes, lives in, or used water, whether organic or inorganic, whether for better or for worse. Total dissolved solids values are found to be in the range of 800 - 1500ppm. Not all the values of water samples are above the permissible limits of WHO value is (500ppm).

**TDS**

#### DO

The amount of free oxygen dissolved in water, expressed in mg/L, parts per-million

(ppm), or in percent of saturation, i.e. where saturation pertains the maximum amount of oxygen that can be dissolved theoretically in water at particular altitude and temperature. The dissolved oxygen concentration is found to be the range 3- 5ppm. The permissible limits for dissolved oxygen set by WHO value is 5ppm.



6

**sampling variations in DO**

4

2

0

1

2

3

4 **sam**5**pling sta**6**tions** 7

8

9

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#### BOD

**DO**

Biological Oxygen Demand is defined as the amount of dissolved oxygen

required by aerobic microorganisms to breakdown the organic materials in a sample of water at a specific temperature & timeframe. The BOD concentration is found to be range 14-29 ppm. BOD values of all river water samples are found to be above the permissible limit of WHO value 10 ppm in all the river water samples.



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**sampling variations in BOD**

30

20

10

0

1

2

3

4 **sam**5**pling stat**6**ions** 7

8

9

10

**BOD**

#### COD

The chemical oxygen demand (COD) is a measure of water and wastewater quality. The COD test is often used to monitor water treatment plant efficiency. The COD concentration is found to be in the range of 23-37 ppm. COD values of all water samples are found to be above the permissible limit of WHO value 10ppm in all the river water sample.



**sampling variations in COD**

40

35

30

25

20

15

10

5

0

1

2

3

4

**sa** 5 **ling sta** 6 **ns**

**mp**

**tio**

7

8

9

10

**COD**

#### Cu

Copper is a metal that exists in the environment as a mineral in rocks and soil. It is

commonly found at low levels in natural water bodies. It is also an essential trace element that is required to maintain good health. The copper values are found to be in the range of 0.03- 0.11ppm.All river water samples are found in the range below the permissible limit of WHO value (2ppm).



**Variation of Cu**

0.15

0.1

0.05

0

1

2

3

4

5

6

7

8

9

10

**Sampling stations**

**Cu**

#### Pb

**Ni**

The Cauvery river water quality standard of lead is desirable and maximum permissible limit (WHO) is 0.01 mg/l. All of the water samples are exceeding then WHO desirable limit and maximum permissible limit of Pb. The concentration of pb in the samples varies from 0.03 to 0.21 ppm.



**sampling variations in Pb**

0.3

0.2

0.1

0

1

2

3

4

5

6

7

8

9

10

**sampling stations**

**Pb**

#### Nickel

Nickel is a chemical element and abundant on Earth, most notably the planet's iron/nickel core. It is also used in fertilizers and enters groundwater from farm runoff. The human body contains about 10 mg of Nickel. water generally contributes 0.005–0.025 mg daily. The nickel values are found to be in the range of 0.16-0.27ppm.



**sampling variations in Ni**

0.3

0.25

0.2

0.15

0.1

0.05

0

1

2

3

4

**sam**5**pling sta**6**tions**

7

8

9

10

#### Table:1

#### Influence of industrial wastes in Uyyakondan canal water - Tiruchirappalli

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **parameters** | **pH** | **EC** | **Salinity** | **TDS**  **ppm** | **DO**  **ppm** | **BOD**  **ppm** | **COD**  **ppm** | **Cu**  **ppm** | **Pb**  **ppm** | **Ni**  **ppm** |
| **Sampling station** |
| **A1** | 7.55 | 1803 | 1.3 | 1190 | 4 | 29 | 33 | 0.11 | 0.03 | 0.20 |
| **A2** | 7.48 | 1660 | 1.2 | 1070 | 4 | 22 | 31 | 0.05 | 0.03 | 0.23 |
| **A3** | 7.64 | 1900 | 1.4 | 1500 | 5 | 17 | 37 | 0.03 | 0.08 | 0.24 |
| **A4** | 7.60 | 1300 | 0 | 800 | 3 | 16 | 23 | 0.08 | 0.05 | 0.22 |
| **A5** | 7.39 | 1530 | 1.0 | 990 | 3 | 19 | 29 | 0.04 | 0.13 | 0.26 |
| **A6** | 7.53 | 1770 | 1.2 | 1140 | 4 | 16 | 31 | 0.05 | 0.14 | 0.16 |
| **A7** | 7.24 | 5080 | 3.8 | 3300 | 5 | 24 | 36 | 0.07 | 0.17 | 0.19 |
| **A8** | 7.27 | 1720 | 1.1 | 1110 | 4 | 26 | 37 | 0.12 | 0.18 | 0.27 |
| **A9** | 7.67 | 1140 | 0.14 | 900 | 3 | 24 | 35 | 0.02 | 0.21 | 0.16 |
| **A10** | 7.66 | 1310 | 1.4 | 1140 | 4 | 14 | 28 | 0.11 | 0.21 | 0.19 |

#### CONCLUSION

The river water samples were collected from Uyyakondan canal of ten different stations in and around Trichy district and the physico - chemical parameters like Salinity, Conductance, TDS, pH, DO, Chemical oxygen demand, Biological oxygen demand and heavy metals Copper, lead and nickel were analyzed by using standard procedures.

Most of the physico - chemical parameters and heavy metal concentrations were above the permissible limits of WHO values. The results are compared with the prescribed values of WHO for each parameter. The analysis of the water quality parameter shows that EC, TDS, DO, COD, BOD are found to be higher than the permissible limit of the WHO value and PH, Temperature, Copper and nickel are found to be lower than the permissible limit of the WHO values.

Due to the presence of industries in the area, the water in this area is recommended to be fit for domestic purposes and unfit for drinking. So, people should be made aware of the water quality. By sanitations and economical water treatments like filtration and boiling would prove beneficial to avoid water born diseases. The remedial measures must be taken to safe guard and conserve the precious water resources from pollution for future generation.

#### REFERENCES

1. Rakesh Singh Asiwal, Dr. Santosh Kumar Sar\*, Shweta Singh, Megha Sahu (2019).Wastewater Treatment by Effluent Treatment Plants. International Journal of Civil Engineering. Vol (3) 12, pp29-34
2. M. Romeo Singh and Asha Gupta, Centre for Biodiversity, Department of Botany Nagaland University, Lumami-798627, India- Water pollution- sources, effects and control (2016)
3. Shamsul Haq, Shoukat Ara, Syed Maqbool Geelani and Asma Absar Bhatt (2016). Assessment of surface and ground water for irrigational purposes, International Journal of Applied And Pure science and Agriculture, vol.(2), no. 2 (2016).
4. Manish Kumar, Gurmeet Singh, Tushara Chaminda, Pham Van Quan and Keisuke Kuroda (2014). Emerging Water Quality Problems in Developing Countries, The Scientific World Journal . no.158796.
5. Roy and Ritabrata (2018), An Introduction to water quality analysis, International Journal for Environmental Rehabilitation and Conservation, no. 3, pp. 94-100.
6. Subodh Kumar, Hari Mohan Meena and Kavita Verma (2017), Water Pollution in India: Its Impact on the Human Health: Causes and Remedies, International Journal of Applied Environmental Sciences,vol.(12), no. 2, pp. 275-279.
7. K Gopavanitha and S Nagaraju (2017), A low cost system for real time water quality monitoring and controlling using IOT,International Conference on Energy, Communication, Data Analytics and Soft Computing.
8. Brinda Das and P C Jain (2017), Real-time water quality monitoring system using Internet of Things, 2017 International Conference on Computer, Communications and Electronics.
9. Agbugui, M.O. and Deekae, S. N (2014). Assessment of the physico-chemical parameters and Quality of water of the New Calabar-Bonny River, Port- Harcourt, Nigeria. Cancer Bio 4(1)pp1-9
10. Effiong, Y. I., George, U. U., Mbong, E. O.Spatial and Seasonal Variations in Water Quality parameters of a Humid Tropical River, Niger Delta, Nigeria, Researcher 2021;13(4).

11.Poonam Prasad & Meenal Chaurasia &R. A. Sohony & Indrani Gupta & R. Kumar.Water quality analysis of surface water: a Web approach(2013)

12.Kalbus, F. Reinstorf, and M. Schirmer UFZ – Centre for Environmental Research Leipzig- Halle in the Helmholtz Association, Department of Hydrogeology, Permoserstr. Leipzig, Germany(2006)

1. N.N. Mitina Institute of Water Problems, Russian Academy of Sciences, Moscow, Russia. properties of oceans, inland seas, coastal zones, and estuaries.Vaughn Barrie, Kim Picard, in Seafloor Geomorphology as Benthic Habitat, 2012.
2. Yu. K. Vasil'chuk and A.C. Vasil'chuk ,Types And Properties Of Water – Vol. II– Chemical Properties of Glacial and Ground Ice – Yu. K. Vasil’chuk(2009)
3. Nitin Bassi M. Dinesh Kumar Anuradha Sharma P .Pardha-Saradhi- Status of wetlands in India: A view of extent, ecosystem benefits, threats and management strategies, Journal of Hydrology: Regional Studies 2 (2014) 1–19.