

SEAWATER INTRUSION AND WATER QUALITY STUDY OF COASTAL REGIONS OF KANCHEEPURAM

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in
Civil Engineering

by

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY – 2022



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Abhinav Manodh(38200001)**, **Joel Sathiyar Varughese(38200013)** carried out the project entitled "**SEAWATER INTRUSION AND WATER QUALITY STUDY OF COASTAL REGIONS OF KANCHEEPURAM**" under our supervision from December 2021 to April 2022.


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Submitted for Viva voce Examination held on _____

Internal Examiner

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DECLARATION

We **Abhinav Manodh and Joel Sathiyar Varughese** hereby declare that the Project Report entitled **SEAWATER INTRUSION AND WATER QUALITY STUDY OF COASTAL REGIONS OF KANCHEEPURAM** done by us under the guidance of Ms.ESHANTHINI.P is submitted in partial fulfilment of the requirements for the award of **Bachelor of Engineering degree in Civil Engineering**.

DATE: 19-04-2022

PLACE: CHENNAI

1. 

2. 

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Seawater intrusion and submarine groundwater outflow are two opposing processes that are essential in groundwater management in coastal areas. Groundwater is the principal supply of water for drinking, agriculture, and other industrial applications in locations where there are no rivers. This study aims to identify the seawater intrusion zones along Kancheepuram district coastal regions. During the study, groundwater and ocean samples were collected along the coastal zones. Thirteen water samples have been collected. The collected water samples have been tested for the following physio-chemical parameters includes colour, odour, turbidity, total suspended solids, total dissolved solids, electrical conductivity, salinity, total alkalinity, and total hardness. The possible places of seawater intrusion were identified based on groundwater electrical conductivity. From the journal (V.Manivannan et al. 2020) if the electrical conductivity is more than 3000 $\mu\text{S}/\text{cm}$, it indicates that there is seawater intrusion. The result of the analysis shows that the electrical conductivity range of all the sampling locations are within the limits, which reveal that there is no seawater intrusion in Kancheepuram's coastal regions.

Keywords: Groundwater, Seawater intrusion and Electrical Conductivity.

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LIST OF ABBREVIATIONS

SWI	Seawater Intrusion
GW	Groundwater
EC	Electrical Conductivity
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
ArcGIS	Aeronautical Reconnaissance Coverage
	Geographic Information System
pH	Potential of Hydrogen
mg/l	Milligram per litre
µS/cm	Microohms per cm
NTU	Nephelometric Turbidity Units

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CHAPTER 1

INTRODUCTION

Natural processes in coastal regions include seawater intrusion and undersea groundwater discharge. Seawater intrusion is the passage of seawater into the aquifer from the land. The movement of fresh groundwater into sea from the aquifer is called submarine groundwater discharge. The seawater intrusion phenomena affects several aquifers across the world that are located in coastal locations. The increasing need for freshwater has been imposed by the development of population in coastal areas, as well as the concomitant increase in human, agricultural, and industrial activity. Horizontal encroachment from the ocean due to excessive water withdrawals from coastal aquifers, or upward movement from deeper saline zones due to upconing at coastal discharge/pumping wells are the two processes that cause seawater intrusion into coastal aquifers. This rise in water demand is frequently addressed by significant groundwater pumping, lowering the water table and disturbing the dynamic balance between freshwater and saltwater water bodies. Seawater intrusion raises the salinity of groundwater, making it unfit for human consumption. It is important to recognise the extent of saline water incursion in order to prevent groundwater quality degradation. With denser seawater below freshwater, a contact between freshwater and seawater is maintained.

Reduced water levels in a coastal aquifer can lead seawater to be attracted into the aquifer's freshwater zones when groundwater is drained from it. The influx of seawater reduces the amount of freshwater stored in the aquifers. This groundwater does not meet drinking-water or agricultural water-quality standards if it is not treated. In the coastal region, the impacts of salt water intrusion affect not only the community and financial systems, but also the entire environment of the afflicted area. It also can be a major issue for coastal populations who rely on fresh groundwater for their survival.

In natural situations, there is a constant interplay between surface and subsurface water bodies. Surface water bodies are frequently employed as groundwater discharge points in humid regions. Streams and lakes, for example, function as natural drainage systems because of the enormous recharge of groundwater caused by rainfall events, and the subsurface flow is largely directed towards them. Water travels from surface water bodies to groundwater systems in arid and semi-arid regions. As a result, the salinity and pollution levels of these surface water bodies have an impact on groundwater quality.

After air, water is one of the most important requirement in life. Water quality has received a lot of attention in the scientific community. "It is the physical, chemical, and biological qualities of water," says the most common definition of water quality. The ability of a body of water to suit the needs of one or more biotic species, as well as any human need or purpose, is referred to as water quality. Water is divided into four groups based on its quality.

The purpose of this study is to find out whether or not there is seawater intrusion in the coastal regions of Kancheepuram. The pH, electrical conductivity, salinity, and various other parameters of water samples were measured in this study at Kancheepuram's coastal regions. The Kanchipuram shoreline stretches between Tiruvanmiyar and Chunampet. As a result of this study, we will be able to assess whether the water is safe to drink.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

A study review's main goal is to provide a summary of the research as well as in-depth knowledge about the research that has been undertaken. This serves as the foundation for carrying out work and formulating project strategy. The research study on integrated seawater intrusion in coastal regions was identified in the following literature survey.

2.2 LITERATURE SURVEY

Eyal Shalev (2021), completed a journal on the Seawater Intrusion into Coastal Aquifers in the western coastal aquifers of South Korea. According to this report, seawater intrusion studies have been done in South Korea's west coastal aquifers during the previous two decades. When saltwater is injected into the ground, cation exchange activities take place, as do intentional pollution, water-rock interactions and redox processes that alter groundwater geochemistry.

Sung-Wook Jeon et al., (2021), Review of Seawater Intrusion in Western Coastal Regions of South Korea. In this review paper, we were able to comprehend the many seawater intrusion investigations carried out in South Korea's western coastal districts, as well as the general methods for detecting and interpreting seawater intrusion and the associated geochemical processes.

Zuleikha Pembe-Ali et al., (2021), did a review on Application of the Kilimanjaro Concept in Reversing Seawater Intrusion and Securing Water Supply in Zanzibar, Tanzania. In this study, for the first time, the generic notions of KC are adapted to the specificities of a site, Zanzibar Island. Water management in this case includes groundwater recharge, which stops and reverses seawater intrusion.

Leticia Baena-Ruiz and David Pulido-Velazquez (2021), did a paper on GIS-SWIAS: Tool to Summarize Seawater Intrusion Status and Vulnerability at Aquifer Scale. They present GIS-SWIAS, a unique generalised ArcGIS ArcToolbox that aids in the analysis of seawater intrusion (SWI) status and vulnerability at the aquifer scale (SWIAS) in this study.

Antoifi Abdoulhalik et al., (2021), did a review towards a Correlation between Long-Term Seawater Intrusion Response and Water Level Fluctuations. An important aspect of water resources management, boundary water level changes and external measures of seawater intrusion are linked in this experiment in a controlled laboratory setting for the first time.

Muhammad Hasan et al., (2020) did a Geophysical Assessment of Seawater Intrusion into Coastal Aquifers of Bela Plain in Pakistan. The purpose of this study was to determine the boundaries between saline, brackish, and fresh groundwater in a coastal area of Pakistan (Bela Plain). The research area is experiencing seawater intrusion as a result of over-exploitation of freshwater resources, particularly for agricultural purposes, and this poses a significant challenge for the proper management of freshwater resources in Bela Plain.

Swayam Siddha and Paulami Sahu (2020) did a review on the status of seawater intrusion in coastal aquifer of Gujarat. They conducted this research to assess the vulnerability of Gujarat's coastal aquifers to SWI. They also concentrate on the numerous scientific studies and management strategies that can be used to tackle the SWI threat.

Manivannan et al., (2020) Identification of seawater intrusion and submarine groundwater discharge zones: A case study along the coastal part of South Chennai, was a preliminary study to identify the sea water intrusion and submarine groundwater discharge zone. 22 ground water samples and 21 pore water samples were collected in this study. Groundwater and pore water pH ranged from slightly

acidic to neutral. In this area, the pH of groundwater was higher than that of pore water.

Prusty.P and Farooq. S.H (2020) did a journal on “Seawater intrusion in the coastal aquifers of India”, and found out that the problem of seawater intrusion is more frequent in Tamil Nadu, and very saline ground water extends to deep inland places. The main cause of ground water salinity in the state has been recognised as the presence of saltpans with excessive ground water pumping.

Costall.A.R et al., (2020), Groundwater throughflow and Seawater Intrusion in High Quality Coastal Aquifers. Seawater intrusion and increasing stress on coastal groundwater systems are clearly demonstrated in this study.

Senthilkumar. S et al., (2019) did an Integrated seawater intrusion study of coastal region of Thiruvallur district where the sea water intrusion was assessed using integrated geochemical and geophysical techniques. The influence of sea water intrusion was effectively indicated by major ionic composition, TDS, sodium, and chloride concentrations in this study.

Min Wang et al., (2019) completed a study on seawater intrusion in Laizhou bay coastal zone based on groundwater model. Monitoring groundwater chlorinity along the coast of Laizhou Bay helped determine the degree of seawater intrusion, and the causes of seawater intrusion were investigated, providing a reference for seawater intrusion catastrophe prevention and control.

Nawal Alfarrah and Kristine Walraevens (2018) completed a research on Groundwater overexploitation and seawater intrusion in coastal areas of arid and semi-arid regions. Seawater intrusion with chemical processes alters the hydrochemistry of the coastal aquifer in this study. Artificial recharge of coastal aquifers, which are particularly overexploited, may provide an effective technique of

countering seawater intrusion and thereby preventing an unavoidable and irreversible decline of water quality.

Mehdi Nezhad Naderi et al., (2013), did a review paper on Seawater intrusion and groundwater resources management in coastal aquifers. It is determined in this work using earlier research correlations that the height of the seawater-freshwater interface in Mazandaran coastal aquifers is. In the Mazandaran coastal aquifers, sections A, B, and O have been found to be unsuitable for extraction development.

Harikrishna. K et al., (2012), a Study on Saltwater Intrusion around Kolleru Lake, Andhra Pradesh, India. In this article, the analysis of Vertical Electrical Soundings (VES) data and chemical data from observation wells near the resistivity location, as well as hydrogeomorphic units, is compared.

Paul M. Barlow (2010), completed a study on Salt water intrusion in coastal regions of North America. The goals of this study was to present a synopsis of the amount and types of seawater intrusion along North America's coastal regions, as well as a quick assessment of the future prospects for managing saltwater intrusion issues.

Adekunle Abraham Adepelumi (2008), did a journal on Delineation of Saltwater intrusion into the freshwater aquifer of Lekki Peninsula, Lagos, Nigeria. The Schlumberger sounding resistivity method was found to be an effective instrument for evaluating the saltwater-freshwater interface in a coastal environment in this study.

Letha and D. B. Krishnan (2008) did a case study on Seawater intrusion into coastal aquifers. The goal of this work was to simulate seawater intrusion into coastal aquifers using a numerical code that has already been developed and

published in the literature, and to use it in this study to estimate the extent and pattern of seawater intrusion in the study region.

Maria A. Koukadaki et al., (2007), a journal on Identification of the Saline Zone in a Coastal Aquifer using Electrical Tomography Data and Simulation. Faults, which affect groundwater flow and the distribution of freshwater and saltwater, were discovered in this study.

Sherif. M.M and Singh. V.P (2002), Effect of Groundwater Pumping on Seawater Intrusion in Coastal Aquifers was the subject of the review paper. This research examines the phenomena of seawater intrusion in coastal aquifers. In Egypt's Nile Delta aquifer, researchers are looking into the effects of pumping operations on seawater intrusion. For any further pumping to take place, it was decided that it should be concentrated in the middle of the Delta.

CHAPTER 3

AIM AND SCOPE OF THE INVESTIGATION

3.1 AIM

1. To collect groundwater samples and pore water samples from the coastal regions of Kancheepuram.
2. To determine the various physio-chemical parameters of the water samples.
3. To determine if there is any seawater intrusion in Kancheepuram's coastal areas and examine the water quality.

3.2 SCOPE

1. Determining whether or not there is seawater intrusion in the coastal regions of Kancheepuram.
2. To check whether or not the water is safe to drink.

CHAPTER 4

EXPERIMENTAL OR MATERIALS AND METHODS USED

4.1 METHODOLOGY

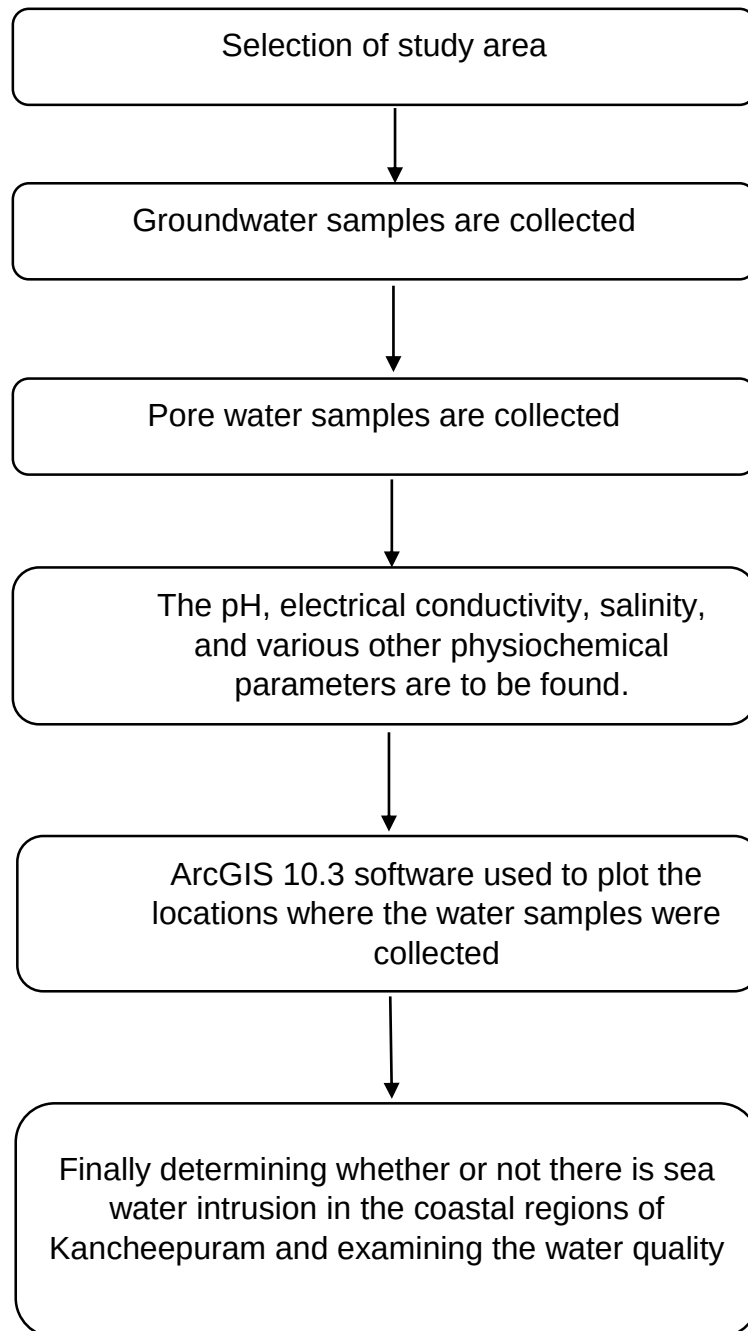


Fig 4.1 : Flow chart

4.2 STUDY AREA

Kancheepuram's coastal region serves as the study site. Between Tiruvanmiyur and Chunampet, the Kancheepuram shoreline extends. It is situated between the latitudes of 12°20'-12°52'30"N and the longitudes of 79°20'-80°17'30"E. This coastal district spans 4963 square kilometres. A sandy beach with beach sand can be found in this coastal location. Figure 4.2 shows the study area.

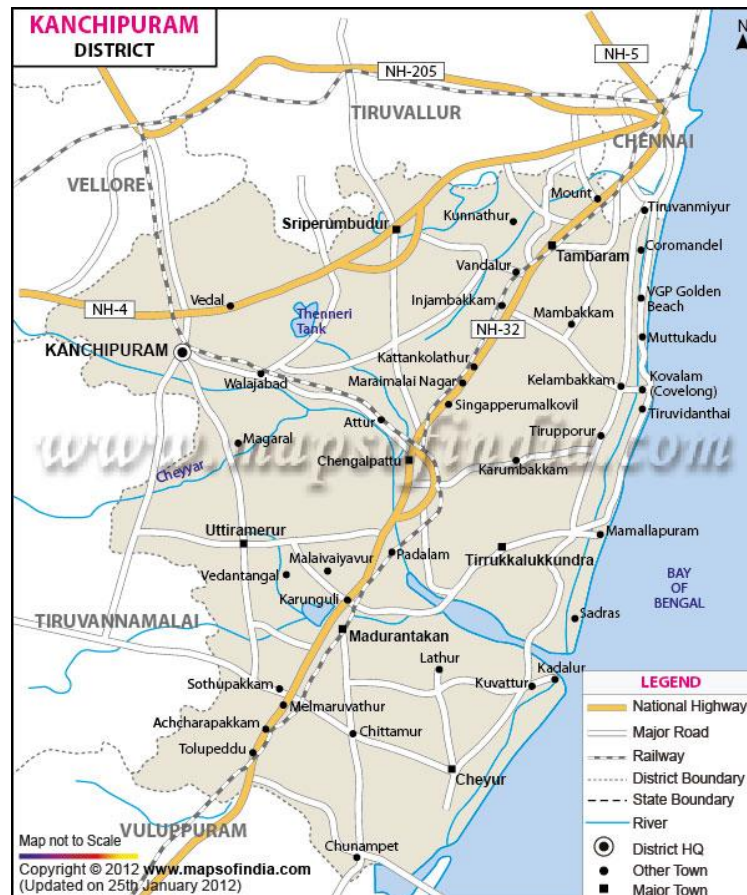


Figure 4.2 : Kancheepuram map

Several strand lines, lagoons, mangroves, salt marsh, estuaries, streams, barrier dunes, spits, and beach terraces characterise Kancheepuram's coastal environment. The ground water occurs when the water table is low. The coastal sands, which reach 30-40 feet, are the main water bearing deposit. The thickness of the sand is growing as it gets closer to the coast. Both monsoons occur here, and the summer heat is much reduced by the sea breeze in the coastal area. The temperature can reach 40 degrees Celsius in April and May, while it never drops below 18 degrees Celsius in the winter. Around 1200mm of rain falls each year. During the North East Monsoon, gales and cyclones batter the entire coast.

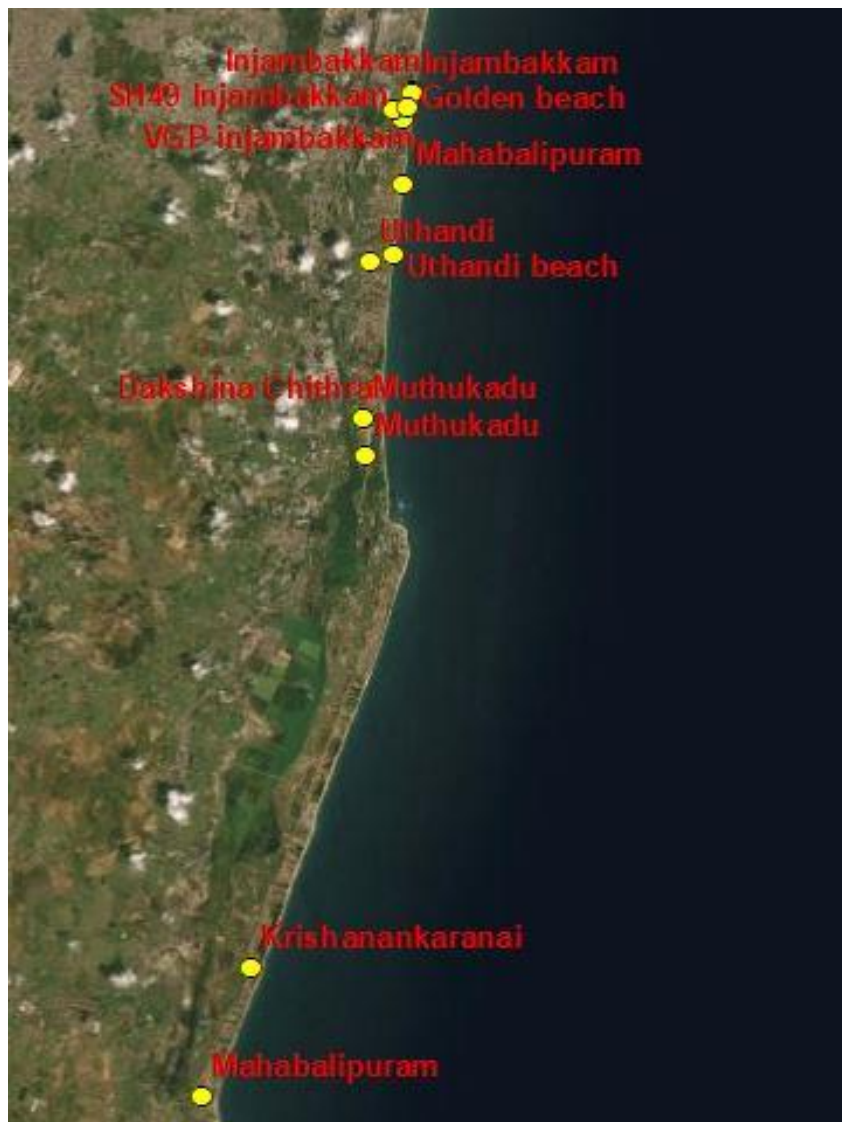


Figure 4.3 : Sampling locations

You can use ArcGIS to handle and analyse geographic data, such as climate data or trade flows, by creating layer-based maps that can be used to visualise these statistics. These are the numerous places where water samples were obtained, as shown on the map using ArcGIS 10.3 software in Fig 5.6. This software assisted us in locating and plotting the locations where water samples were taken.

4.3 WATER SAMPLE COLLECTION PROCESS

The research area is in the Kancheepuram district of Tamil Nadu. The purpose of this study is to determine whether or not there is seawater intrusion in the coastal areas. The field work was done during low tide to avoid the effects of high tide, which can lead to high concentrations in groundwater chemistry. To begin, we gathered groundwater samples from the Kancheepuram district's numerous coastal locations. Groundwater samples were taken from eight locations, including an open well and a bore well. The groundwater was collected from the coastal regions such as Golden beach, Injambakkam, Muthukadu, Dakshina Chitra, Mamallapuram, Kovalam, Krishanankaranai, Kancheepuram. Clean 500 mL plastic bottles were used to collect groundwater samples. All the key parameters were then examined on the samples. The pH, Electrical Conductivity, and Total Dissolved Solids were among the physiochemical parameters assessed. From figure 4.1.2, 4.1.3, 4.1.4, 4.1.5 you can see the groundwater samples collected from the study area.



Figure 4.3.1: Muthkadu



Figure 4.3.2: Injambakkam



Figure 4.3.3: Mahabalipuram



Figure 4.3.4 : Krishanankaranai

After collecting the groundwater samples, the pore water samples were collected. Samples of porewater were taken from the beaches of coastal regions by digging for a depth of 1m. The samples were collected from Injambakkam, Muthukadu, Golden beach, Mamallapuram, Krishanankaranai. Figure 4.1.6 and 4.1.7 shows the pore water samples collected from the study area. The pore water samples were gathered by excavating in the sands of the seashore. The pore water samples were also collected in clean 500 ml plastic bottles. The physiochemical characteristics were examined on five pore water samples which was collected from the coastal regions of Kancheepuram.



Figure 4.3.5 : Injambakkam

The pH of both groundwater and porewater is slightly acidic to neutral, with groundwater having a higher pH than porewater. The locations of possible seawater intrusion is determined based on the electrical conductivity of the groundwater.



Figure 4.3.6 : Uthandi beach

The groundwater samples were taken from an open well and a bore well, while the pore water samples were taken from the beach's adjacent areas. To find out if seawater or groundwater had been leaking into the system, the samples were studied in detail. Finally, these data will allow us to assess if seawater intrusion has occurred in Kancheepuram's coastal regions and if the water is fit for human consumption.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 GROUNDWATER SAMPLE TEST RESULTS

Table 5.1.1 : SH 49, Injambakkam

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Slightly Turbid Clear	-	-	-
2	pH value at 25°C	-	7.46	6.5 – 8.5	6.5 – 8.5	Alkaline in nature
3	Color	Hazan Unit	15.0	5	15	Within limit
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	8.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	1420	-	-	Less than 3000
7	Total Suspended Solids	mg/l	20.0	-	-	-
8	Total Dissolved Solids	mg/l	810	500	2000	Within limit
9	Salinity as NaCl	mg/l	399	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	274	200	600	Within limit
11	Chlorides as Cl	mg/l	242	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	231	200	600	Within limit

Table 5.1.2 : Dakshina Chithra

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Slightly Turbid Clear	- -	- -	
2	pH value at 25°C	-	7.55	6.5 – 8.5	6.5 – 8.5	Alkaline in nature
3	Color	Hazan Unit	15.0	5	15	Within limit
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	7.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	1440	-	-	Less than 3000
7	Total Suspended Solids	mg/l	16.0	-	-	-
8	Total Dissolved Solids	mg/l	820	500	2000	Within limit
9	Salinity as NaCl	mg/l	368	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	256	200	600	Within limit
11	Chlorides as Cl	mg/l	223	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	288	200	600	Within limit

Table 5.1.3 : Krishanankaranai

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Turbid Clear	- -	- -	-
2	pH value at 25°C	-	6.65	6.5 – 8.5	6.5 – 8.5	Acidic in nature
3	Color	Hazan Unit	50.0	5	15	Not permissible
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	28.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	460	-	-	Less than 3000
7	Total Suspended Solids	mg/l	190	-	-	-
8	Total Dissolved Solids	mg/l	230	500	2000	Safe
9	Salinity as NaCl	mg/l	69.0	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	128	200	600	Safe
11	Chlorides as Cl	mg/l	42.0	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	125	200	600	Safe

Table 5.1.4 : Mahabalipuram

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Turbid Clear	- -	- -	-
2	pH value at 25°C	-	7.05	6.5 – 8.5	6.5 – 8.5	Neutral in nature
3	Color	Hazan Unit	50.0	5	15	Not permissible
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	20.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	2240	-	-	Less than 3000
7	Total Suspended Solids	mg/l	165	-	-	-
8	Total Dissolved Solids	mg/l	1460	500	2000	Within limit
9	Salinity as NaCl	mg/l	878	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	163	200	600	Safe
11	Chlorides as Cl	mg/l	532	250	1000	Within limit
12	Total Hardness as CaCO ₃	mg/l	477	200	600	Within limit

Table 5.1.5 : Injambakkam

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Slightly Turbid Clear	- -	- -	-
2	pH value at 25°C	-	7.15	6.5 – 8.5	6.5 – 8.5	Alkaline in nature
3	Color	Hazan Unit	15.0	5	15	Within limit
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	8.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	1370	-	-	Less than 3000
7	Total Suspended Solids	mg/l	16.0	-	-	-
8	Total Dissolved Solids	mg/l	780	500	2000	Within limit
9	Salinity as NaCl	mg/l	297	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	261	200	600	Within limit
11	Chlorides as Cl	mg/l	180	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	339	200	600	Within limit

Table 5.1.6 : Muthukadu

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Slightly Turbid Clear	- -	- -	-
2	pH value at 25°C	-	7.40	6.5 – 8.5	6.5 – 8.5	Alkaline in nature
3	Color	Hazan Unit	15.0	5	15	Within limit
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	6.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	360	-	-	Less than 3000
7	Total Suspended Solids	mg/l	14.0	-	-	-
8	Total Dissolved Solids	mg/l	190	500	2000	Safe
9	Salinity as NaCl	mg/l	45.0	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	144	200	600	Safe
11	Chlorides as Cl	mg/l	27.0	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	140	200	600	Safe

Table 5.1.7 : VGP Injambakkam

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Turbid Clear	- -	- -	-
2	pH value at 25°C	-	7.46	6.5 – 8.5	6.5 – 8.5	Alkaline in nature
3	Color	Hazan Unit	30.0	5	15	Not permissible
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	14.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	850	-	-	Less than 3000
7	Total Suspended Solids	mg/l	65.0	-	-	-
8	Total Dissolved Solids	mg/l	470	500	2000	Safe
9	Salinity as NaCl	mg/l	196	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	192	200	600	Safe
11	Chlorides as Cl	mg/l	119	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	233	200	600	Within limit

Table 5.1.8 : Uthandi

SL. NO	PARAMETERS	UNITS	RESULTS	As Per IS 10500:2012		INFERENCE
				Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	
1	Appearance:	-	Turbid Clear	- -	- -	-
2	pH value at 25°C	-	7.20	6.5 – 8.5	6.5 – 8.5	Alkaline in nature
3	Color	Hazan Unit	30.0	5	15	Not permissible
4	Odor	-	Agreeable	Agreeable	Agreeable	-
5	Turbidity	NTU	14.0	1	5	Not permissible
6	Electrical conductivity at 25°C	Micromhos/cm	300	-	-	Less than 3000
7	Total Suspended Solids	mg/l	60.0	-	-	-
8	Total Dissolved Solids	mg/l	160	500	2000	Safe
9	Salinity as NaCl	mg/l	43.0	-	-	Marginal
10	Total Alkalinity as CaCO ₃	mg/l	93.0	200	600	Safe
11	Chlorides as Cl	mg/l	26.0	250	1000	Safe
12	Total Hardness as CaCO ₃	mg/l	100	200	600	Safe

5.2 POREWATER SAMPLE TEST RESULTS

Table 5.2.1 : Muthukadu

SL. NO	PARAMETERS	UNITS	RESULTS	TEST METHOD
1	pH value at 25°C (30 % solution)	-	7.98	IS:2720
2	Electrical conductivity at 25°C (30% solution)	Micromhos/cm	9877	IS:2720
3	Total Dissolved Solids	mg/l	7408	IS:2720
4	Total Suspended Solids	%w/w	96.0	IS:2720
5	Temperature	°C	27	IS:2720
6	Salinity as NaCl	mg/l	1852	IS:2720

Table 5.2.1

Table 5.2.2 : Injambakkam

SL. NO	PARAMETERS	UNITS	RESULTS	TEST METHOD
1	pH value at 25°C (30 % solution)	-	7.65	IS:2720
2	Electrical conductivity at 25°C (30% solution)	Micromhos/cm	49770	IS:2720
3	Total Dissolved Solids	mg/l	37328	IS:2720
4	Total Suspended Solids	%w/w	90.0	IS:2720
5	Temperature	°C	27	IS:2720
6	Salinity as NaCl	mg/l	9332	IS:2720

Table 5.2.3 : Uthandi beach

SL. NO	PARAMETERS	UNITS	RESULTS	TEST METHOD
1	pH value at 25°C (30 % solution)	-	8.15	IS:2720
2	Electrical conductivity at 25°C (30% solution)	Micromhos/cm	6746	IS:2720
3	Total Dissolved Solids	mg/l	4520	IS:2720
4	Total Suspended Solids	%w/w	95.0	IS:2720
5	Temperature	°C	27	IS:2720
6	Salinity as NaCl	mg/l	1130	IS:2720

Table 5.2.4 : Golden Beach

SL. NO	PARAMETERS	UNITS	RESULTS	TEST METHOD
1	pH value at 25°C (30 % solution)	-	8.14	IS:2720
2	Electrical conductivity at 25°C (30% solution)	Micromhos/cm	12214	IS:2720
3	Total Dissolved Solids	mg/l	9160	IS:2720
4	Total Suspended Solids	%w/w	96.0	IS:2720
5	Temperature	°C	27	IS:2720
6	Salinity as NaCl	mg/l	2289	IS:2720

Table 5.2.5 : Mamallapuram

SL. NO	PARAMETERS	UNITS	RESULTS	TEST METHOD
1	pH value at 25°C (30 % solution)	-	7.98	IS:2720
2	Electrical conductivity at 25°C (30% solution)	Micromhos/cm	11135	IS:2720
3	Total Dissolved Solids	mg/l	8240	IS:2720
4	Total Suspended Solids	%w/w	94.0	IS:2720
5	Temperature	°C	27	IS:2720
6	Salinity as NaCl	mg/l	2060	IS:2720

5.3 TEST RESULTS AND DISCUSSION

The statistical results were obtained utilising eight groundwater samples and five porewater samples, as shown in tables 5.1 and 5.2. Most of the samples showed a little alkaline environment, with pH ranging from 6.65 to 8.14.

Groundwater samples had electrical conductivities ranging from 300 $\mu\text{S}/\text{cm}$ to 2240 $\mu\text{S}/\text{cm}$, with an average of 1,055 $\mu\text{S}/\text{cm}$. Areas of seawater intrusion are defined as areas where the electrical conductivity of the groundwater exceeds 3000 $\mu\text{S}/\text{cm}$. The electrical conductivity data of groundwater samples for all of the locations are shown in Fig 5.3.1.

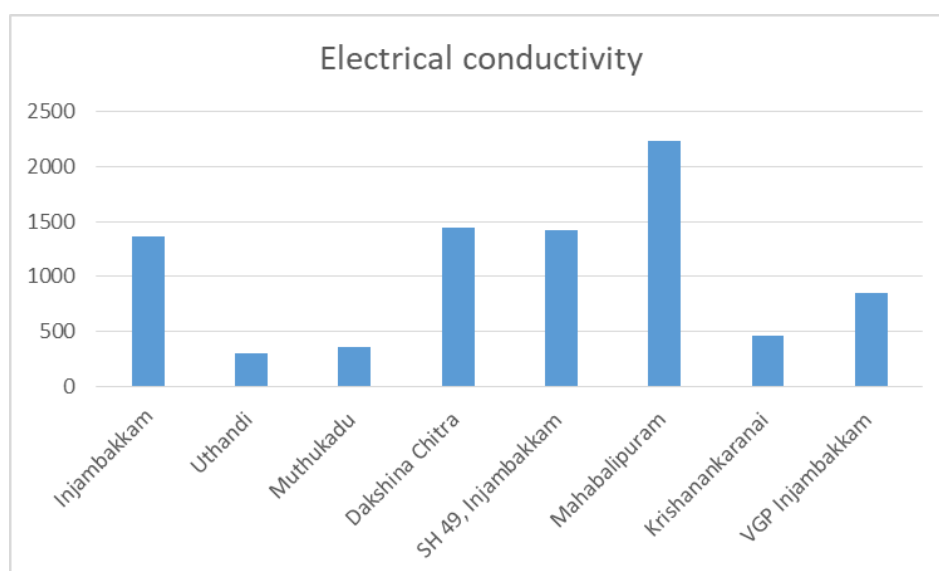


Fig 5.3.1 : Electrical conductivity

The pH of the groundwater samples ranged from 6.65 to 7.55, indicating that they were slightly acidic to neutral from fig 5.3.2. Porewater has an alkaline pH that ranges from 7.65 to 8.15. Groundwater and porewater temperatures averaged 25°C and 27°C, respectively.

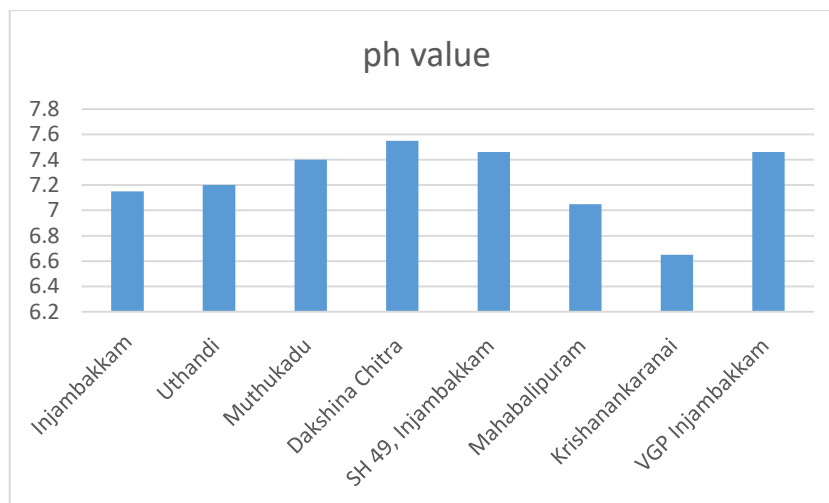


Fig 5.3.2 : pH value

Groundwater salinity had ranged from 43 to 878 mg/l, having an average of 286.875 mg/l. The salinity of groundwater is higher in areas with high electrical conductivity. Porewater salinity had ranged from 1130 to 9332 mg/l, having an average of 3332.6 mg/l. Porewater has a salinity that is higher than groundwater and comparable to seawater. Fig 5.3.3 and 5.3.4 shows the data of groundwater and porewater salinity of all locations.

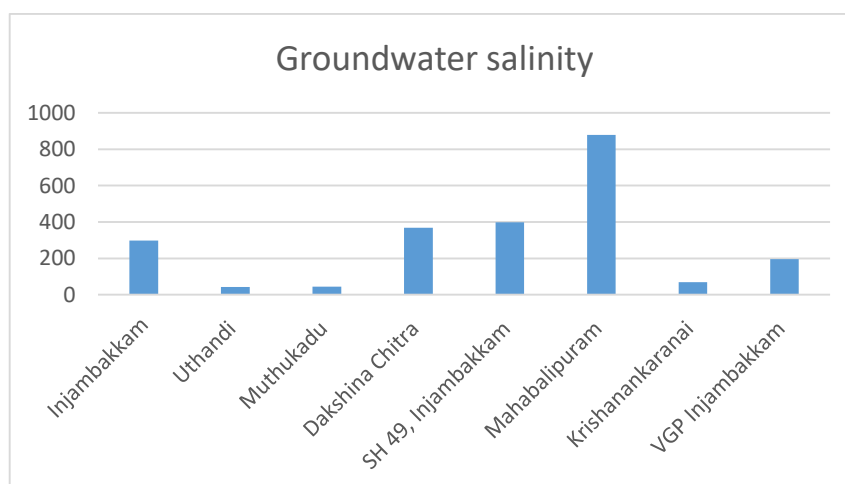


Fig 5.3.3 : Groundwater salinity

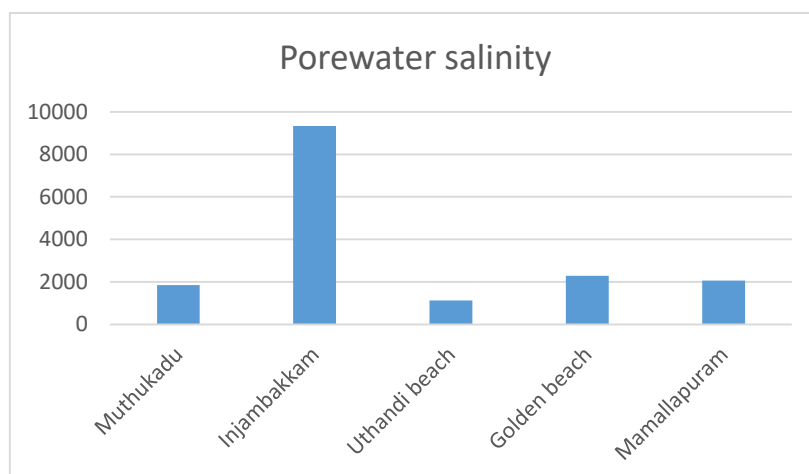


Fig 5.3.4 : Porewater salinity

Groundwater chloride levels ranged from 26 to 532 mg/l, with an average of 173.875 mg/l. Chlorides of the water samples are within the safe limits. So the chlorides of the water samples of all the locations are shown in fig 5.3.5.

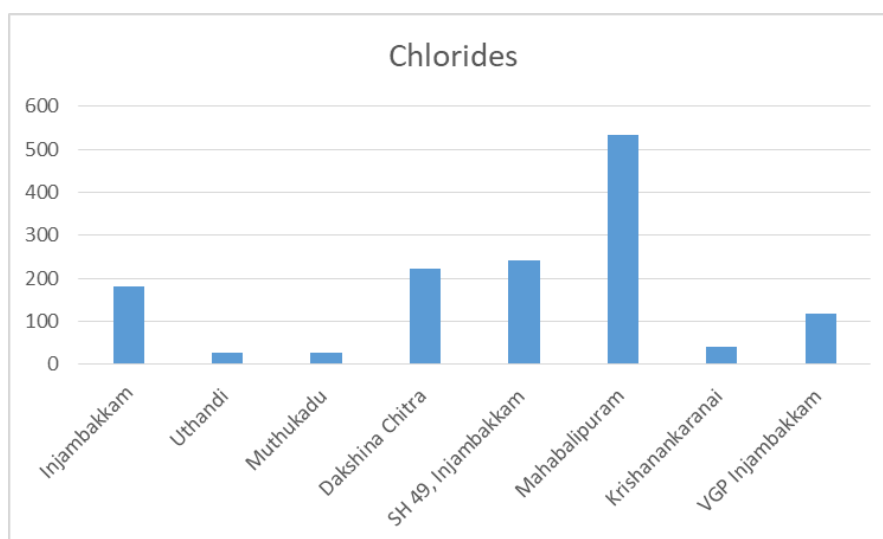


Fig 5.3.5 : Chlorides

The turbidity and colour of the majority of samples are not within limit and not permissible (Fig 5.3.6 and Fig 5.3.7). The total dissolved solids of the groundwater samples were within limit (Fig 5.3.8) and the total suspended solids of the groundwater samples ranged between 14 and 190 mg/l with an average of 68.25 mg/l (Fig 5.3.9).

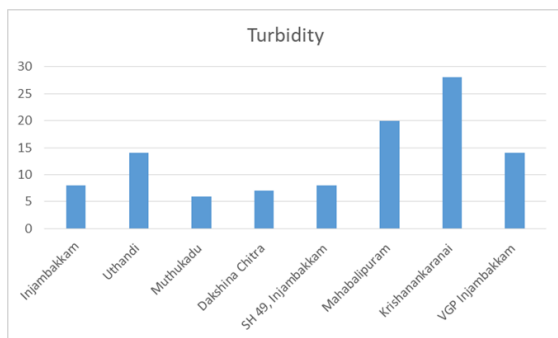


Fig 5.3.6 : Turbidity

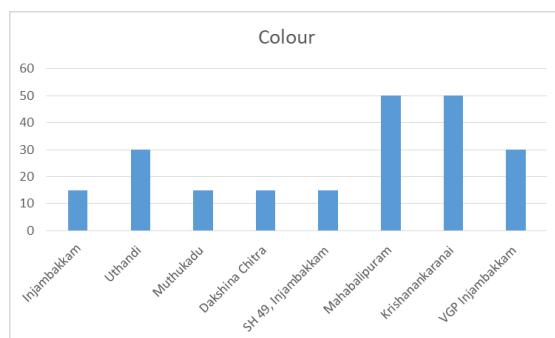


Fig 5.3.7 : Colour

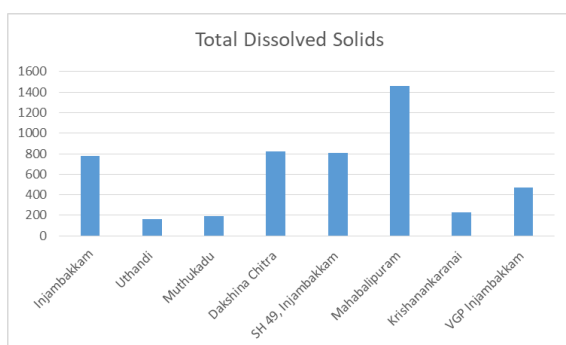


Fig 5.3.8 : Total Dissolved Solids

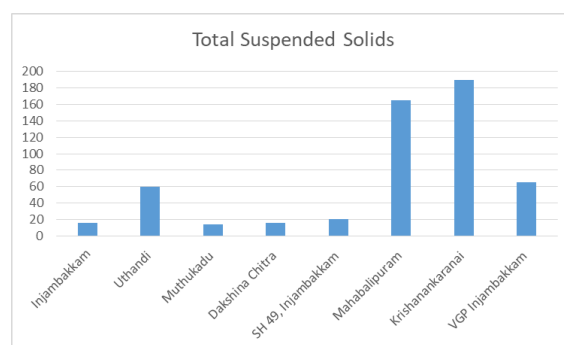


Fig 5.3.9 : Total Suspended Solids

The total alkalinity and total hardness of the groundwater samples collected were within limits and safe. From Fig 5.3.10 and Fig 5.3.11, you can see the results of total hardness and total alkalinity of all the locations represented graphically.

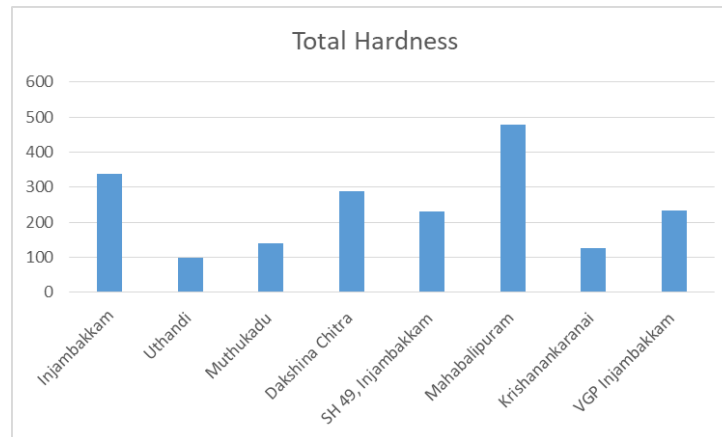


Fig 5.3.10 : Total Hardness

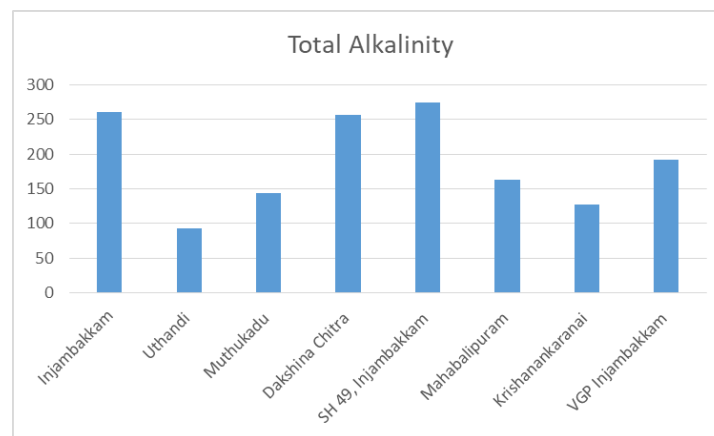


Fig 5.3.11 : Total Alkalinity

Based on electrical conductivity of groundwater, the possible locations of seawater intrusion is identified. Areas of seawater intrusion are defined as areas where the electrical conductivity of the groundwater exceeds 3000 $\mu\text{S}/\text{cm}$ (V.Manivannan et al. 2020). The region reveals there is no seawater intrusion if the electrical conductivity does not exceed 3000 $\mu\text{S}/\text{cm}$. As a result of our tests, we were able to identify that the electrical conductivity of all the groundwater samples were less than 3000 $\mu\text{S}/\text{cm}$, indicating that seawater intrusion is not present in the study area. This showed that there is no seawater intrusion in the coastal regions of Kancheepuram, and there is no mixing of groundwater and seawater.

5.4 DISCUSSION ABOUT WATER QUALITY

5.4.1 Turbidity

Turbidity is the term for the cloudiness of water. It is a metric for the capacity of light to move through water. Clay, silt, organic matter, plankton, and other particle components suspended in water are to blame for the pollution problem. Because turbidity makes the water appear hazy, drinking water is undesirable. A nephelometric turbidimeter, which converts turbidity into NTU or TU units, is used to measure turbidity. A TU is one milligramme of silica in suspension per litre. Because of natural filtration as water runs through the earth, groundwater has a very low turbidity. From our results we found out that the turbidity of the collected water samples were above the permissible limit, therefore it is not suitable for drinking purpose.

5.4.2 Colour

By comparing it to conventional colour solutions or coloured glass discs, the hue of the water can be established. The colour produced by a platinum solution (potassium chloroplatinate (K_2PtCl_6)) at a concentration of 1 mg/L is referred to as a colour unit. The colour of a water sample can be described as follows: The apparent colour of a water sample is the colour of the entire sample, including both dissolved and suspended components. The real colour of the water sample is measured after it has been filtered to remove any suspended material. On a scale of 0 (clear) to 70 (dark), colour is rated (dark). Water has no colour units and is hence colourless. From our results it was clear that majority of the water samples collected had colour above the permissible limit which was close to fifty.

5.4.3 Taste And Odour

Water's flavour and smell can be tampered with by organic or inorganic components, as well as dissolved gases. Natural, household, and agricultural sources can all supply these components. The collected water samples had agreeable limits.

5.4.4 Total Suspended Solids

Both solution and suspension of solids are possible within water. A glass fibre filter can be used to separate these two sorts of solids from one another. If the filtered portion of the water sample is placed in a small dish and then evaporated, the particles will remain as a residue. Hence, "TDS" is the name given to it.

Total solid equals total dissolved solid plus total suspended solid.

The TDS per litre level will categorise water as follows:

TDS: 1500 mg/L in freshwater;

TDS in brackish water ranges from 1500 to 5000 mg/L.

TDS >5000 mg/L in saline water

5.4.5 Electrical Conductivity

The capacity of a solution to carry or conduct an electrical current is measured by its electrical conductivity. The higher the concentration of ions in a solution, the higher the conductivity of the solution.

Electricity does not conduct well via pure water.

Ultra-pure water has a specific gravity of 5.5106 S/m, while drinking water has a specific gravity of 0.005–0.05 S/m and seawater has a specific gravity of 5 S/m. TDS can be calculated using electrical conductivity. The results of our water samples collected suggested that most of them were within the permissible limit.

5.4.6 pH

pH is one of the most important water quality indicators. It's known as the negative logarithm of hydrogen ion concentration. Water's acidity or alkalinity is measured by its pH. The pH scale ranges from 0 - 14, with 7 being neutral. pH value < 7 shows acidic value, whereas a pH > 7 shows basic value. pH levels in drinking water should be between 6.5 and 8.5 for home usage and living organisms. The pH of the water samples collected was mostly basic in nature.

5.4.7 Alkalinity

The acid-neutralizing ability of all titratable bases is used to calculate the alkalinity of water. Alkalinity levels in water that are too high could indicate contamination from industry or chemicals. Volcanoes, for example, can produce alkalinity or acidity naturally. Fish and other aquatic species are protected from excessive pH variations by the natural acidity and alkalinity of streams. The alkalinity of the water samples collected was within the acceptable limit.

5.4.8 Chloride

Chloride is naturally found in groundwater, streams, and lakes, however high chloride concentrations in freshwater (about 250 mg/L or above) could suggest wastewater contamination. Chloride ions in drinking water have no adverse health effects, but excessive amounts can give most people a salty taste. We discovered that the water samples collected were within the permitted limit based on our findings.

5.4.9 Hardness

Hardness can be used to characterise the characteristics of severely mineralized waters. Dissolved minerals in water produce scale deposits in hot water pipes and difficulty generating lather with soap. Bicarbonates, sulphates, chlorides, and nitrates are examples of these ions. The toughness of groundwater is often higher than that of surface water.

Permanent hardness is caused by sulfates and chlorides, which are the primary causes of transient hardness. To be classified as "soft," water must have a softness of less than 75 milligrammes per litre or have a hardness of less than 300 milligrams/liter. Hardness up to 500 mg/L is considered harmless from a health standpoint, but anything higher may have a laxative impact. Except for a few samples, the hardness of the water we collected was generally below the allowable limit, according to our analysis.

5.5 WATER QUALITY CONCLUSION

Water quality standards changes depending on how the water will be used. "Water unsuited for one application may be quite satisfactory for another," according to Tchobanoglous et al., "and water may be regarded acceptable for a particular use if water of superior quality is not accessible.

Water quality criteria should be in compliance with government-established water quality standards, which serve as legal duties. In general, there are three different kinds of standards: in-stream, drinkable water, and wastewater discharge. Each type has its own set of requirements, which are all measured in the same way. The World Health Organization (WHO) has developed fundamental drinking water criteria that should be met by all countries.

Even though, most of the water quality parameters were within the limits, colour, odour and turbidity were not up to the standards, which suggested that the water samples collected was not fit for drinking purpose, but can be used for agricultural as well as industrial purposes.

CHAPTER 6

SUMMARY AND CONCLUSION

1. The principle of this study was to see if there was any evidence of seawater intrusion in Kancheepuram's coastal areas.
2. The samples of groundwater and pore water were taken from the coastal regions. Bore wells were used to collect groundwater, while beach sands were dug up to collect pore water.
3. The pH, electrical conductivity, salinity, colour, odour, turbidity, total suspended solids, total dissolved solids, total alkalinity, and total hardness of the samples were determined.
4. We were able to determine from the test results that there was no evidence of seawater intrusion in Kancheepuram's coastal areas and there is no mixing of groundwater and seawater.
5. Despite the lack of seawater intrusion, the water was not suitable for drinking because it does not meet the safety standards for drinking water, but can be used for agricultural as well as industrial purposes.

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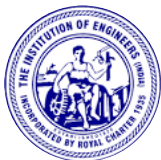
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