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WATER QUALITY ANALYSIS OF A COMMUNITY WATER SUPPLY IN KUTTANAD

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ABSTRACT
Waterborne diseases are a norm in the low-lying Kuttanad area led to the exploration of a community wherein a single borewell was shared by households of 72. Freshwater lakes and rivers exposed to contamination made groundwater their safest reliability. Water samples from the borewell were examined for water quality tests and evaluated under the Kerala Water Authority (KWA). The results confirmed the presence of E. coli and coliform. In addition, alkalinity, turbidity, and total dissolved solids were found to be above the desired limit. Primarily, the water is alkaline that has a higher amount of total dissolved solids such as calcium, magnesium, sodium, and potassium. The presence of E. coli indicates faecal contamination, making it unpotable.

KEYWORDS: ***Water-borne diseases, Groundwater, Water quality analysis, Kuttanad, Community water supply***

1. INTRODUCTION

Potable water is essential for society's human welfare and needs. More than 40% of the world's population lives in areas with an acute shortage of fresh drinking water, which furthermore is continuously growing.

The drinking water crisis is a major issue faced by the majority in the low-lying lands of Alappuzha. Around 80% of Alappuzha lies in the coastal region and 13% of the district constitutes waterbodies. Kuttanad thrives on below-sea-level paddy farming. Although, the Thaneermukkom barrier was constructed in the Kuttanad area to prevent the intrusion of salt into the backwaters, during the non-rainy season an intrusion of salt and surface run-off of chemicals from paddy fields into these freshwaters could be found. Freshwater can no longer be considered a source of reliability for households as seen in *Fig 2 (a)*. The only reliable source of non-treated water is groundwater (*Fig 2 (b)*).

This led to the exploration of an area in Alappuzha, where a community of 72 families shares borewell water for household purposes. The borewell is dug on a 40.46 m^2 piece of land at a depth of 120 m. This paper shows the case study of this community. The water from the borewell was tested for 17 physiological and 2 bacteriological parameters.

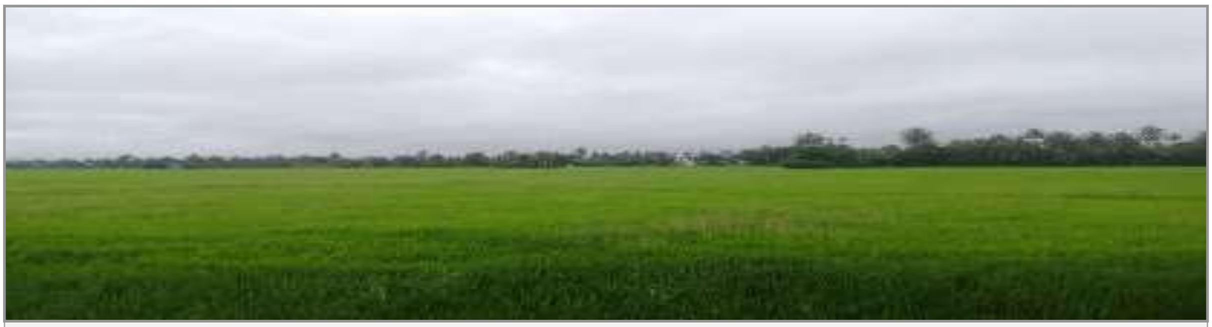

Fig 1: Paddy polders (Padasherakams) around which the community (72 households) lives.

1.1. Study Area

Chempempuram is a small hamlet in the Champakkulam block of Alappuzha with a population density of 655 people/km^2. As aforementioned, potable water is a crisis in this area, and groundwater is a major source of dependability. As part of a development scheme, the people in the neighbourhood formed a community where a common borewell was dug for 72 households. *Fig 1* shows the 72 houses that are around paddy polders (approx. 185 acres of land). The community has an official committee of 11 members and a pump operator. This paper deals with the problem faced by this community and an analysis of the water quality test done in September 2022

1.2. Groundwater Scenario

According to the Central Ground Water Board (CGWB), the Champakkulam block falls under the safety category for groundwater resource assessment. An area is categorised as safe when the Stage of Extraction (SoE) is less than or equal to 70%. *Table 1* reveals the dynamic groundwater resources of the Champakkulam unit.

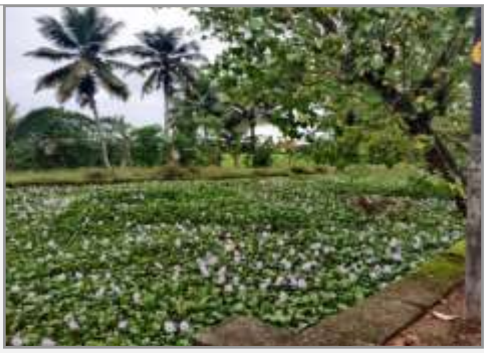

Fig 2: (a) Stagnant freshwater that cannot be used for drinking

Fig 2: (b) Borewell (source point) pumps to 72 households.

Assessment Unit	Annual Extractable Groundwater Recharge (Ham)	Current Annual Groundwater Extraction (Ham)	Annual Groundwater Allocation for Domestic use as of 2025	Net Groundwater Availability for Future use	Stage of Groundwater Extraction (%)
Champakkulam	3558.73	596.16	541.49	2943.29	16.75

Table 1: Assessment of dynamic groundwater resources of Kerala (2020).
(Source: Central Groundwater Board)

2. METHODOLOGY

An interview with a committee member was conducted about the borewell and the problems faced in the community. Samples were then collected in a 2L High-Density Polyethylene (HDPE) from the nearest tap for physicochemical tests. A 20 mL sterilised HDPE bottle was used for bacteriological tests. The samples were collected at their brim to prevent interaction with the air and systematically labelled. The Indian Standard IS:3025-1 was strictly followed to ensure the quality of collected data. Samples were tested under Kerala Water Authority, Thiruvalla to assess the parameters. The standard 17 physical-chemical tests and 2 bacteriological tests were performed. The physicochemical tests include colour, odour, taste, turbidity, pH, alkalinity, TDS, hardness, Ca, Mg, Cl, electrical conductivity, acidity, SO_4, F, Fe and NO_3. The bacteriological tests consisted of checking the presence of Coliform and E. coli by membrane filtration method.

3. RESULTS AND DISCUSSIONS

3.1. Analysis of Interview

Information collected from the committee member tells us that the borewell is situated on a 40.46 m^2 piece of land at a depth of 120 m. It consists of a 2 Hp submersible pump and additionally two 5000L tanks. A pump operator is assigned for any faulty situation. Batch-wise pumping is practised. An amount of 100 rupees (1.24 USD) is collected from each household for the payment of bills and cleaning of tanks. Cleaning is usually done once every 6 months. However, the problem faced in the community is that water does not reach the end users. The absence of a metre at each household led to uncontrolled water usage per household. Misuse of water supply can be seen in the community. In regardless to the availability of water supply to a household or not, the uninstallation of metre leads a household to pay an equal share of approximately 25 USD.

3.2. Analysis of Water Quality Test

Kerala Water Authority follows the Indian Standard IS 3025 for different tests, as shown in *Tables 2 & 3*. From Table 2, it can be inferred that turbidity, alkalinity, and total dissolved solids are more than the permissible limits. *Table 3* shows the presence of *E. coli and* Coliform. The rest of the physical and chemical parameters are within the standard limit. Constraints that are not within the threshold are explained below.

3.2.1. Turbidity

As per IS 3025:1984 (part 10), the nephelometric method is applied where the sample's intensity from scattered light is measured under defined conditions. It is measured in Nephelometric Turbidity Units (NTU). According to the World Health Organisation (WHO), consumable water should not be more than 5 NTU and ideally should be 1 NTU. The results show 1.81 NTU which is more than the ideal limit. There can be several reasons for the increase of turbidity in water: sediments from erosion, algae growth, particulate matter such as clay, silt, organic, inorganic matter, and other microscopic organisms.

3.2.2. Alkalinity

As per IS 3025:1986 (part 23), potentiometric and indicator methods are used for the determination of alkalinity. It gives us the degree of resistance to the change of pH when an acid is added. The maximum permissible limit is 600 mg/L. *Table 2* shows a slight increase in alkalinity from the standard 200 mg/L. It exceeds the desired limit. The value of alkalinity shows the presence of natural salts in water. Paddy is a major crop grown in Kuttanad. The fertilisers used for the crop may sweep into the ground leading to an increase in alkalinity.

3.2.3. Total Dissolved Solids (TDS)

As per IS 3025:1984 (part 16), a gravimetric method for the determination of filterable residue is used. Groundwater generally has a higher amount of TDS in comparison to surface water. However, *Table 2* shows a value that is higher than the permissible value of 500 mg/L. The higher presence of TDS is generally due to the leaching of salts from soil or domestic sewage that may percolate from the soil.

3.2.4. Bacteriological Parameters

To assess the presence of bacteria, the membrane filtration method is done. In this method, bacteria of size larger than 0.45 µm are trapped within a porous membrane. *E. coli* is a sub-group of Coliform, mainly found in faecal contamination. The presence of Coliform makes the water unsuitable for drinking.

Sl. No	Characteristics	Unit	Desirable Limits as per IS 10500:2012	Test Method	Result
1.	Colour	HU	5	APHA 2120 B	5
2.	Odour			IS 3025 (part 5) – 2018	Agreeable
3.	Turbidity	NTU	1	IS 3025 (part 10) -1984	1.81
4.	pH at 25 ^{o}C		6.5 – 8.5	IS 3025 (part 11) – 2022	7.19
5.	Alkalinity	mg/L	200	IS 3025 (part 23) – 1986	212.16
6.	Total Dissolved Solids (TDS)	mg/L	500	IS 3025 (part 16) – 1984	560.7
7.	Total Hardness (as $CaCO_3$)	mg/L	200	IS 3025 (part 21) -2009	154
8.	Calcium (as Ca)	mg/L	75	IS 3025 (part 40) – 1991	32.06
9.	Magnesium (as Mg)	mg/L	30	APHA 3500 - Mg B	17.98
10.	Chloride (as Cl)	mg/L	250	IS 3025 (part 32) – 1988	145.98
11.	Taste			IS 3025 (part 8) – 1984	Not Tested
12.	Electrical Conductivity at 25	micromhos/cm		IS 3025 (part 14) – 2013	830.5

	°C				
13.	Acidity	mg/L		IS 3025 (part 22) – 1986	25.48
14.	Sulphate (as SO_4)	mg/L	200	IS 3025 (part 24/Sec 1) – 2022	5.34
15.	Fluoride (as F)	mg/L	1	APHA 4500 – F D	0.04
16.	Iron (as Fe)	mg/L	1	IS 3025 (part 53) – 2003	0.62

Table 2: Test results of physicochemical parameters

Sl. No	Parameters	Acceptable Limits as per	Test Method	Result
1.	Coliforms	Shall not be detected/100 ml	Membrane Filtration Method	Present
2.	E-coli	Shall not be detected/100 ml	Membrane Filtration Method	Present

Table 3: Test results of bacteriological parameters

4. CONCLUSION AND SUGGESTIONS

A conclusion that the water is alkaline can be made from the report obtained from physical-chemical tests. Alkalinity in drinking water is considered safe and is an indication of non-polluted water. However, the presence of E. coli and Coliform from bacteriological tests signifies that water is unsafe for drinking. These bacterial strains do not cause illness but rather indicate faecal contamination and other disease-causing organisms. Water as such can be used for non-drinking purposes and after treatment can be fit for drinking purposes.

SUGGESTIONS

1. An awareness among the community about the exploitation of water should be created. A metre should be installed in every household to track down its usage.
2. Alkalinity, total dissolved solids, turbidity, and bacterial contamination can be removed by the installation of reverse osmosis filter systems. However, the filtration system will be quite expensive for the community.
3. A practical and cheap method of reducing alkalinity, TDS, turbidity, and bacteria that can be practised in every household would be sedimentation and boiling. Sedimentation would settle down particles present in water and make water less cloudy. The temperature increased over 40 ^{0}C, increases E. coli cell growth. Nevertheless, some E. coli can survive 70 ^{0}C and above.

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