Ground Water Quality Analysis in the Chunnakam Area, Jaffna

By

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DECLARATION OF THE CANDIDATE

I do hereby declare that work described in this thesis was carried out by me under the supervision of Prof.G.M.Bandaranayake and Mr. H.H. Leelananda and report on this thesis has not been submitted in whole or in part to any University or any other institution for another Degree/Diploma.

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ABSTRACT

Most of the Earth's liquid fresh water is found, not in lakes or rivers, but is stored underground in the aquifers.The Jaffna Peninsula covers an area of 1012.01sq.m including inland waters with a population of 607,158 and is located in the northern tip of Srilanka Chunnakam aquifer is the high capacity and acceptable quality for drinking and other usage.This water is supplying to many water scarcity areas.Population of valikamam also takes second rank in Jaffna,because population is also based on the water availability.Continuously observed fuel smell in Chunnakam water wells.the water wells located very close to the Chunnakam fossil fuel power station. CPS dump the waste oil directly to the land which was mixed up with surrounding groundwater wells and the well water odour was changed unfavourably. Therefore several wells were not used for domestic and agricultural purpose in nearby areas.

For the study water well data collected from NWSDB.109 wells were selected for analysis. These wells water quality were analysed for EC, Hardness, pH, Nitrate, COD and Oil and Grease. 68 (62%) wells have shown the higher oil level than the standerd, 07 (6%) wells under the limit and 34 (32%) wells were not contaminated with oil and grease. From the analysis the oil and grease contamination was observed within 1.5 km surroundings of the power station. The ground water quality information maps of the entire study area have been prepared using GIS spatial interpolation technique for all the above parameters. As per the predicted maps, the high oil and grease concentration layers observed in the surrounding of the CPS area. Higher Nitrate concentration also was observed in Chunnakam area because high agricultural practices are going on this area. COD showed the unexpected results and other water quality parameters were mostly complying with the SLS 614(1983) and WHO water quality standards.

KEYWORDS: Chunnakam aquifer, Groundwater wells, Contamination, Water quality, GIS

Chapter One

INTRODUCTION

1.1 Introduction

Ground water

Most of the Earth's liquid fresh water is found, not in lakes or rivers, but is stored underground in the aquifers. Indeed, these aquifers provide a valuable base flow supplying water to rivers during periods of no rainfall. They are therefore an essential resource that requires protection so that groundwater can continue to sustain the human race and the various ecosystems that depend on it. The contribution from groundwater is vital; according to Morris and et.al, two billion people depend directly upon aquifers for drinking water, and 40 percent of the world's food is produced by irrigated agriculture that relies largely on groundwater. In the future, aquifer development will continue to be fundamental to economic development and reliable water supplies will be needed for domestic and irrigation purposes. Water stored in the ground beneath our feet is invisible and so its depletion or degradation due to contamination can proceed unnoticed, unlike our rivers, lakes and reservoirs, where drying up or pollution rapidly becomes obvious and is reported (Morris et al. 2003).

The groundwater is believed to be comparatively much clean and free from pollution than surface water. Groundwater can become contaminated naturally or because of numerous types of human activities; residential, municipal, commercial, industrial, and agricultural activities can all affect groundwater quality (U.S. EPA, 1993; Jalali, 2005a; Rivers et al., 1996; Kim et al., 2004; Srinivasamoorthy et al., 2009; Goulding, 2000; Pacheco and Cabrera, 1997). Contamination of groundwater can result in poor drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water

supplies, and/or potential health problems. A wide variety of materials have been identified as contaminants found in groundwater. These include synthetic organic chemicals, hydrocarbons, inorganic cations, inorganic anions, pathogens, and radionuclide's (Fetter, 1999). The importance of water quality in human health has recently attracted a great deal of interest. In developing countries like India around 80% of all diseases are directly related to poor drinking water quality and unhygienic conditions (Olajire and Imeokparia, 2001; Prasad, 1984).

LocationThe Jaffna Peninsula covers an area of 1012.01sq.m including inland waters with a population of 607,158 and is located in the northern tip of Srilanka.(Statistical hand book,Jaffna 2013).

The topography is low and flat,the highest elevation is only +10 m MSL.

The Peninsula is split in to three parts by lagoons which are connected to the sea.

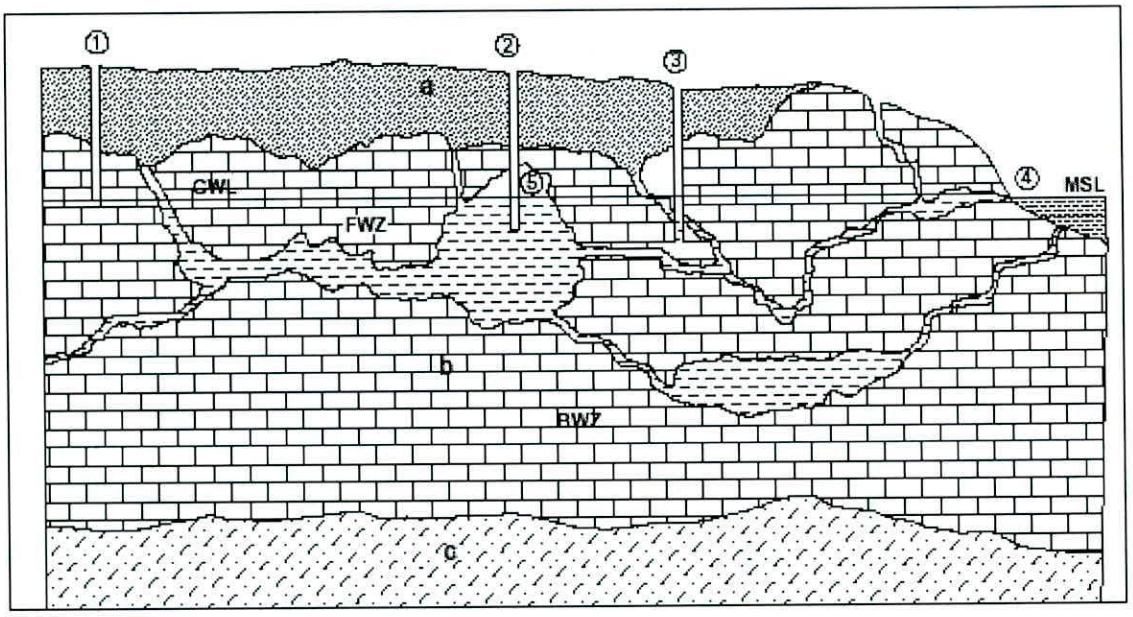
The Jaffna Peninsula falls within the dry zone in Sri Lanka, is underlain by Miocene limestone that is considered to have appropriate aquifer properties for groundwater storage and discharge. The absence of perennial rivers or major water supply schemes to the Peninsula highlights the importance of groundwater as the predominant water resource for domestic, industrial and agricultural use.

Geology

The Jaffna Peninsula is unique in geology and aquifer conditions. The limestone is an important aquifer, and together with thin sand layers form an extensive cover providing a source of drinking water and irrigation across the Jaffna Peninsula. It is almost flat-bedded with a slight dip to the west, and is a creamy colored hard compact, indistinctly bedded and partly crystallized rock. It is massive in parts but some layers are richly

fossiliferous into a honeycombed mass. Easily soluble limestone gives rise to a number of underground solution caverns.

Figure 1.1. Geology and condition of groundwater in the Jaffna Peninsula.



Source: Sirimanne 1952.
Notes: (a) Red earth, (b) Jaffna limestone, (c) Granitic genesis, MSL (mean sea level), GWT (groundwater level), FWZ (zone of freshwater saturation), BWZ (probable zone of brackish water); (1) dry well, (2) bottomless well or tidal well (Nilavarai),(3) ordinary successful well, (4) spring of Keerimalai type, (5) solution cavern.

Immediately after the wet season when water levels are higher, almost all parts of the Peninsula are underlined by freshwater. As the groundwater depletes during the dry season the freshwater lens decreases in size and increases the areas underlined by brackish water. The shallow lens of freshwater remaining at the end of the dry season is extremely sensitive to pumping. Thus, excessive pumping in this area of the Jaffna Peninsula is responsible for several of the water management problems that have emerged.

Soil type

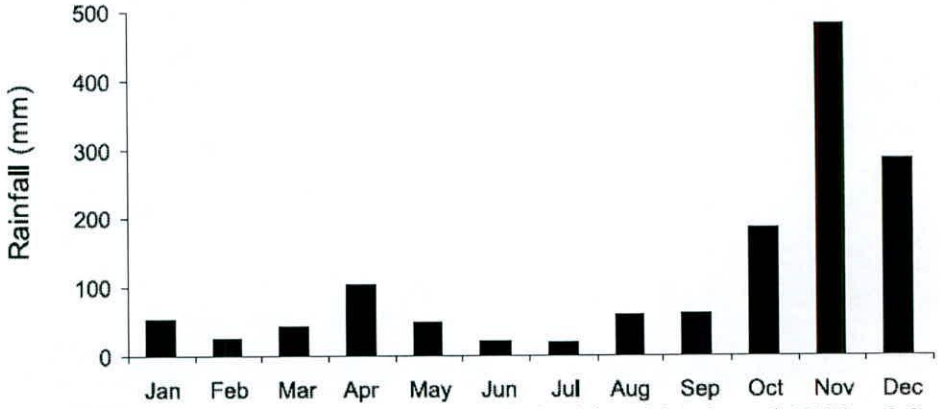
The soil and water resources of the Jaffna Peninsula are both related to the limestone geology of the land. The soils are formed on marine deposits and sediments under the

influence of sea waves and wind. A thin mantle of soils with a thickness of less than 2 m is found above the limestone rock (Rajasooriyar et al. 2002). The soil of the District varies from well-drained and highly productive red yellow latosols in the central area (60,000 hectares (ha); alkaline, saline regasol soils in the coastal area (26,000 ha); and alluvial soils in the Valukki Aru area (10,000 ha).

Climate and Rainfall

The Jaffna Peninsula experiences the typical dry zone climate of Sri Lanka, characterized by a wet and a dry season. The major wet season occurs during October to December and is associated with the northeast monsoon. The minor wet season occurs during April to May due to the southwest monsoon. The period between the southwest and northeast monsoons is dry and this dryness extends from June to September. The months of September/October to January/February and February/March to August / September are referred to as *Maha* (wet season) and *Yala* (dry season), respectively. The bulk of the rainfall is received during the months from October to January, with little or no rainfall thereafter.Of the total annual average rainfall, 80% of the rainfall occurs during the northeast monsoon.. The estimated 75% probability of rainfall in the Jaffna District is 510 millimeters (mm) in *Maha* and 102 mm in *Yala*. The mean monthly rainfall from 2002 to 2011 is presented in Figure 1.6.

Figure 1.2. Mean monthly rainfall derived from year 2002 to 2011.



Source: 2002 to 2010 – Jaffna district statistical hand book and 2011 – Meteorological station.

TABLE 1.1. Mean monthly meteorological parameters of Thirunelvely (derived from 2002-2011).

Month	**Rainfall** (mm)	**Air temp** (°C)	**Relative humidity** (%)	**Wind speed** (km/hour)	**ETo*** (mm/day)
January	52	25.7	73.2	5.91	3.8
February	25	28.4	68.8	5.94	4.4
March	44	28.2	67.4	6.94	5.1
April	103	29.8	71.0	12.00	5.4
May	49	30.2	75.0	11.96	5.6
June	21	29.9	73.5	10.64	5.3
July	18	29.7	73.2	10.66	5.4
August	59	29.4	73.1	10.89	5.4
September	60	29.2	75.3	10.89	5.4
October	187	28.2	78.4	6.38	4.1
November	480	26.5	82.8	4.51	3.1
December	287	26.2	79.4	5.83	3.3

Source: 2002 to 2010 – Jaffna district statistical hand book and 2011 – Meteorological station.
Notes: * Penman-Monteith method using CROPWAT.

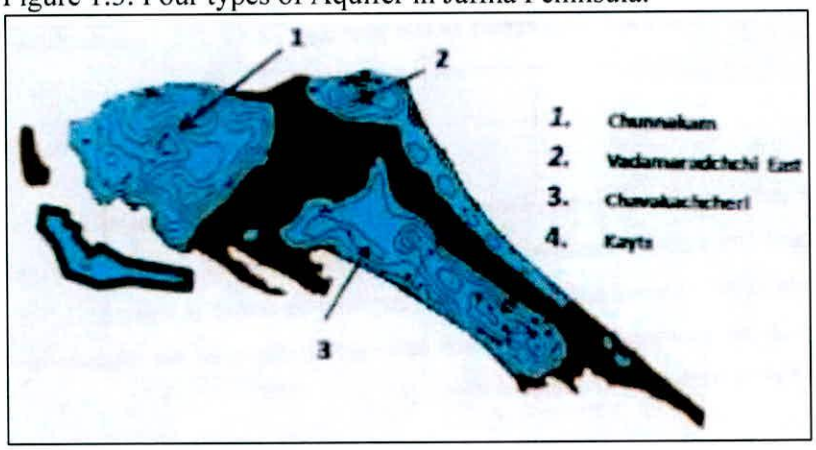
Table 1.1 presents the mean monthly meteorological parameters for Thirunelvely. Average temperature does not vary significantly over the year and ranges from 25 to 30 °C, with significant fluctuation between daytime and nighttime temperatures (Table 1.4.). The relative humidity increases from a low of 67% in March to a high of 80% in November. High wind speeds are experienced in July and August, which are characterized by high evaporation and drought conditions. The highest sunshine hours per day is observed during June to July and the lowest in December.Further, uniformly

high temperatures prevail in the study area all year-round and contributes to an evaporation level of 45-48% of the annual rainfall. In addition, due to the karstic formation in the limestone in the western and northern coast of the study area, freshwater seepage is observed and 5-8% of recharge is lost to the sea (Navaratnarajah 1994).

Ground water resource in Jaffna peninsula

In Jaffna mainly four ground water aquifers are available for water consumption depends on the water capacity and quality of the water.

Figure 1.3. Four types of Aquifer in Jaffna Peninsula.



Sourse:Jaffna feasibility study,2006

Those four aquifers are Chunnakam aquifer, Vadamarchi- east aquifer,Chavakachcheri aquifer and Kyts aquifer. Of these four aquifers Chunnakam aquifer contains the highest capacity of water.

There are three non-perennial rivers in the region, namely Thondaman Aru (9.48 kilometers(km), Uppu Aru (19.31 km) and Valuki Aru (9.66 km) which have water only during the rainy season. The bulk of water supply comes from 19,241 agro-wells and 2,433 ditches, most of which are used for agricultural purposes. In addition, over 631 small ponds are available in the Jaffna District. Punthakey and Gamage (2006) estimated