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Oil spill contamination of Ground water in Chunnakam Aquifer, Jaffna, Srilanka

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Cover Page Footnote

First and foremost let me place on record my sincere gratitude to the Research Appraisal Committee, Assistant General Manager (R&D) and the Research and Development section for entrusting this research project and giving me the time extension to complete this project. The assistance given to me by the Deputy General Manager (N), Regional Manager (J) and the supporting staff of Regional Office to complete my project on time, they have been good enough to give the guidelines from time to time to proceed with the research. It is the Chief of laboratory services, who have been giving me the relevant advice as and when required without any hesitation and made all the necessary arrangements to provide the chemicals and the glassware, when our supplies got depleted. I am really thankful to him for all his continuous assistance. In this connection the timely assistance given by the Manager, Palmyrah Research Institute by providing an important chemical on loan at the appropriate time helped us to overcome our shortage. My Research Assistant Ms. P. Sutharshini, and the staff attached to the Regional Laboratory, Jaffna has given me their whole hearted support to complete the research work smoothly. Last but not least in importance is the moral support and encouragement given to me by my parents and the circle of friends.



Oil spill contamination of Ground water in Chunnakam Aquifer, Jaffna, Srilanka

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ABSTRACT

The Chunnakam aquifer has high capacity and contains acceptable quality water for drinking and other usages. Water supplies are generated from this area. Fuel smell had been continuously observed in Chunnakam water intake site. The intake site is located very close to the Chunnakam fossil fuel power station, and on analysis, the intake well and the adjacent wells showed oil contamination. A research study was carried out during the period November 2013 to August 2014. The total number of 150 wells was analyzed, of these 109 (73%) wells have shown higher oil level than the Srilankan standard 614(1983) of 1.0 mg/l, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease. From the analysis the oil and grease contamination was observed within 1.5 km surrounding of the power station. The high oil and grease concentration layers were observed in the surrounding of the Chunnakam power station area.

Keywords

Oil and Grease, Chunnakam, Ground water, Wells, Power station

1. Introduction

The Jaffna peninsula is located in the Northern tip of Srilanka. It covers an area of 1,012.01 km², including inland waters with a population of 607,158.(Statistical Hand book, Jaffna 2013)

In Jaffna, four main groundwater aquifers are available for water consumption based on the water capacity and quality of the water. Those four aquifers are Vadamarachchi-east, Chavakachcheri, Chunnakam, and Kayts. Of these four aquifers, Chunnakam aquifer has high capacity and acceptable quality water for drinking and other usages. Due to this high capacity and good quality, water supplies are drawn from this area. This water is supplied to many water scarcity areas such as Watharawaththai, Atchuvely, Navaly, Kantharodai, Sandilipay, Karainagar, and Jaffna municipality areas.

Agriculture is practiced to a larger extent in this area. Therefore the aquifer is exposed to number of severe vulnerabilities such as over-extraction of groundwater excessive fertilizer usage, and other forms of pollution by anthropogenic activities. (Feasibility study, March 2006)

Fossil fuel power plants use chemical energy, which is stored in fossil fuels such as coal, fuel oil, natural gas or oil shale. Oxygen of the air is converted successively into thermal energy, mechanical energy and, finally, electrical energy. (Wikipedia)

Chunnakam power station is located in this area which is operated by the Ceylon Electricity Board (CEB). It was started in 1958 for the supply of the electricity to Jaffna. The CEB gets electricity from sub-contractors, and their fossil power plants are operated from the same premises. (Wikipedia) During the war period, Jaffna received its entire electricity supply from

these power plants and at that time they were unable to comply with the Environmental regulations and priority was given to the security of the plants. From time to time though the contractors changed, but all were operating the fossil power plants. From this power station waste water and the waste oil were dumped into the adjoining bare lands without proper treatment. Due to this, the waste oil reached the underground aquifer. The oil and grease contamination affected the community in different ways. Aromatic carbons and heavy metals caused high health risk to the people.

Statement of problems

The waste oil was directly dumped in to the land and got mixed with the surrounding groundwater wells. This caused the well water odour to change unfavorably. Due to that, several wells were abandoned as unusable in nearby areas. Kerosene oil-type odor was also observed in Bowsered water and the pipe-born supply water from Chunnakam intake. Chunnakam intake and the surrounding wells were checked for oil & grease and oil & grease residues were observed in all the wells. Ministry of Health (MOH), Central Environment Authority (CEA), Board of Investment (BOI), Predesha Sabah (PS) and National Water Supply & Drainage Board (NWSDB) jointly visited the site. MOH collected the samples from the Power station oil dumping point. In all those samples, oil & grease contents exceeded the CEA standard. Wells in the surrounding of CEB power station were also checked by NWSDB and were found to have oil & grease residue. The Chunnakam Intake site was given up due to this contamination.

Based on the above, research was designed to study the extent of waste oil penetration in the Chunnakam aquifer and to identify the level of water quality deterioration in the study area.

Methodology

From Zone A (0 to 200 m) - all well locations were collected, From Zone B (200- 500 m) - problem reported location wells' details were collected and From Zone C (more than 500 m) - locations were randomly selected.

Groundwater samples were drawn from the 100 wells from November 2013 to August 2014. The samples were collected from surface and the bottom of the dug wells by using a specific water sampler. For the tube wells samples were collected from direct pumping, because most of the tube wells are connected with electric driven pumps and hand pumps. n-Hexane extractable gravimetric methodology was used to analyze the Oil & Grease by (USEPA method).

Results and Discussion

Oil & grease concentration was analyzed in 150 locations. The total analysis is 226. 116 out of 150 wells had oil and grease contaminations.

81% of the wells had more than 1.00 mg/l oil & grease concentration within a 200m distance from the power station. 74% of wells exceeded the 1.00 mg/l. These wells are located at 200 – 500 m distance from the power station. Only 51% of the wells have more than 1.00 mg/l oil concentration in more than at 500 m distance. 1.00 mg/l is the maximum permissible limit of the SLS 614, 1983 publication.

31.020 mg/l oil concentration was observed as high value among all the wells. It was observed in the MOH office, located in front of the power station. Most of the wells showed a thin oil film layer in the surface of the wells, which are mostly close proximity to the power station.

150 wells were analyzed, in which 109 (73%) wells have shown the oil level above standard, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease.

As per the Figure 3 and 4, the oil contamination level has decreased with the distance. Beyond the 1500 m radius no contamination was observed.

Oil Concentration Vs type of Usage

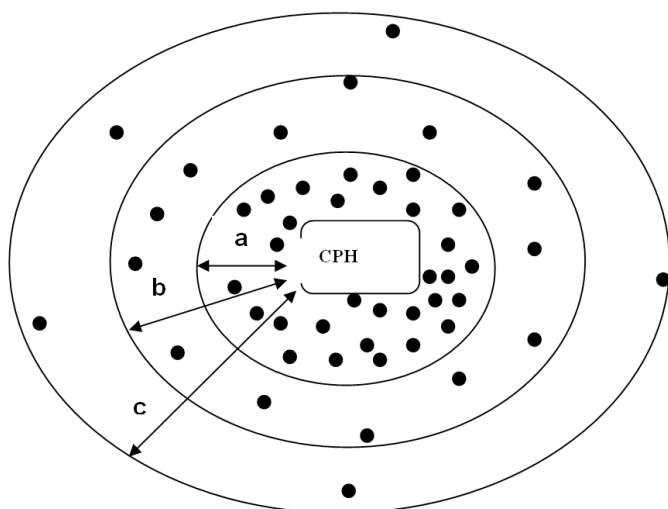


Figure 1. Diagrammatic figure of the well selection from the study area.

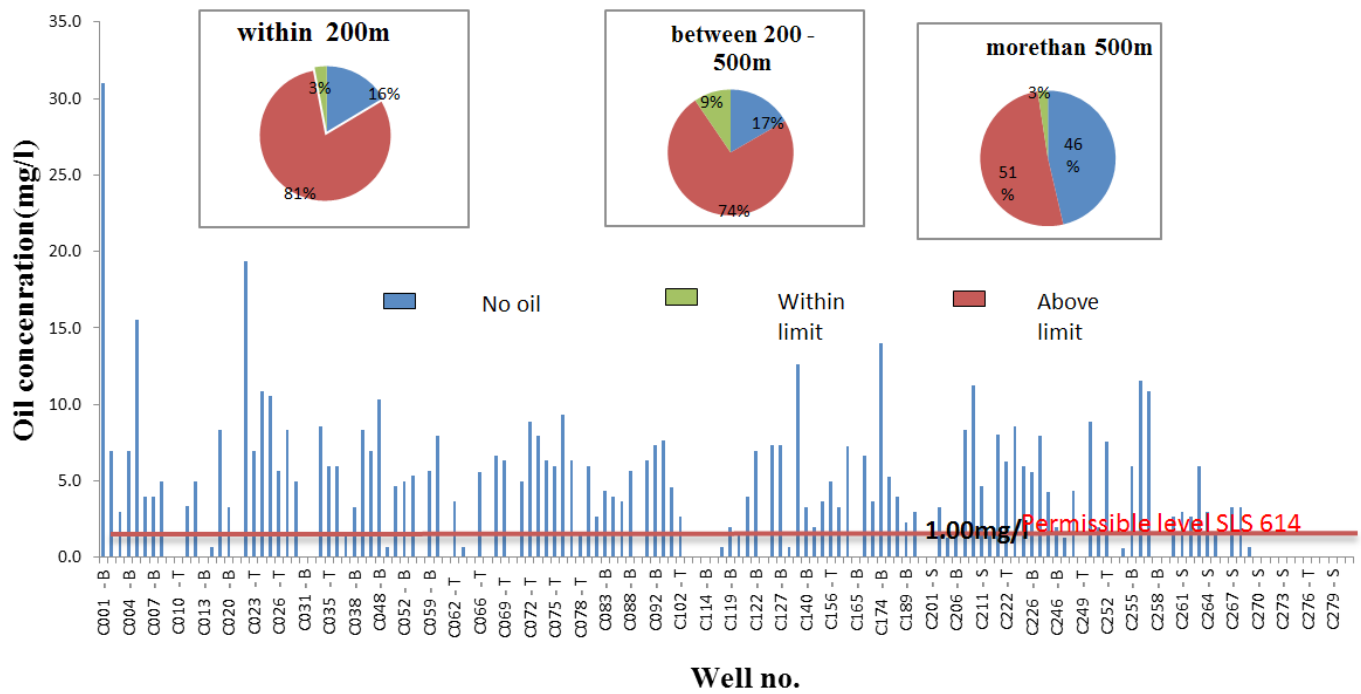


Figure 2. Oil concentration of analyzed wells.

Distance	% of the wells exceeding 1mg/L
Within 200 m from CPS	81
200 m - 500 m from CPS	74
> 500 m from CPS	51

Table 1. Contamination level vs. distance.

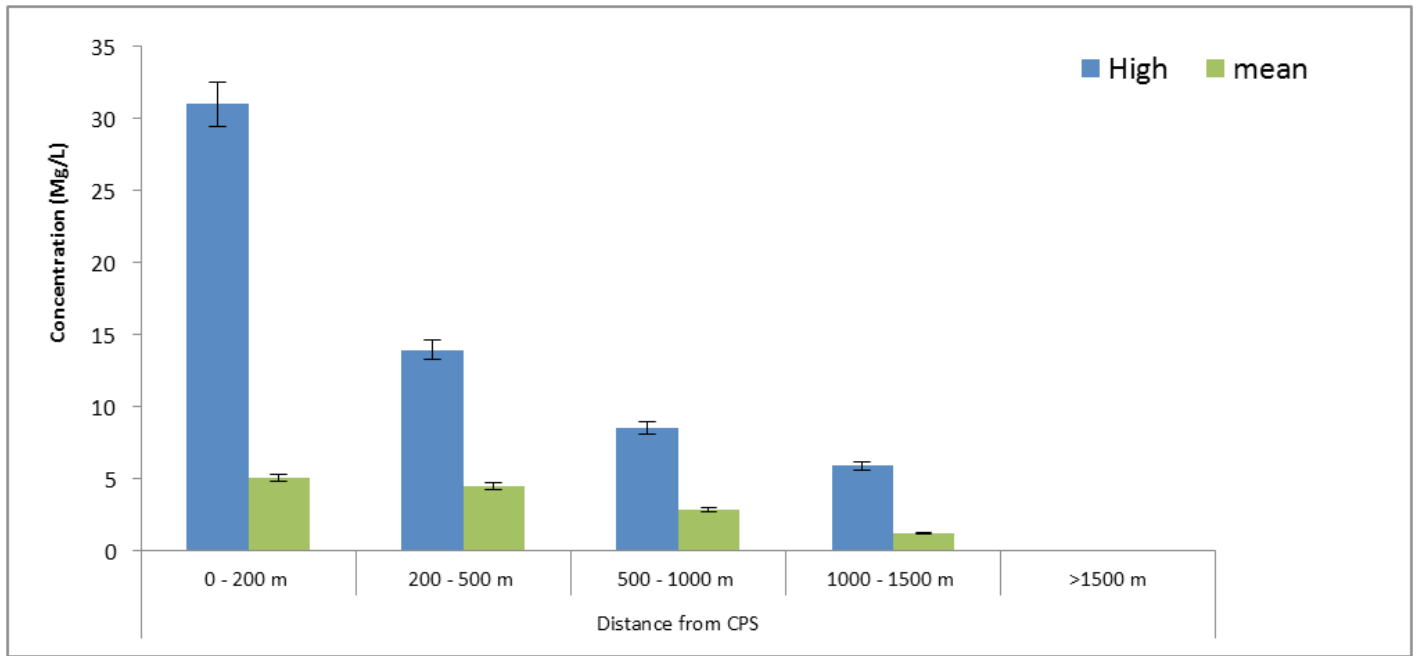


Figure 3. Oil contamination level with distance ranges

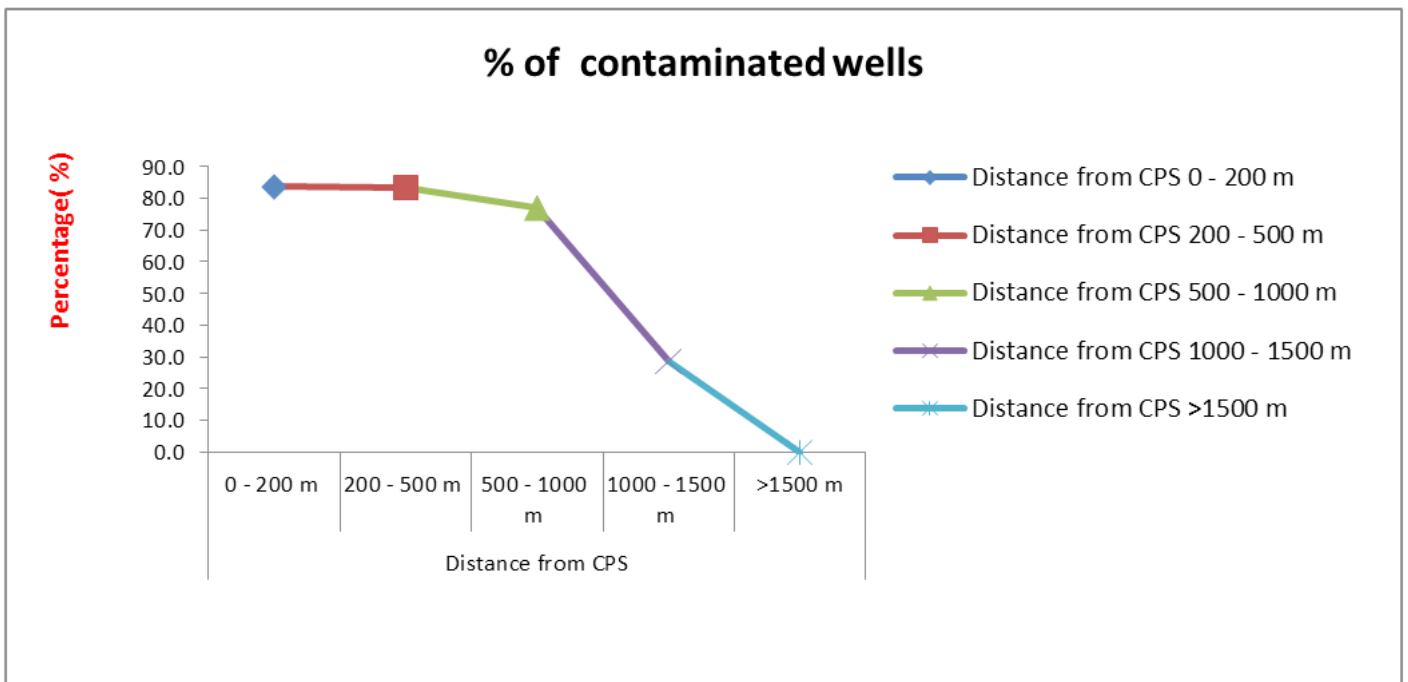


Figure 4. Number of contaminated wells with distance ranges

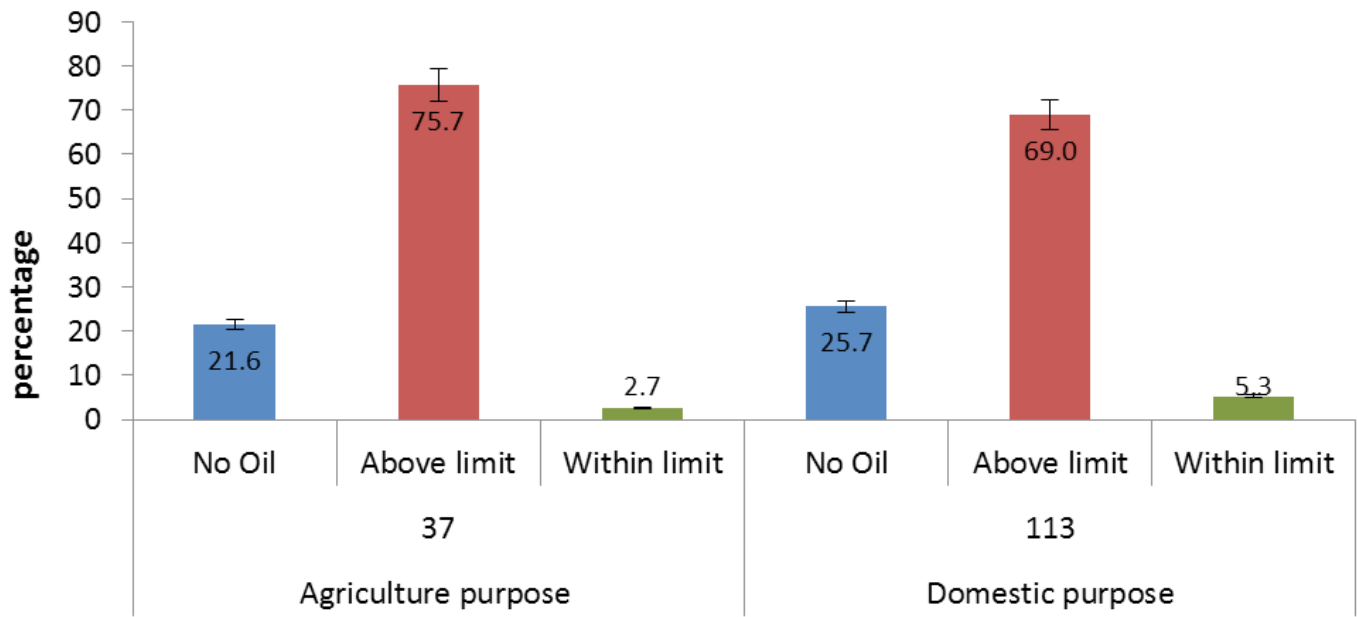


Figure 5. Oil and Grease concentration level in Agro and Domestic wells

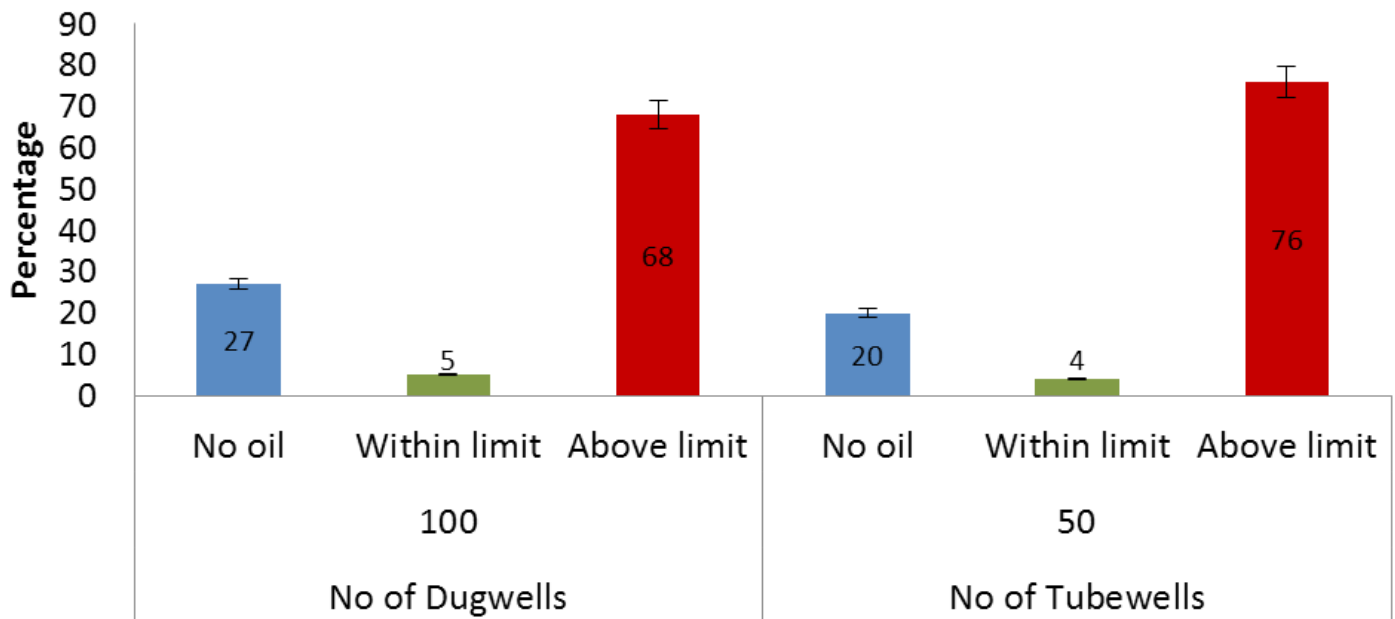


Figure 6. Oil and Grease concentration in different well types.

Figure 5 shows the oil concentration with the type of usage of the wells. There were no differences in oil contamination. Both agricultural wells as well as domestic wells showed the same oil contamination pattern. We may be able to conclude that the point extraction does not affect the oil and grease spreading.

Oil concentration vs well type

Figure 6 shows the oil concentration with the type of wells. There were no significant differences of oil contamination between dug wells and tube wells. The tube wells and dug wells are shallow, around 10 m depth; the well profile also mostly same.

Conclusion

109 (73%) wells showed the oil level above the standard of 1.0 mg/l, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease. The results clearly showed the suspected oil spilled area and the high concentrations were observed in the area closer to Chunnakam power station and the surrounding.

The oil contamination level has decreased with the distance. Beyond the 1500 m distance from the Chunnakam Power station, no contamination was observed.

From the above facts, we can conclude that the oil concentration of the water is high in the surrounding of Chunnakam power station and spreads out from this point. It has already spread up to 1500 m surrounding.

The entire conclusions are based on the research results obtained during the period of November 2013 to August 2014 and assumption would be drawn that sampling and analysis were not affected by rainfall during project period.

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