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GIS technique for surface water contamination

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Abstract- The three-forth of the world is surrounded by water, out of which around 1% of water can only be able to use for the drinking purposes. Water is essential for life and access to clean drinking water is a necessity for good health. However, clean drinking water is not available everywhere, due to water scarcity and pollution of existing water resources. At present Capetown city of Southafrica is facing water scarcity problem. The pollution can be in the form of natural or anthropogenic activities. This study focuses on the Impact of anthropogenic activities on the water quality of 4 downstream water tanks in Coimbatore city and its contribution to the groundwater quality. Due to encroachment and other anthropogenic activities, the quality of water is being depleted rapidly. Disposal of municipal waste and waste from other various industries into the tank depletes the quality of water in the tank. This water along with the leechate may percolate through the pore spaces between the soil particles and interact with the groundwater. Because of this interaction the quality of groundwater will also be affected. The contaminants will be transported and contribute to the nearby well head and affect the quality of water in the well too. Therefore, in this study water quality parameters were tested for both tankwater and groundwater and was spatially interpolated using ArcGIS. The spatially interpolated water quality map was obtained as output from ArcGIS. This spatially interpolated water quality map was helpful in understanding the variation in quality of both tankwater and groundwater with respect to space.

Key words: **GIS, GPS, Anthropogenic activity, Leachate, Groundwater quality, Spatial Interpolation.**

1.INTRODUCTION

Water is the basic element of social and economic infrastructure and is essential for a healthy society and sustainable development**.** Water that exists in the pore spaces and fractures in rock and sediment beneath the Earth surface is called Ground water. Groundwater being the favourite alternative to water provided through taps, is facing threats due to anthropogenic activities in India, which has led to deterioration of ground water quality. Hence, monitoring of ground water quality has become indispensable. The water used for drinking purpose should be free from any toxic chemicals, living and non living organism and excessive amount of minerals that may be hazardous to health. At present, groundwater is not excessively used for drinking purpose except in few areas. The quality of groundwater is influenced by the surface water quality upto some extent depending upon the lithological charateristics. Therefore it is important to assess both the tank water and ground water quality in order to study about the impact of these water on human health.Waste disposal has always been an important issue for human societies. Solid wastes are disposed on or below the land surface resulting in potential sources of groundwater contamination. As the natural environment can no longer digest the produced wastes, the development of solid waste management has contributed to their automated collection, treatment and disposal. However in many landfill sites because of lack of lining and precautions in the construction, the seepage of leachate is found.

Leachate is defined as the polluted liquid emanating from the base of the landfill. The downward transfer of leachate contaminates groundwater resources, whereas the outward flow causes leachate springs at the periphery of the landfill that may affect surface water bodies. Hence, leachate seepage is a long- term phenomenon that must be prevented in order to protect natural water resources.The waste generated from biomedical waste, clinics, hospitals, nursing homes, pathological laboratories, blood banks and veterinary centers have also been disposed along with municipal solid waste at disposal site. This waste is hazardous to human being and environment. Hence, monitoring and conserving this important resource is essential. The quality of water is defined in terms of its physical,

chemical and biological parameters. Groundwater assessment has been based on laboratory investigation, but the advent of Satellite Technology and Geographical Information System (GIS) has made it very easy to integrate various databases. The Spatially interpolated maps using GIS software (ARCGIS) will be helpful in understanding the interaction between surface and groundwater and also in determing the flow of groundwater.

2.METHODOLOGY

Data collection is the important component in the model development process. Primary data includes collection of water samples along the stretch of four tanks namely, Singanallur Tank, Ukkadam Periyakulam, Selvachinthamani Kulam and ValanKulam. The bore hole points are located using GPS. The samples were tested for physical and chemical parameters. The result obtained is spatially interpolated using GIS Software. This software is helpful in identifying the limits of parameters.The quality of groundwater is influenced by the surface wáter quality upto some extent depending upon the lithological charateristics. Therefore it is important to assess both the surface and ground wáter quality using some laboratory experiments such as physico-chemical tests. The Spatially interpolated maps using GIS software (ArcGIS) will be helpful in understanding the interaction between surface and groundwater and also in determing the flow of groundwater. After obtaining the test results a integrated water quality map of study area will be prepared considering the ground water quality parameters obtained from the laboratory test results.

3.ArcGIS

ArcGIS is a Geographic Information System (GIS) for working with Maps and Geographic Information. GIS is a powerful tool for developing solutions for water resources such as assessing water quality and managing water resources on a local or regional scale. Hydrologists use GIS technology to integrate various data and applications into one manageable system.

The suite of tools contained in Arc Hydro facilitates the creation, manipulation, and display of hydro features and objects within the ArcGIS environment. This software is necessary for our study to produce a spatially interpolated water quality map. The spatially interpolated mapping involves data interpolation for which raster interpolation and natural neighboris used. It involves the analysis and mapping of physical and chemical parameters.The Geo-referencing is the initial process to fix the latitude and longitude of the location. Finally the output is compared for both the surface and ground water for Post-Monsoon Season.

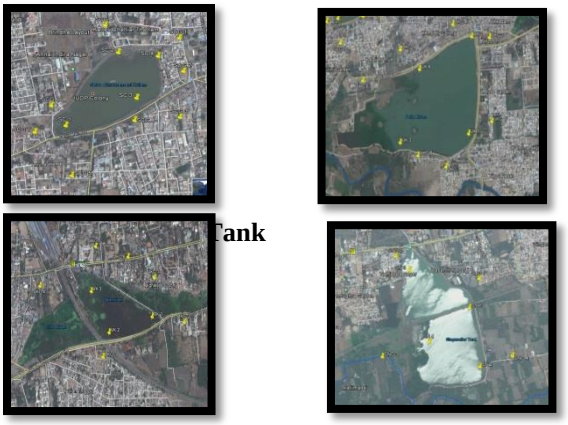
3.1Study Area Characterictics

Coimbatore city has totally 8 surface water tanks along the Noyal river stretch. There are 21 Anaikuts and 31 Tanks in Noyal river system, Among them 8 major tanks are located in Coimbatore namely, Narasampathi, Krishnampathi, Selvampathi, Kumarasamy tank, Selvachinthamani Kulam, Ukkadam periyakulam, Valankulam, Singanallur tank, that serves Coimbatore district in Noyal river system. All these tanks are located to the North of Noyal River. Among these tanks, our study area is 4 downstream tanks. Since the downstream tanks are comparatively more polluted than the upstream tanks.

Chitrachavadi Anaikut has been constructed across the Noyal River to divert water into Chitrachavadi canal which is 11.75 km long. The first five tanks are being fed by the Chitrachavadi canal.Coimbatore anaikut has been built across the Noyal River near Perur to divert the water into Coimbatore canal located 3 kms away from Coimbatore Periyakulam. Coimbatore Periyakulam is being fed by this Coimbatore canal. The surplus water from Coimbatore Periyakulam is fed into Valankulam. Singanallur anaikut has been constructed across Noyal River system to Serve Singanallur tank which is located 3kms away from the anaikut. More waste from government hospitals has been dumped into valankulam. More drainage waste are being dumped into singanallur tank. The concentration of the contaminants and the type of contaminant vary from tank to tank. Above all, the concentration of the contaminants and the type of contaminant vary from tank to tank. Hence, samples are collected separately at various locations of all the four tanks and the water quality parameters are also spatially interpolated.

3.2 Location

Coimbatore is an important district in Western part of Tamilnadu, which lies between $10^0 13'$ N and $11^0 23'$ N latitudes and $76^0 39'$ E & $77^0 30'$ E longitudes. It covers a total geographical area of 7,649 km^2. The area is bounded on the North West by the Nilgiris Hills, the Western Ghats in the West Anamalai and Palani Hills, which are the extension of the Western Ghats, in the South and in the North East by Erode District.



Valankulam **Singanallur Tank**

Fig-1 Sample collection points positioned in Google Earth

3.3 Sample Collection

For water analysis and assessment regarding the suitability of water for drinking and agricultural purposes, specialized sampling and sample handling procedures are required. The four sampling sites are selected randomly by considering the domestic, agricultural and industrial areas. The ground water and tank water of the **Post –Monsoon season (November-December)** were analyzed for various parameters. Various physical and chemical parameters like Colour, Odour, Turbidity, Total Dissolved Solids(TDS) ,Electrical conductivity(EC), pH, Total Alkalinity(TA), Total hardness(TH), Chlorides, Sulphates and Dissolved Oxygen(DO) have been assessed. The results were compared with the drinking water guidelines of Indian Standard (IS 10500:2012) and World Health Organization (WHO 2008)

3.4 Analysis of Ground Water Samples

The groundwater and tank water samples of the post monsoon season were analyzed for various physical and chemical parameters. It was noted that most of the ground water samples were found colourless and only few ground and tank water samples were found greenish, yellowish, slightly greenish and slightly yellowish.

In case of odour most of the tank water samples were found within Objectionable and Algal. And only a few ground water samples were found Earthy, Metallic and Muddy. Odour is recognized as a quality factor affecting acceptability of drinking water. Both the colour and odour indicates the presence of organic and inorganic chemicals. These chemicals may originate from industrial waste discharges, domestic waste discharges, etc.,

3.5 Spatial interpolation using Arc GIS

In general, pH is the measure of acidity or alkalinity of water. It is one of the most important operational water quality parameters with the optimum pH required often being in the range of 7.0-8.1. The maximum permissible limit for pH for drinking water as given by the WHO is 6.5 – 8.5. The pH values in the collected Samples varies from 6.3 to 8.3 which is showing that all the water samples are slightly alkaline in nature. The values of pH show that all of the samples display a pH value within the maximum permissible limit.

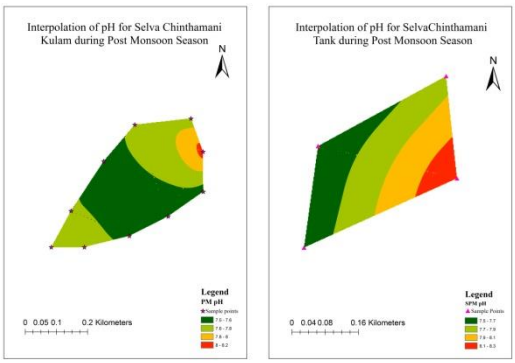


Fig-2 Spatially Interpolated Water Quality Map for pH

The importance of EC is its measure of salinity, which greatly affects the taste. Thus EC has a significant impact on determining the portability of water. Variation in pH is due to some presence of solid as EC. The measurement of electrical conductance is directly related to the concentration of ionized substances in water and may also be related to problems of excessive hardness or other mineral contamination.

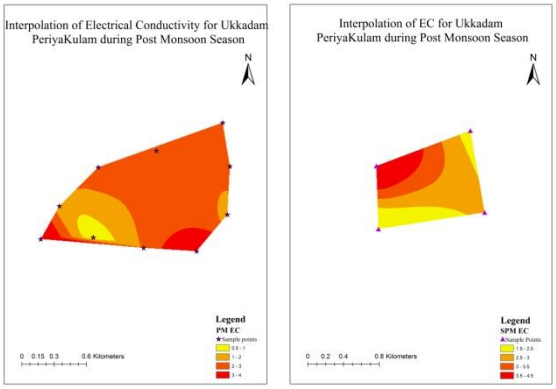


Fig-3 Spatially Interpolated Water Quality Map for Electrical Conductivity

Turbidity is the property of water which determines the degree of dispersing light. The range of Turbidity varies from 1 – 10 NTU. The maximum permissible limit given by WHO is 15 NTU. The Turbidity value for the collected sample is above the permissible limit.

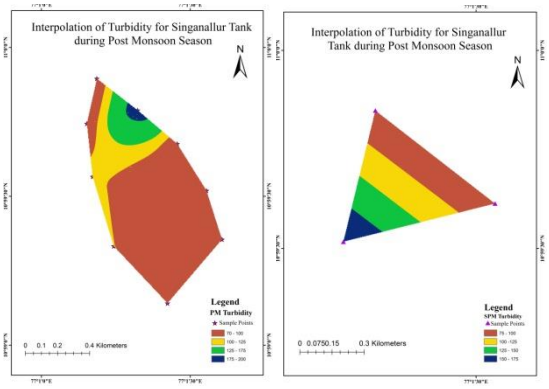


Fig-4 Spatially Interpolated Water Quality Map for Turbidity

The net turbidity is required to find the concentration of SO_4^{2-} present in the water. This net turbidity can be determined by the difference between the turbidity of the sample and the turbidity of the blank solution. The permissible limit for sulphates given by WHO is 500mg/L. The water samples collected displays the value which is within the maximum permissible limit.

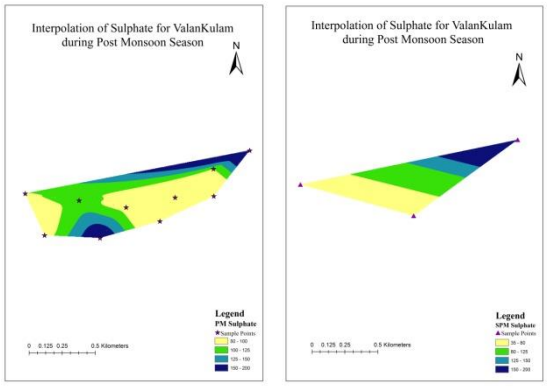


Fig-5 Spatially Interpolated Water Quality Map for Sulphates

TDS is the amount of dissolved solids that is present in water. The maximum permissible limit is 500 – 2000mg/L. The tested samples shows that the TDS is minimum and the water is suitable for drinking.

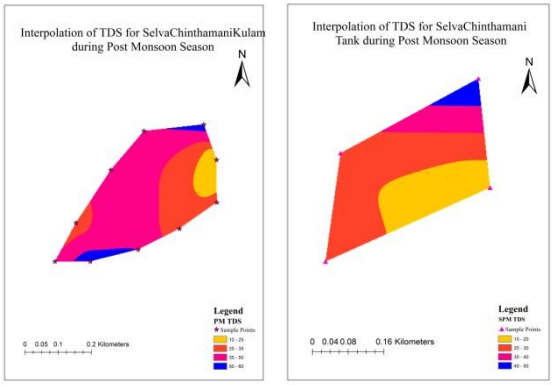


Fig-6 Spatially Interpolated Water Quality Map for Total Dissolved Solids

The Hardness of water is due to presence of certain salts, such as Carbonates and bicarbonate, Chloride and Sulphates of Calcium and Magnesium dissolved in it. The maximum Permissible limit for Hardness as specified by WHO for drinking water is 150 – 500mg/L.

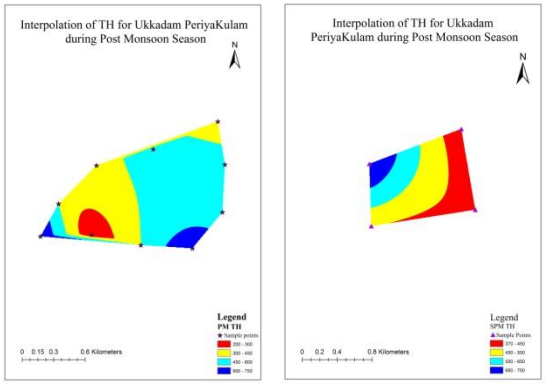


Fig-7 Spatially Interpolated Water Quality Map for Total Hardness

4. CONCLUSION

The Water quality parameter determined by conducting physio-chemical test in the laboratory clearly shows that Turbidity, pH, TDS and Sulphate values of all samples were found within the desirable permissible limit. It indicates ground water suitability to drinking water. Total Alkalinity, Total Hardness and Concentration of Chloride ion values of the ground and surface water samples exceeded the desirable permissible limit. It indicates ground water is slightly not suitable for drinking purpose. From the obtained results, it is suggested to monitor the surface and ground water quality and assess periodically in this study area to prevent the further contamination. Spatially interpolated water quality map was obtained using ArcGIS which

would be helpful in viewing the spatial variation along the study area.Spatially varying water quality map for both surface and groundwater samples were separately determined using ArcGIS. Spatially interpolated water quality map was obtained using ArcGIS which would be helpful in viewing the spatial variation along the study area. Spatially varying water quality map for both surface and groundwater samples were separately determined using ArcGIS.

Since the quality of water is being deteriorated because of anthropogenic activities, the contaminant gets transported and affects the groundwater quality also. As there is no desirable limit for values of Electrical Conductivity and Dissolved Oxygen. So, there is no problem with these parameters. Usage of ground waters without pre-treatment and some remedial measures causes several health issues. In order to overcome the problems, water quality is to be improved. To improve the water quality; several remedial measures are available such as adoption of primary pre-treatments such as filtration, aeration, chlorination etc. If the water is heavily polluted the secondary treatment is required.

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