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Contamination of Groundwater Quality Due to Municipal Solid Waste Disposal – A GIS Based Study

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Abstract: *The leachate produced by waste disposal sites contains a large amount of substances which are likely to contaminate ground water. The impact of such sites upon ground water can be judged by monitoring the concentration of potential contaminants at a number of specific monitoring points. Pirana in Ahmedabad is one such open dump yard with on an average about 2500 tons/day of waste is dumped on the site. The disposal causes hazards to ground water quality in and around the dumpsite. In this study the intensity of ground water contamination around the Pirana dump yard is examined using Geospatial Technology. Physico Chemical analyses were carried out on water samples collected at various radial distances from the boundary of the dumping yard. The study has revealed that the ground water quality around the dump yard especially in areas like Behrampura, Nagma Nagar, Faisal Nagar, and Chhipakuva were severely polluted and parameters like Sulphates, Phosphates, Chloride and other parameters exceeds the Stipulated limits of Indian standards of Drinking water (BIS 1500:991) and the World Health Organization. Furthermore, ground water in and around the landfill sites shall not be used for drinking purposes unless it meets specific standards. Indiscriminate dumping of wastes in developed areas without proper solid waste management practices should be stopped.*

Key words: *Geo-Spatial technology, Solid waste management, Physico-chemical parameter, Landfill, Ground water contamination.*

Introduction:

Rapid growth of population, changing life style, and developing industrialisation are the root causes of increasing solid waste generation in developing countries. In India, about 0.15 million tons of solid waste are generated daily due to human activities. Landfill has been consider as one of the major cause of Groundwater pollution and it is believed as one of the common method to dispose municipal solid waste due to its favourable economics[1].

Open dump yard creates unhygienic environment and foul smell. Hence the landfill has to be managed efficiently as it creates major threats to human lives as well as the environment. This is because 90% of wastes are dumped directly into the landfill. [2] The landfill consists of municipal solid wastes and these wastes are known as trash or garbage. The waste dump constituents include wastes from domestic such as kitchen wastes, clothes, cardboards, plastic, glass, paper etc. Municipal solid wastes also include construction wastes such as bricks, concrete, sand and adding on wastes from fish markets and vegetable markets. [3].Overall dumping rate all over the world is found to be 1.3 billion tons per year and are expected to increase to approximately 2.2 billion tons per year by 2025 and Metro cities in India generate about 30,000 tonnes of waste per day and Class I cities about 50,000 tonnes per day. [4] The dumped wastes when coming in contact with the moisture tends to extract organic and inorganic substances from trash into liquid which is known as leachate. [5]

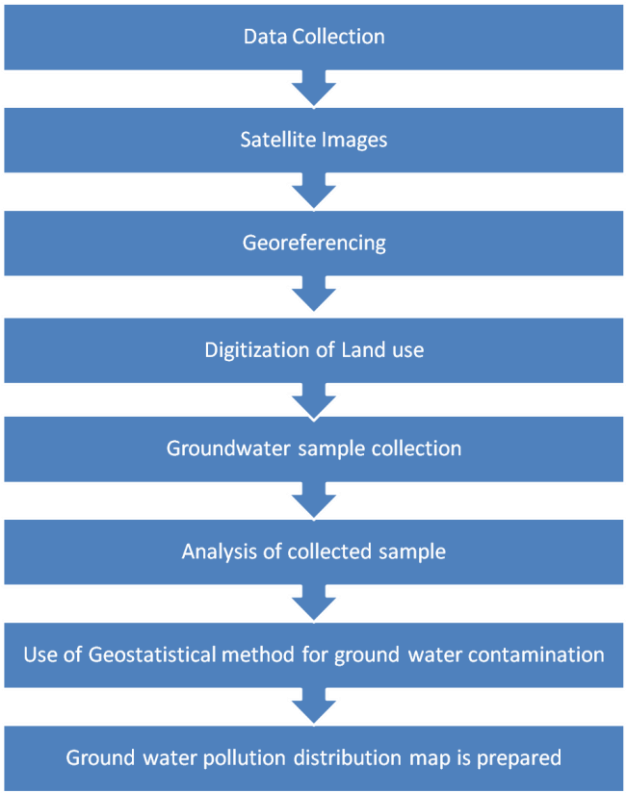
In the present work, the influence of physio-chemical parameters of the ground water are studied thoroughly by collecting the water samples around the dump yard boundaries and testing them for various parameters such as Total dissolved solids, Calcium and Magnesium Hardness, Total Hardness, Chloride, Sulphate, Nitrate pH and also collected various values from the official such as Ahmedabad Municipal Corporation.

Study Area

The study area is located near the highway away from the central part of the city. The industrial and residential areas are also nearby to the landfill site. The Sabarmati River is situated near to the site of around 3 km. The total area of Pirana landfill site is 84 hectares. 65 hectares land has been used up so far for the disposal of waste since 1980. The average depth/height of the waste is 22 meters. As per survey conducted by Abellon Clean Engg. in Feb 2010 at Pirana dump site, food waste constitute around 40% of sample tested. There is no mechanism in Ahmedabad for ensuring Recycling of food waste. It was found that around 70,000 flies can live in 1 cubic foot of garbage.

The landfill started operation in 1980 and on an average about 2500 tons/day of waste is dumped on the site with the waste filling heights varying from 20 to 22 meters. The wastes dumped into this site are largely from domestic and commercial sources. Nearly 61% of the accumulated waste is collected from municipal bins and street sweeping. More than 12500 workers are employed by AMC and they work on all 365 days of a year and twice a day – 6:30 am to 11:30 am

and 3:00 pm to 6:00 pm. The site is a non-engineered open pit and the waste brought here by collection trucks from different parts of the city are dumped haphazardly without segregation. AMC has identified more than 1100 locations as waste collection points. 900 closed body 7 cubic meter metal community storage bins have been provided at these points and AMC ensures that these containers are lifted at least once on a daily basis



Data Collection

Data collection is the first and foremost work in GIS Database creation. Based on the quality of the data used, the standard of GIS data varies. The data that has been acquired in this study is ASTER DEM (Digital Elevation Modelling) and Satellite imagery. Collected data were Geo-referenced by uniform coordinate reference system (WGS 84 UTM). [10]

Georeferencing

Georeferencing of Raster data is an important process in most GIS projects. The process of Georeferencing involves assigning real world co-ordinates to each pixel of raster. The aerial photo image or the internal co-ordinate system of a map can be related to geographic co-ordinates of the Earth. These co-ordinates could be obtained by performing field surveys (i.e.) collecting co-ordinates with a GPS device for some easily identifiable features in the map or image. In Georeferencing, WGS 1984 geographic coordinate system was used. The co-ordinate system that has been projected is WGS_84_UTM_zone_43N which is followed for Raster as well as vector data in the study for maintaining unity. The obtained coordinate transforms are stored typically in the form of image file[11].

Digitization

Digitization is one of the crucial step in data processing, storage and transmission because it is used for carrying information of all kinds in all formats with same efficiency and also for intermingling. The land use features such as Industrial area, Water body, Railway lines, Road network that are around the study area were digitized and are stored in a vector type spatial database.

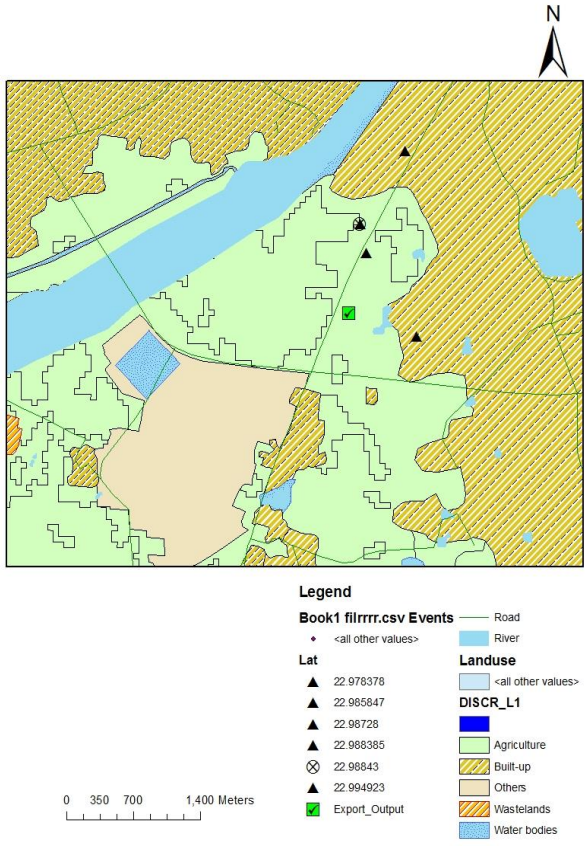


Figure 1 Well loaction

The digitized data are finally maintained in uniform co-ordinate system (WGS 84, UTM zone 43N) for both vector and raster layer. The Maximum benefits could be obtained by using QGIS tool for digitizing road areas, some parameters need to be determined. Through digitization, raster file are converted into vector file for calculating the areas. [11]

Digitization is done by representing different features in different forms such as polygons, lines etc. and in different colors[12]. Digital data is mostly preferred by many organizations around the world over analog data as the latter suffers loss of quality during each time it is copied or transmitted. In digital form, data can be propagated indefinitely with absolutely no degradation. Digitization helps in easy understanding of the study area for the users.[13] The digitized image of the study area is shown in figure given below.

Ground Water Sample Collection

To study the quality of the groundwater around Pirana dump yard, total 15 groundwater samples are collected.

All the sampling points are reached by navigating to the noted co-ordinates using satellite maps. Ground water samples are collected using polythene containers of two.

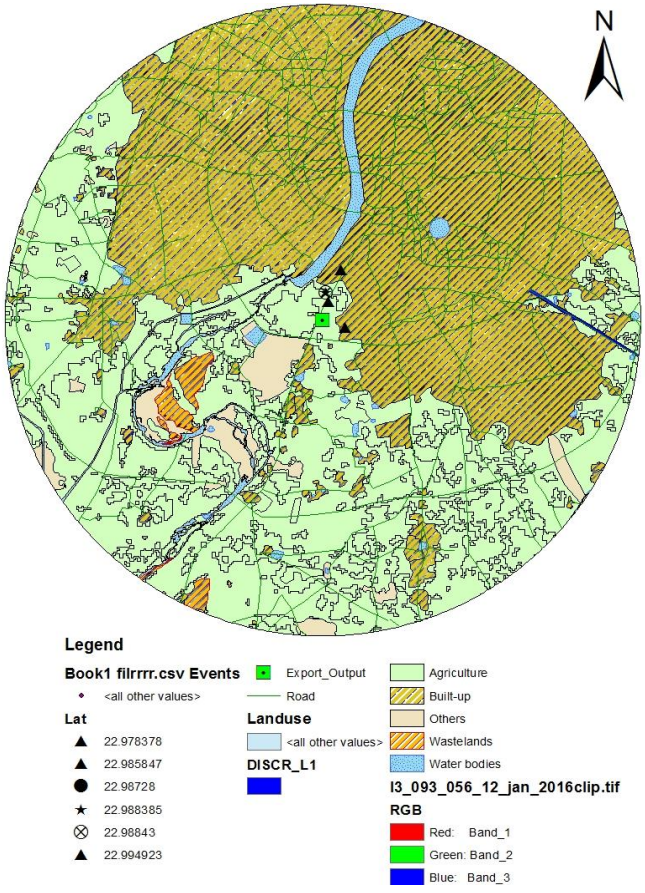


Figure 2 Digitization

liters capacity which are cleaned and sterilized well before using for the sample collection. [14] During sample collection utmost care was taken to avoid any kind of contamination.[15] The sample collection points are represented in the figure

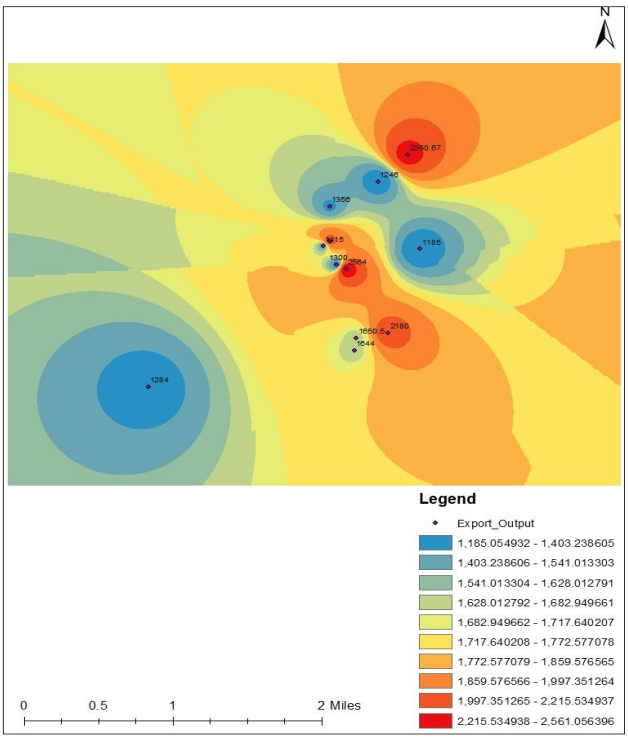
Physico-chemical Characteristics of Groundwater:

Groundwater water samples are collected and analyzed for the various physico-chemical parameters such as Turbidity, Hardness, Magnesium, Ammonia, Chloride, Calcium, Dissolved Oxygen, Fluoride, Iron, Phosphate, Sulphate, pH, Specific conductance and Total Dissolved Solids. Analyzed Physico-chemical parameters of different groundwater samples are tabulated in Table

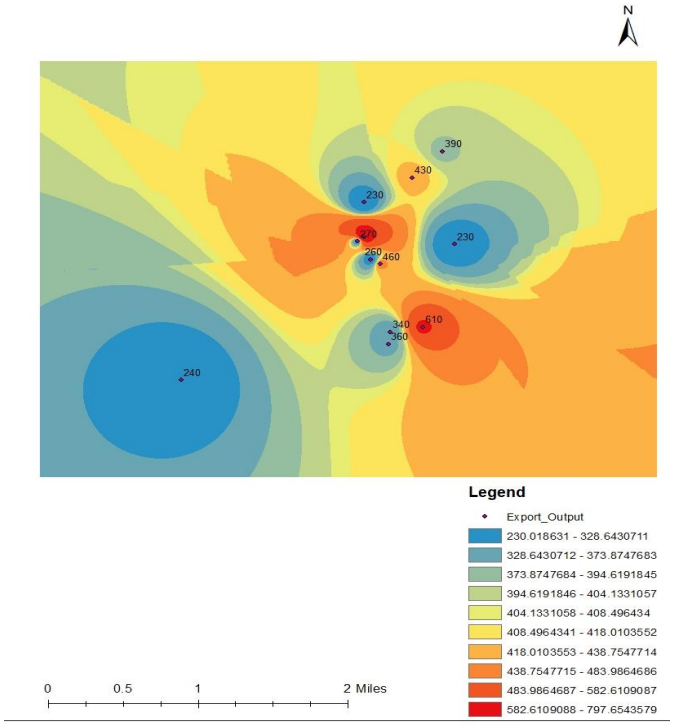
Interpolation

Interpolation is the process of estimating values of unknown points using known points. By using spatial analysis tool from the GIS software, the data is interpolated. Inverse Distance Method is the easiest method to interpolate various physical chemical parameters of water samples. In this study Quantum GIS software is used to prepare spatial variation of various parameters. The spatial variability of different parameters are listed below.

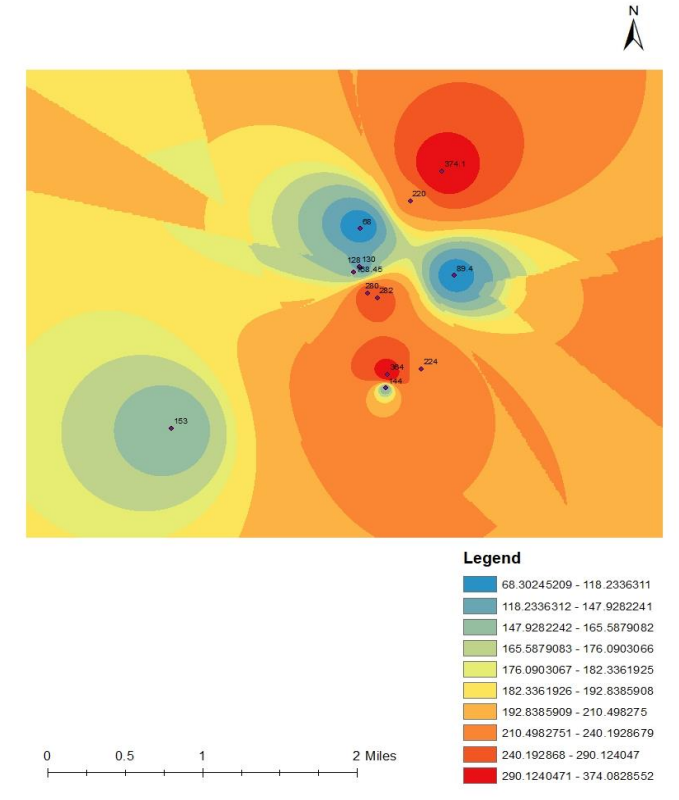
Sr. No.	pH	Total Dissolved Solids as mg/l	Total Hardness as mg/l	Calcium Hardness as mg/l	Magnesium Hardness as mg/l	Sulphates as mg/l	Chlorides as mg/l	Nitrates as mg/l
1	7.6	2180	610	390	220	390	680	223
2	7.83	856	570	350	220	360	330	146
3	7.54	1300	490	330	160	280	410	166
4	7.35	2100	630	370	260	220	760	120
5	7.64	2096	810	490	320	330	430	158
6	7.46	820	430	280	150	320	255	173
7	7.4	1356	230	120	110	68	384	168
8	7.73	1644	360	240	120	144	510	138
9	7.98	1284	240	130	110	153	456	127
10	7.31	2564	460	250	210	282	729	146
11	7.71	1185	230	126	104	89.4	370.4	153
12	7.93	1650.50	340	210	130	364	557.86	140
13	7.42	1415	310	200	110	168.45	405	132
14	7.3	2350.67	390	240	150	374.1	525.3	168



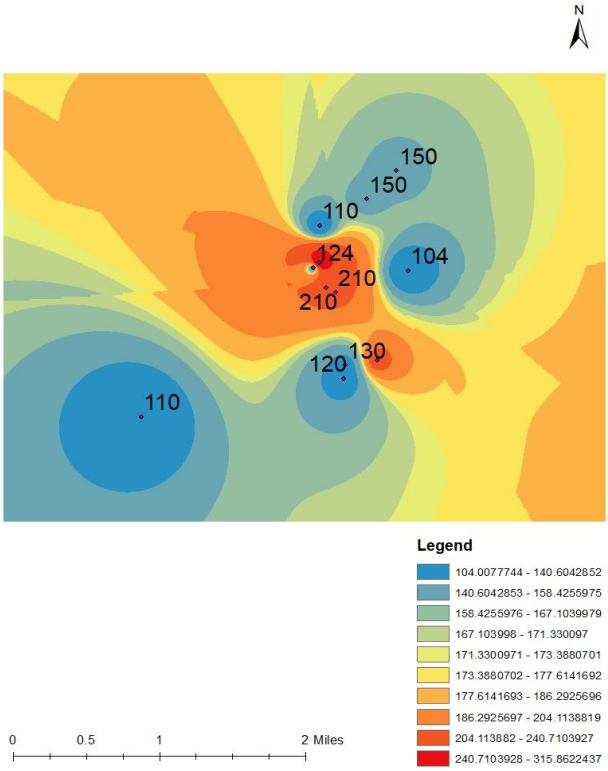
Total Hardness



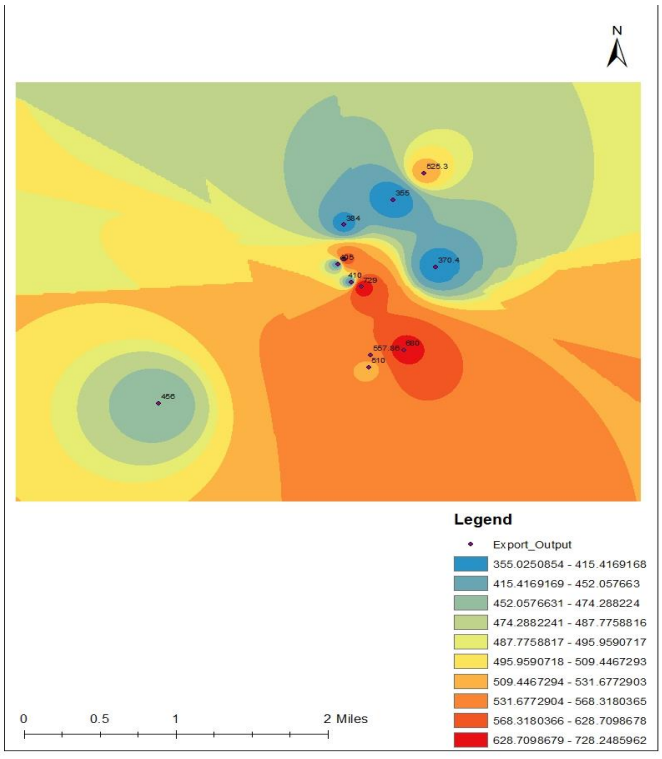
Nitrates

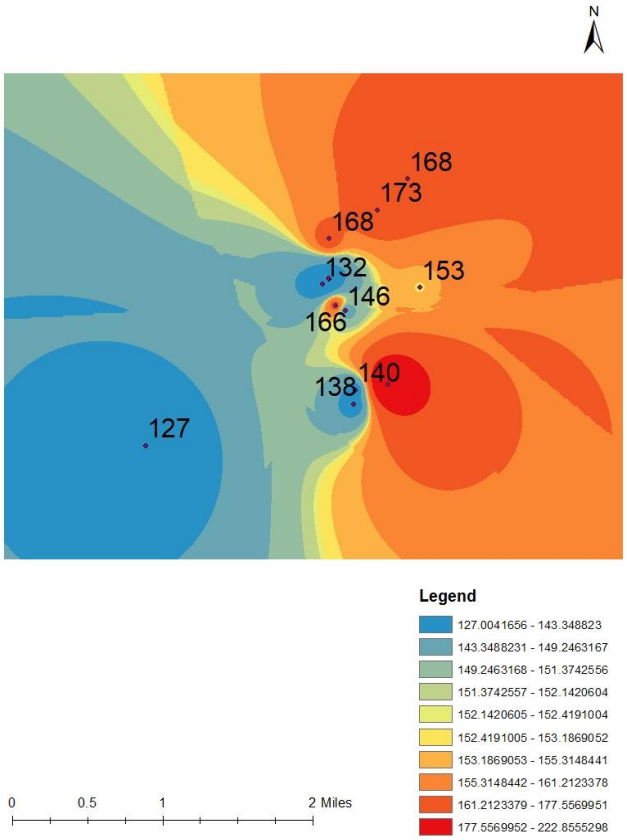


Chloride

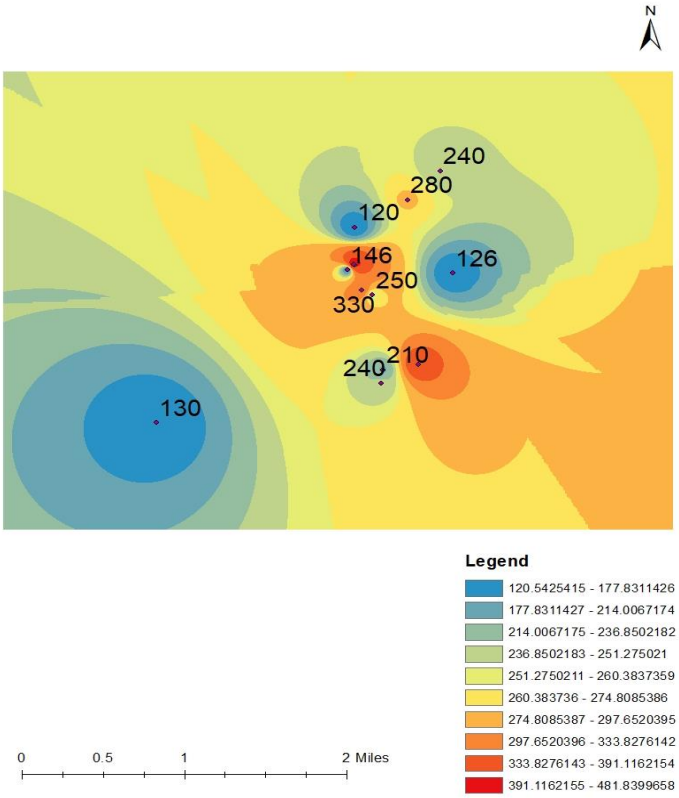


Magnesium Hardness

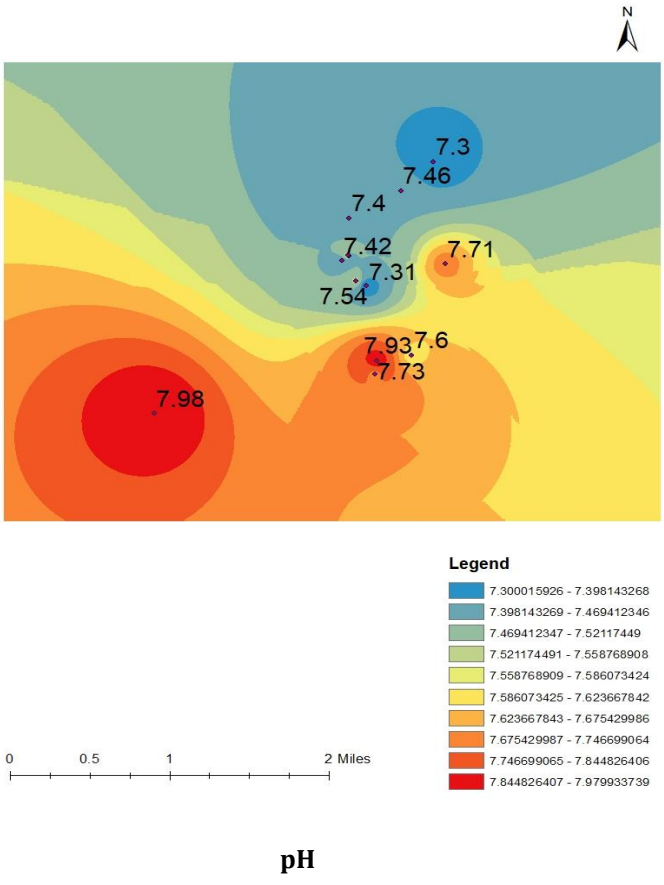




Sulphate



Calcium Hardness



pH

Conclusion

From the study it has been found that the areas such as Behrampura, Nagma Nagar, Faisal Nagar, and Chhipakuva are heavily contaminated. The results shows that values of various parameters are too larger than the stipulated limits given by the Indian Standards of Drinking Water (BIS 1500:991) and World Health Organization and parameters like Sulphates, Chloride and Specific conductance is present in higher concentration and exceeds the limits of standards. So, it's not recommended for drinking purpose. Counter measures such as provision of clay liners, Monitoring wells can be placed to reduce the further contamination of Ground Water around the dump yard.

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