International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.11, pp 205-212, 2017

Suitability Analysis of Ground and Surface Water Quality for Domestic Purpose along Upstream Side of Coimbatore City

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Abstract : 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. 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 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 leech ate 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.. This spatially interpolated water quality map was helpful in understanding the variation in quality of both surface and groundwater with respect to space. Visual MODFLOW incorporated with MT3D was used to simulate the groundwater flow. The direction of groundwater flow was obtained as output from MODFLOW. The direction and magnitude of the contaminant transport was obtained as output from MT3D. In this study, chloride has been chosen as contaminant transport parameter. Semi-structured interview was conducted in the study area to study about the source for drinking water, method of waste disposal and spread of disease among the people residing nearby the tank.
Keywords : MODFLOW, MT3D, Contaminant, Magnitude, anthropogenic.

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 is 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 up to some extend depending upon the lithological characteristics. Therefore it is important to assess both the surface and ground water quality in

order to study about the impact of this 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.

Methodology Data Collection

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, Narasampathy, Krishnampathy, Selvampahty, Kumaraswamy tank. Secondary data such as rainfall data, water quality data, groundwater level data, lithology data, and aquifer parameters data for the year of 1980-2010 are collected from State surface Water and Groundwater Board, Taramani, Chennai.

MODFLOW

MODFLOW is the USGS's three-dimensional (3D) finite-difference groundwater model. MODFLOW is considered an international standard for simulating and predicting groundwater conditions and groundwater/surface-water interactions. Originally developed and released solely as a groundwater-flow simulation code when first published in 1984, MODFLOW modular structure has provided a robust framework for integration of additional simulation capabilities that build on and enhance its original scope. The family of MODFLOW-related programs now includes capabilities to simulate coupled groundwater/surface- water systems, solute transport, variable-density flow (including saltwater), aquifer-system compaction and land subsidence, parameter estimation, and groundwater management. This software is necessary for our study to understand about the interaction between groundwater and surface water, to predict the flow of groundwater and the flow of contaminants etc.,

Steady state

Steady state calibration of the flow model was achieved by comparing the hydraulic heads obtained from available groundwater level contour maps of the first and second model layer and the calculated hydraulic heads of the MODFLOW simulation in order to simulate the flow.

Study 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 tanks are located in Coimbatore namely, Narasampathi, Krishnampathi, Selvampathi, Kumarasamy tank, Selvasindhamani, 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, my study area is 4 upstream tanks. Since the upstream tanks are comparatively more polluted, so far the study will be carried over there. Flow through all these tanks are only through gravity.

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.

1. Narasampathi tank is located to the west of Coimbatore city adjacent to Thondamuhtur road and also to the west of Kumaraswamy tank, this tank lies between latitude: 10^0 $59^{'}$ $58^{''}$ N and

longitude: $76^0 54' 31''$ E. Narasampathi is the first lake to receive water from the Noyal river through Chitrachavadi anaicut channel. It also receives a runoff from the stream course coming from the Maruthamalai forest area.

2. The Krishnampathi tank is located to the west of Coimbatore city on Thadagam to Thondamuthur road and close to Seeranaickenpalayam, the location of this tank lies between latitude :$11^0 0.283'$ N and longitude : $76^0 55.237'$ E. Krishnampathi lake receives the water from the Noyal river through Chitrachavadi channel and also getting the surplus water from the Narasampathy lake.
3. The Selvampathy lake is situated to the left side of Coimbatore-Thondamuthur road and west of Kumaraswamy lake and it lies between latitude: $10^0 59.457'$ N and longitude:$76^0 56.701'$ E. The surplus water from Krishnampathi reaches to Selvamapthi and outlet of this tank is connected to the Kumaraswamy lake. Selvampathy tank receives the sewage water from the two sewage inlets.
4. Kumaraswamy tank is the last tank of my study area which is situated to the left side of Coimbatore at Thondamuthur road and the east of Selvampathy lake, this tank obtains the surplus water directly from the Selvampathy lake . 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.

Location:

Coimbatore is an important district in western part of Tamilnadu, which lies between 10013' N & 11023' N latitudes and 76039' E & 77030' E longitudes. It covers a total geographical area of 7,649 km2.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.

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. A four sampling sites are selected randomly by considering the domestic, agricultural and industrial areas.

Analysis of Ground Water Samples:

The ground and surface water samples of the post monsoon season and monsoon season were analyzed for various physic-chemical parameters as shown in the table 1 to 4 .It was noted that most of the ground water samples were found within colourless and only few ground and surface water samples were found within greenish, yellowish, slightly greenish and slightly yellowish.

In case of odour most of the ground water and surface water samples were found within objectionable and algal. And only a few ground water samples were found within earthy 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.,

BoundaryConditions:

In this study, Noyal river has been assigned as boundary for one providing all the necessary boundary condition details, the model is made to run to simulate the flow of groundwater.

Contaminant transport using MT3D

Since the concentration of chloride was above the permissible limits for all the tanks, contaminant transport for the study area has been done with chloride as the water quality parameter using MT3D package. Figure 1 shows the contaminant transport map of the study area. Contaminant transport map is obtained as the output from the transport model after giving some parameters like Concentration observation wells, Initial concentration, Constant concentration, Recharge concentration and Evapotranspiration concentration.

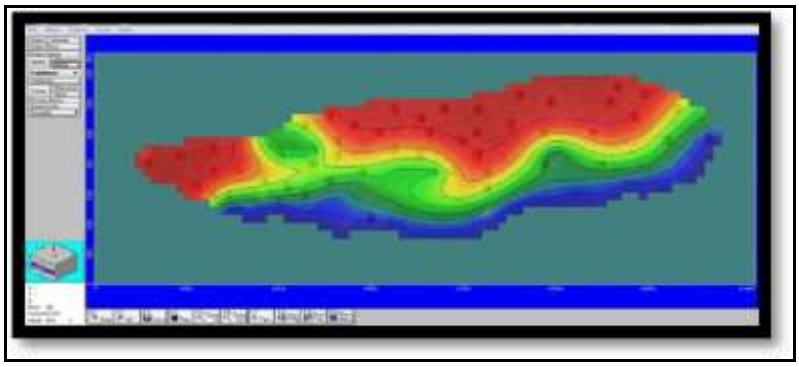

Figure 1 Contaminant transport map

Table-5.1 Water Quality Parameter Variations of Narasampathy Tank

Physical chemical parameters	Water Limit			Ground water and Surface water sample Nos.											
				Surface water				Ground water							
	IS 10500:2012		WHO	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
	(A)	(B)													
Colour	-	-	-	CL	CL	CL	SG	CL	CL	CL	CL	CL	CL	SY	G
Odour	Agreeable	Agreeable	-	O	O	E	O	O	M	O	O	M	O	O	O
Turbidity (NTU)	1	10	15	73	84	72	80	72	72	82	91	178	72	81	70
TDS(mg/L)	500	2000	-	80	10	20	30	80	40	20	30	10	55	60	20
EC	-	-	-	3.5	0.32	1.22	0.25	1.72	0.914	0.421	1.526	0.636	0.767	3.11	4.36
pH	6.5	6.5	6.5-8.5	7.82	8.13	7.65	7.56	7.64	7.78	7.77	7.71	7.7	7.77	7.42	7.21
TA(ppm)	200	600	-	420	370	340	210	450	200	100	360	450	250	350	410
TH(mg/L)	200	600	150-500	575	175	490	220	560	430	150	415	160	350	510	620
Cl^-(mg/L)	250	1000	250	415.7	261	13.99	283.86	57.97	41.98	45.3	119.94	79.96	50.4	209.9	355.82
$SO4^{2-}$ (mg/L)	200	400	500	567	6.4	69.5	35.33	95.417	0.21	14.55	86	313	32.12	154.78	211.16
DO(mg/L)	-	-	-	2.4	2.6	3.3	3	2	3.1	3.5	2.6	3.1	3.2	3.1	3.5
BOD	-	-	-	2	1.6	4.4	2	0.8	3.2	1.5	2.4	3.5	4.1	4.4	3

CL – Colour less, SG – Slightly Grey, SY – Slightly Yellow, G – Grey
O – Odour, E – Excess Odour, M – Moderate odour

Table-5.2 Water Quality Parameter Variations of Krishnampathy Tank

Physical chemical parameters	Water Limit			Ground water and Surface water Sample Nos.											
				Surface water				Ground water							
	IS 10500:2012		WHO	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
	(A)	(B)													
Colour	-	-	-	CL	G	CL	CL	SG	CL	CL	CL	CL	CL	CL	CL
Odour	Agreeable	Agreeable	-	O	O	E	O	O	M	O					
Turbidity (NTU)	1	10	15	87	81	84	71	73	74	72	85	74	82	80	75
TDS(mg/L)	500	2000	-	80	40	10	20	40	10	30	20	10	50	40	20
EC	-	-	-	2.59	2.87	1.59	4.95	2.11	0.077	5.07	2.15	4.4	3.2	1.94	2.77

pH	6.5	6.5	6.5-8.5	7.81	8.01	8.2	7.56	7.61	7.38	7.56	8.1	7.8	7.5	7.52	7.13
TA(ppm)	200	600	-	440	425	235	330	310	250	520	325	400	530	340	525
TH(mg/L)	200	600	150-500	450	575	490	850	465	200	760	600	525	800	175	650
Cl^-(mg/L)	250	1000	250	197	133	217.8	215.8	385.8	193.9	219	150	123.3	200.1	163.9	143.93
$SO4^2$(mg/L)	200	400	500	174	137	103	707.8	156	6.4	621	123.5	155.7	167.8	137.2	156
DO(mg/L)	-	-	-	2.4	1.8	2.1	1.8	2	2.2	2.1	1.6	1.9	2.5	3.1	2.1
BOD	-	-	-	3.2	2.8	0.8	0.9	0.8	2.1	3.3	1.6	3.1	1.9	2.1	1.7

CL – Colour less, SG – Slightly Grey, SY – Slightly Yellow, G – Grey
O – Odour, E – Excess Odour, M – Moderate odour

Table-5.3 Water Quality Parameter Variations of Selvampahty Tank

Physical chemical parameters	**Water Limit**			**Ground water and Surface water Sample Nos.**							
				Surface water			**Ground water**				
	IS 10500:2012		**WHO**								
	(A)	**(B)**		**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
Colour	-	-	-	CL	CL	CL	SG	CL	CL	CL	CL
Odour	Agreeable	Agreeable	-	O	O	E	O	O	M	O	O
Turbidity (NTU)	1	10	15	76	222	74	74	75	75	74	77
TDS(mg/L)	500	2000	-	90	10	50	50	20	30	50	90
EC	-	-	-	2.69	2.63	2.91	2.79	2.48	2.69	1.57	0.188
pH	6.5	6.5	6.5-8.5	6.42	6.51	6.54	6.37	6.62	6.38	6.54	6.32
TA(ppm)	200	600	-	475	500	460	480	460	475	375	400
TH(mg/L)	200	600	150-500	775	425	700	800	650	825	350	150
Cl^-(mg/L)	250	1000	250	277.86	229.89	237.88	213.89	203.9	233.88	183.91	223.89
$SO4^{2-}$(mg/L)	200	400	500	101.87	64.61	130.39	256.72	140.29	234.6	118.75	10.47
DO(mg/L)	-	-	-	3.1	3	3	1.8	3	3.2	2.9	1.9
BOD	-	-	-	1.6	0.8	0.8	2.4	1.6	3.2	1.9	2.1

CL – Colour less, SG – Slightly Grey, SY – Slightly Yellow, G – Grey
O – Odour, E – Excess Odour, M – Moderate odour

Table-5.4 Water Quality Parameter Variations of Kumaraswamy Tank

Physical chemical parameters	Water Limit			Ground water and Surface water sample Nos.								
				Surface water			Ground water					
	IS 10500:2012		WHO	S1	S2	S3	S4	S5	S6	S7	S8	S9
	(A)	(B)										
Colour	-	-	-	CL	CL	CL	SG	CL	CL	CL	CL	CL
Odour	Agreeable	Agreeable	-	O	O	E	O	O	A	O	O	M
Turbidity (NTU)	1	10	15	65	64	83	81	75	92	83	66	65
TDS(mg/L)	500	2000	-	10	40	20	70	30	10	60	40	10
EC	-	-	-	2.21	2.47	0.092	1.61	1.493	1.133	2.23	1.99	2.53
pH	6.5	6.5	6.5-8.5	6.45	6.56	6.63	6.81	6.72	6.63	6.9	6.62	6.47
TA(ppm)	200	600	-	325	425	390	305	355	430	365	370	340
TH(mg/L)	200	600	150-500	600	860	180	355	460	450	380	595	730
Cl^-(mg/L)	250	1000	250	213.89	173.91	305.85	115.94	303.85	123.94	149.93	137.93	333.83
$SO4^{2-}$ (mg/L)	200	400	500	246.24	183.6	55.62	215.39	400.65	193.26	115.26	139.51	42.49
DO(mg/L)	-	-	-	5.36	3.6	3.2	5.9	4.5	3.6	3.5	5.2	4.6
BOD	-	-	-	1.2	0.8	0.9	3.2	5.2	0.8	4.2	2.5	3.1

CL – Colour less, SG – Slightly Grey, SY – Slightly Yellow, G – Grey
O – Odour, E – Excess Odour, M – Moderate odour

Source for drinking water

The percentage of people using Corporation water, Bore water and Tank water in all the four tanks separately is shown in Figure 5.56. From this Figure 1, we could infer that few people from Narasampathi and Krishnampathi tank are only using tank water for drinking purpose. More than 25% of people in all the tank use bore water for drinking and the remaining majority of people use corporation water for drinking.

Conclusion

Viewing of the output from the MODFLOW, Direction of groundwater flow in study area could be determined .Calculated vs. observed head difference is obtained in the form of graph from MODFLOW. The correlation coefficient value is around 0.9, Standard error of the estimate value is within 2m and the Root mean squared value is within 8m and therefore we could conclude that the field condition has been matched well with the model and the model has been trained well .Model was validated from 2011 to 2013, Finally the Groundwater flow was predicted for 2013 2014 to 2016. The actual values of the flow and dispersion parameters such as dispersion, hydraulic conductivity and porosity would help better for prediction of solution movement. The contaminant (chloride) flow direction was simulated using MT3D package. The contaminant concentration contour map, output from the MT3D is helpful in understanding the movement of contaminant. Finally Semi-structured interview conducted in the study area was helpful to understand the source of drinking water for the people residing in and around the tank, their method of waste disposal and the spread of water borne and vector borne disease among the people residing in and around the tank. From the analysis of the semi-structured interview, it is clear that more than 50% of the people residing around the tanks dispose the waste from their households into the tank, which is the prime reason for water quality deterioration. Since the quality of water is being deteriorated because of anthropogenic activities, the contaminant gets transported and affects the groundwater quality also.

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