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RESEARCH ARTICLE

Assesment of ground water pollution using peizometer techniques in Coimbatore district of Tamil Nadu, India

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SUMMARY : In order to monitor the ground water quality, peizometer (ground water monitoring wells), studies were conducted at different places of the study area, each representing the heavy metal hot spots. The results inferred that the toxic concentrations of Pb and Ni were seen in water samples collected from rhizosphere zone and ground water of Ukkadam, Ganapathy, Pilamedu, Kurichi and Nanjundapuram villages of Coimbatore district. Keeping the rhizosphere zone devoid of toxic Pb and Ni metals, is essential to take up cropping activities thereby avoiding bio magnification. The toxic concentration of Pb and Ni in rhizoshphere zone (0.5 m) and ground water (2.0 m) and in between these two depths (1.0 m) were studied in this experiment. The place Ukkadam in Coimbatore district stands first in Pb pollution because of continuous sewage irrigation practices to agricultural fields followed in those areas. Hence, food crop cultivation in those areas may lead to adverse effects on animals and human beings. Similarly, the place, Ganapathy in Coimbatore district occupies first in Ni pollution. Hence, it may cause ill effects to food chain. The continuous letting of untreated effluents of electroplating industries may be the root cause for Ni pollution in Ganapathy. The lead content ranged from 1.81 to 11.81 ppm and Ni content ranged from 3.95 to 17.85 ppm in ground water of study area. The severe ground water pollution was noticed for Pb at Ukkadam village and for Ni at Ganapathy village of Coimbatore district. Hence, the soil and ground water of those places may not be much useful for agricultural practices as well as human consumption; unless the routine practices of sewage irrigation and letting of untreated effluents on the land may be stopped.

Key Words :
Peizometer, Ground water pollution, Rhizosphere zone

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Environmental pollution is a by-product of development and in fact a price for progress. The history of pollution faithfully reflects the progress of technology and mankind's failure to design social and political institution, which is capable of properly assessing and controlling technological innovation. Now, modern civilization is completely depending on a large range of metals for all aspects of daily life. The increasing world population and the increasing annual metal usage per capita leads inevitably to ecological problems because of wide dispersal of potentially toxic metals into the natural environment. The water-soluble Pb levels measured are far in excess of the 50 mg L^{-1} drinking water standard (USEPA, 1976). Pande and Sharma (1999) reported that Pb could enter in river water through lead joints of C.I. pipes and lead pipes used for connecting, plumbing fixtures (wash-basins, kitchen sinks etc.).

International standards for drinking water (mg L^{-1})

Element	Maximum permissible USEPA standards	WHO standards
Pb	0.05	0.1
Ni	0.01	0.01

(De, 2000)

The Pb and Ni levels in water (mg L^{-1}) of lakes in urban Coimbatore were given by Mohanraj *et al.* (2000). They stated that the Pb and Ni content of water of few lakes exceeded the prescribed WHO limit for drinking water.

The Pb listed as a regulated hazardous air pollutant under the U.S. clean Air Act, and is one of the most common heavy metals found in the

Location	Pb ($\mu g\ L^{-1}$)	Ni ($\mu g\ L^{-1}$)
Selvachinthamani lake	375.0	6.94
Singanallur lake	26.0	23.8
Ukkadam lake	10.5	6.4
Perur lake	4.5	8.6
Velankulam lake	25.5	24.9
Ammankulam lake	4.5	11.8
Selvampatti lake	15.5	11.5
Kumaraswamy lake	14.5	6.1

(Mohanraj *et al.,* 2000)

flue gases and hazardous waste incinerators and combustion product. A 1974 EPA mandate requiring the use of unleaded fuel in all new automobiles has resulted in significant reductions of Pb emissions in the U.S. (USEPA, 1990). However, leaded gasoline is still burnt in older vehicles, which may account for as much as 30 per cent of vehicular air pollution in some areas, and many other countries have to regulate the use of leaded fuels (World Resource Institute, 1990). Jorgensen (1979) reported the global emissions of Pb and Ni into atmosphere, water and soil. Singh *et al*. (2000) indicated that the higher concentration of Pb and Ni in ground water may be due to various galvanizing, electroplating and other industries which surely reached upto underground sources due to leaching from dumping sites. Madhusudhana Reddy and Subba Rao (2001) indicated considerable deterioration in the ground water quality due to zinc smelters. The reason sighted here was, due to the movement of industrial effluents along with the direction of ground water movement and flow towards central mash land through residential areas due to topographic control. They also suggested that the enrichment of chemical constituent in ground water followed the chemistry of industrial effluents.

Description of study area:

Coimbatore is located in the northwestern Tamil Nadu, close to Western Ghats, at 10^0N latitude, 77^0E longitude and 426.72 m above sea level and has an area of about 109.2 square kilometers. It is the second largest industrial centre in Tamil Nadu. The climate in Coimbatore is tropical with two monsoons. The annual rainfall is 600 to 700 mm. About 50 per cent of annual rainfall is received during NE monsoon and 30 per cent during SW monsoon. The mean minimum temperature is 21^0C and the mean maximum temperature is 34^0C.

There are several numbers of industries such as electroplating, foundries, castings, textiles, plumbing and dying which are located in an unorganized manner under different soil series in different taluks of Coimbatore district. These industries let out the wastes and effluents in the nearby land itself. The effluents that are let out in the soil, may affect the nearby agricultural field and if heavy rainfall occurs, the metals will be leached down, eventually contaminating the ground water.The Noyyal river is flowing all through the Tirupur taluk. The Oorathupalayam dam has been constructed on the embankment of the river, which is the major source for drinking water, and irrigation purposes of the livelihood. The dye effluents from hosiery manufacturing industries are being released into the Noyyal river continuously, that contaminates the dam severely.

EXPERIMENTAL METHODOLOGY

The studies were conducted during October – December, 2003 (winter) and March – May, 2004 (summer) in five severely contaminated places *viz*., Peelamedu, Ganapathy, Kurichi, Nanjundapuram and Ukkadam. The ground water monitoring wells were fabricated by using the PVC tubes of 10 cm diameter that were capped at the bottom and from there for at least 10 cm height grooves were made. These grooves were covered with nylon sieve to avoid the entry of soil particles inside. This set up was buried in a contaminated soil at different depths *viz*., 0.5 m, 1.0 m and 2.0 m. The installed PVC tube was first covered with white clay/Bentonite up to the grooved level, then with the scooped out soil and finally top also covered with white clay/Bentonite in order to arrest the water entry. The set is depicted in Fig.1. The water samples were collected as and when water accumulation was noticed. The water will be seen in peizometer, only if enough moisture saturation occurs in soil which allows lateral flow of soil water which is known as perched ground water. The ground water samples were collected by following the procedure of Sadiq and Alam (1997). The water samples were collected by using small nylon tubes (approximately 5 mm diameter) connected one end with syringe (with no needles). So that after inserting the other end of the tube inside the peizometer, we can outject the syringe so that water will come.This setup was kept for three months. One set of sampling (over a period of two months) during winter and again during summer was done. The water samples were filtered by using Whatman no. 42 filter paper. In the water samples EC, pH, Ni, Pb, Cl^-, NO_3^-, Ca^{++} and Na^+ were analyzed by following the standard procedures. The ground water monitoring wells (Peizometers) were installed at five different metal contaiminated hot spots namely, Peelamedu (S_1), Ganapathy (S_2), Kurichi (S_3) Najundapuram (S_4) and Ukkadam (S_5). The water samples were collected in both summer and winter seasons from the above said places in three different depths (D_1-0.5 m; D_2 – 1.0 m; D_3 – 2.0 m). The ground water and effluent samples were digested by using triple acid (nitric sulphuric and perchloric acid – 9:2:1) mixture and analyzed for their heavy metal content.

EXPERIMENTAL FINDINGS AND DISCUSSION

The ground water (peizometric water samples) collected from five severely polluted spots of Coimbatore district showed toxic concentration of Pb and Ni were seen in 0.5m, 1m and 2m depth. The possible consequences of such toxic concentrations were discussed below:

Site -1 (Peelamedu):

Winter season:

The site Peelamedu occupies central part of the Coimbatore district which was mushroomed with lots of (>3000) electroplating units. The people who are engaged in the plating processes, haphazardously letting out the effluents on the land. The effluents from elecroplating industries had higher amount of toxic Ni (425 mg L^{-1}) and Pb (410 mg L^{-1}). In addition to that, the effluents were rich in soluble salts. These soluble salts also gave the added advantage for the enhanced mobility of Pb and Ni in ground water of Pilamedu areas as discussed in the earlier sections. This was akin to the findings of (Graug *et al*., 1999). The higher concentrations of soluble salts like Cl^-, NO^-_3, CO^-_3 and Ca^{++} were noticed at 1m depth when compared to 0.5 m depth during winter season that might be due to the heavy rainfall received (85 cm) during that period. This was in line with the findings of Singh *et al*. (2000). Ramaswami and Rajaguru (1991) found the similar behaviour in their studies. They reported that the levels of alkalinity, chlorides, nitrates, sulfates, hardness, Mg and Na were found in higher concentrations in the open wells of Tiruppur.

The highest Pb and Ni contents were noticed in the water samples collected from 1m depth during winter season. Here, the depth 1m simulates the zone in between the place of rhizosphere and ground water. The presence of higher concentration of Pb and Ni in this depth might be due to the enhanced movement of Pb by forming strong complexes with organic matter present in the soil as leachate polluted ground water. Also, the continuous release of Ni enriched effluents on the land in combination with mobile nature of Ni that made their presence in the ground water as reported by Jensen *et al*. (1999) .

Summer season:

When compared to winter season, there was a considerable reduction in the soluble salt concentration for all the depths. The high soluble salt concentration was noticed at 0.5 m depth and it was decreased for further depths (1m and 2m). The similar trend was noticed for Pb and Ni content of the water samples. This was in line with the findings of Throat and Masarrat Sultana (2000). They found the low concentration of heavy metals in groundwater samples during summer season than in winter.

Site –II (Ganapathy):

Winter season:

Textural make up of the soil also influenced the metals (Pb and Ni) movement and their subsequent presence in their ground water. The soils of this place are of sandy loam in texture with low organic matter content. In addition to that, lot of electroplating units and sewage irrigation farms are haphazardously loading the soils with metals. Moreover, results of metal residents in the pedons of this site showed, the bio available forms of Pb and Ni could even been seen in 'C' horizon.

The soluble salt concentration increased with increasing depth. The similar trend was noticed for Pb and Ni also. The depth of 2.0 m showed high concentration of Pb and Ni. This depth simulated the typical groundwater table of Ganapathy areas. The enhanced mobility of Pb and Ni through coarse textured soil was a core reason for their presence in ground water. This was in line with the findings of Capri *et al*. (1999).

Summer season:

When compared to winter season, the water samples collected during summer season showed lowest concentration of Pb and Ni in all the depths. This might be due to the insufficient water flow to leach out the metals from surface down to the profile though the texture of the soil was sandy loam. This was supported by Ukonmaanaho *et al*. (1998).

Site –III Kurichi:

Winter season:

The soluble salt concentration was higher in the depth of 2 m compared to 0.5 m and 1 m. Though rainfall is considered as one among the factors for the highest soluble salt concentration at 2 m depth, the inherant nature of the soil (having a calcareous layer rich in soluble salts in between B_2 and C-horizon) also been taken into account for the mobilization of Pb and Ni through soil compartment and their subsequent presence in groundwater samples.

Kurichi is concentrated with various industries *viz.*, foundries, castings, electroplatings and sewage farms. They continuously let out the mixed effluents without any treatment. This encourages the movement of metals in the soil and their subsequent presence in the ground water. This was in line with the findings of Madhusudhana Reddy and Subba Rao (2001). They stated that industrial effluents are moving in the direction of ground water movement and flow towards central marsh land through residential areas due to topographic control. They also quoted that the enrichment of chemical constituents in ground water follows the chemistry of industrial effluents. This was akin to the results obtained in the present study.

Summer season:

The soluble salt concentration, Pb and Ni contents were highest at the depth of 0.5 m. The traces of Pb and Ni were noticed at 2 m depth could be correlated well with organic matter content of the soil. This might be due to mobilization through metal DOC complexes and colloid facilitated transport.

Site -IV (Nanjundapuram):

Winter season:

The sewage water irrigation practices were followed for more than 100 acres of the agricultural lands for more than 5 years. The water samples collected at 2m depth showed toxic concentration of Pb during winter season, when compared to other depths. Because of heavy addition of sludges, the organic carbon content of the soil is high that facilitated the movement of Pb and Ni in soil by forming metal-DOC complexes. Also the heavy rainfall received during that period (95 cm) might have been migrated metals through preferential fluxes as reported by Capri *et al*. (1999).

Summer season:

The highest concentration of Pb and Ni was recorded at the depth of 0.5 m during summer than in winter, might be due to the frequent sewage water irrigation practices followed in those placed that led to accumulation of metals in the 0.5 m depth itself. Lack of sufficient rainwater to leach out the metals downwards may also be one of the season for traces concentration of metals at 1.0 m and 2.0 m depth.

Site –V (Ukkadam):

Winter season:

The Ukkadam sewage farm encompases 45 hectare of total area. It contains 21,000 numbers of sewer entries coming from various places of Coimbatore district. The increasing concentration of soluble salts as well as Pb and Ni concentration were observed as the depth increased. The depth 2 m registered the highest concentration of Pb and Ni. This might be due to the downward movement of Pb and Ni along with rain water as reported by Cattani *et al*. (2001) and the low pH of the soil during rainy season. They stated that sewage sludge significantly increased soil Ni concentration, especially at deeper depth. This can be partly attributed to the mobile nature of Ni, as well as enhanced mobilization through Ni-DOC complexes and colloid facilitated transport.

Summer season:

A slight reduction of Pb content was noticed at 0.5 m depth during summer than in winter. But the increase in Ni content at 0.5 m was noticed during summer which, might be due to lack of sufficient water to leachout the metals through soil compartments.

In general, the presence of toxic concentration of Pb in the ground water samples collected at 2 m depth from various sites during winter season was ranked as follows:

Pb-Ukkadam>Ganapathy>Nanjundapuram>Kurichi>Peelamedu
Ni-anapathy>Nanjundapuram>Ukkadam>Kurichi>Peelamedu

This confirmed the actual presence of Pb and Ni concentration in the ground water samples of major places of Coimbatore district. The similar ranking at 0.5 m depth simulated, the possible entry of metals into food chain wherever agricultural practices are engaged.

Pb-Ukkadam>Ganapathy>Kurichi>Peelamedu>Nanjundapuram
Ni-Ganapathy>Nanjundapuram>Peelamedu>Ukkdam>Kurichi

The metals resided at the depth of 1m forecasts, the possible Pb and Ni pollution occur under long run if the similar condition persists. It may either enter the ground water or it may go upward to cause danger in food chain by as evidenced

Table 1: The lead content (mg kg^{-1}) of lysimetric water samples collected from different sites of Coimbatore district during winter and summer seasons at different depths

Sr. No.	Sites/depth (m)	Peelamedu	Ganapathy	Kurichi	Nanjundapuram	Ukkadam
Winter (October – December, 2003)						
1.	0.5 m	3.90	5.95	3.95	3.01	10.81
2.	1.0 m	6.57	5.51	5.03	4.85	6.67
3.	2.0 m	1.81	7.80	2.07	7.10	11.81
	C.D. (P = 0.05)		Depth	Soil	Soil x Depth	
			0.103	0.133	0.231	
Summer (March – May, 2004)						
1.	0.5 m	3.85	3.50	4.09	5.99	7.99
2.	1.0 m	1.25	2.95	1.99	2.05	3.61
3.	2.0 m	0.07	1.02	0.70	1.31	1.95
	C.D. (P = 0.05)		Depth	Soil	Soil x Depth	
			0.061	0.070	0.135	

Table 2: Nickel content (mg kg^{-1}) of lysimetric water samples collected from different sites of Coimbatore district during winter and summer season at different depths

Sr. No	Sites/Depth (m)	Peelamedu	Ganapathy	Kurichi	Nanjundapuram	Ukkadam
Winter (October – December)						
1	0.5	9.81	15.35	8.01	11.95	9.35
2	1.0	14.91	11.50	24.25	9.80	10.10
3	2.0	3.95	17.85	4.10	13.95	12.89
	C.D. (P = 0.05)		Depth	Soil	Soil x Depth	
			0.136	0.175	0.303	
Summer (March - May)						
1	0.5	8.87	13.15	7.56	10.35	11.99
2	1.0	4.10	10.35	3.85	5.90	6.91
3	2.0	1.99	7.010	1.20	3.99	4.25
	C.D. (P = 0.05)		Depth	Soil	Soil x Depth	
			0.094	0.121	0.209	

by their presence in the rhizosphere zone. These findings were well supported by Marsha and Thibault (1991). They reported that contaminants could also migrate upward to the soil surface in summer season.

The main cause of ground water pollution by Pb and Ni could be explained by Cattani *et al*. (2001). They indicated that mobility of Pb is theoretically very low, but is probable that, along the soil profile, there are preferential fluxes and particular conditions of lack of balance between soil and solution, that bring about their presence in ground water. Similarly, the self-mobile nature of Ni, increased their occurrence in ground water. This was well akin to the results obtained in the present study. The site wise pollution status was ranked for three different depths.

Conclusion:

Rhizosphere zone:

Lead – Ukkadam (10.81 ppm) >Ganapathy (5.98 ppm) >Kurichi (3.95 ppm) >Peelamedu (3.90 ppm) >Nanjundapuram (3.01 ppm).

Nickel–Ganapathy(15.35 ppm)>Nanjundapuram (11.95 ppm)> Peelamedu (9.81 ppm)>Ukkadam (9.35)>Kurichi (8.01).

The place Ukkadam stands first in Pb pollution because of continous sewage irrigation followed in those areas. Hence, food crop cultivation in those areas may lead to adverse effects on animals and human beings. Similarly, the place Ganapathy occupies first in Ni pollution. Hence, it may cause ill effects to food chain. The continous letting of untreated effluents of electroplating industries may be the root cause for Ni pollution in Ganapathy.

Ground water zone:

The toxic heavy metals like Pb and Ni present in the ground water may take their way in to livelihood either directly or indirectly. The metal polluted ground water samples were grouped based on their metal content:

Lead -kkadam (11.81) > Ganapathy (7.80) > Nanjundapuram (7.10) > Kurichi (2.07) > Peelamedu (1.81)

Nickel – Ganapathy (17.85) > Nanjundapuram (13.95) > Ukkadam (12.89) > Kurichi (4.10) > Peelamedu (3.95)

The presence of Pb and Ni in rhizosphere zone and ground water zone of Coimbatore district should alarm the society about the deleterious effect of continous sewage water irrigation and disposal of effluents without any treatment on the land. If this condition persists, the metals will spoil our valuable resources of soil and ground water.

REFERENCES

Capri, Effore, Boccelli, Raffaella, Beltrami, Paolo and Cattani, Ilenia (1999). Mobility of Cu, Zn and Cd in a loamy soil. In: ICOBTE. Planery Abstracts. 6th International Conference on Biogeochemistry of trace elements, Guelph.

Cattani, Caprie, Bogcelli, R. and Del, Re (2001). Heavy metals in groundwater contamination after agricultural sludge applications. In: ICOBTE. Planery Abstracts. 6th International Conference on Biogeochemistry of trace elements, Guelph.

De, Anil Kumar (2000). *Environmental Chemistry* (4th Ed.), New Age International (P) Limited Publishers, NEW DELHI (INDIA).

Graug, G., Riou, C., Lauquet, G., Dia, A., Jafrezic, A. and Molenat, J. (1999). Transport of trace metals; linking the role of colloids, redox conditions and hydrology. In: Proceedings of the extended abstracts from the 5th International Conference on Biogeochemistry of trace elements, July 11-15, 1999, Vienna, Austria.

Jensen, D.L., Ledin, A. and Christensen, T.H. (1999). Speciation of heavy metals in land-fill leachatel polluted ground water. In: Proceedings of the extended abstracts from the 5th International Conference on Biogeochemistry of trace elements, July 11-15, 1999, Vienna, Austria.

Jorgensen, S.E. (1979). *Hand book of experimental data and biological parameters*, Pergamon Press. Oxford, **6**: 589-615.

Madhusudhana Reddy, P. and Subba Rao, N. (2001). Effects of industrial effluent on the ground water regime in Visakhapatnam. *Poll. Res.***, 20**(3): 383-386.

Marsha, Sheppard I. and Thibault, D.H. (1991). A four mobility study of selected trace elements and heavy metals. *J. Environ. Qual.*, **20**: 101-114.

Mohanraj, R., Sathiskumar, M., Azee, P.A. and Sivakumar, R. (2000). Effect of irrigation using sewage water on the distribution of some heavy metals in bulk and rhizosphere soils. *Bull. Environ. Contam. Toxicol.*, **64** : 638-643.

Pande, A. and Sharma, K. (1999). Different sources of heavy metals and their long-term effects on soil biology. *Indian J. Environ. Health.*, **38**: 51-53.

Ramaswami, V. and Rajaguru, R. (1991). Ground water quality of Tiruppur. *Indian J. Environ. Health,* **33**: 187-191.

Sadiq, M. and Alam, I. (1997). Lead contamination of ground water in an industrial complex. *Water, Air & Soil Pollution,* **98**: 167-177.

Singh, R.P., Singh, Y., Swaroop, D., Gupta, N., Singh, S. and Prasad, F.M. (2000). Ground water pollution in Agra City. *Indian J. agric. Chem.,* **33**(3): 114-117.

Thorat, S.R. and Masarrat, Sultana (2000). Pollution status of Salim Ali lake, Aurangabad (M.S). *Poll. Res.*,**19**(2): 307-309.

U.S. Environmental Protection Agency (1990). MINTEQ A_2, version A3.00: Metal speciation equilibrium model for surface and ground water. Centre for exposure Assessment Modelling, Office of Res. and Dev.Environ. Res. Lab., Athens, GA.

Ukonmaanaho, I., Starr, M., Hirvi, J.P., Kokko, P. Mannio, J. Paukola and Tanskanen, H. (1998). Heavy metal concentrations in various aqueous and biotic media in Finnish Integrated Monitoring catchments. *Boreal Environ. Res.*, **3**: 235-249.

World Resource Institute (1990). *World resources 1990-91*. Oxford University Press, Oxford.

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