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Estimation and Distribution of Nitrate Contamination in Groundwater of Wah Town, its Causes and Management

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Abstract: The increase in population at a very fast pace during the past few decades and related anthropogenic activities have created a number of environmental problems such as air pollution, water contamination and effects of solid waste dumping on environment. To accommodate and provide residence facilities to growing population number of residential colonies were developed in private sector in the surrounding of Wah town nearby Dhamrah Kas Nullah. Due to short of necessary facilities for on line disposal through treatment plants, the local citizen disposed off their sewage waste into low lying areas which have been converted into a number of sewage ponds and small lakes. These sewage ponds are one of the major sources of water contamination from where nitrate contaminants migrated into unconfined aquifer. To assess the nitrate concentration water sampling was carried out from 27 dugwells and 3 tubewells which are being used by local inhabitants for drinking water from shallow aquifer located at the depth of 45 to 85 feet in the study area. The results indicate that 26% wells related to the shallow aquifer are contaminated and have crossed the WHO recommended guidelines for nitrate level. Two zones with high nitrate contamination have been identified within the study area. Few samples collected from deep aquifer for comparison indicates that it is still safe from nitrate contamination. Suggestions have also been made to improve the situation.

Key words: Groundwater, unconfined, shallow aquifer, nitrate, contamination

INTRODUCTION

Many researchers have reported surface and groundwater contamination due to urbanization and industrialization and also suggested remedial measures (Oliver, 1999; Khan and Malik, 1995; Khan, 1997; Lerner and Tellam, 1992; Whitehead *et al*., 1999; Foster *et al*., 1999). On the basis of research studies, keeping in view of health effects of various contaminants, WHO (1984) and USEPA (1975) recommended safe permissible limits for various types of water contamination. Foster *et al*. (1999) while discussing the role of high population growth in water contamination has reported, "Urban population growth in Asia and Latin America is occurring on a scale and at a rate, unprecedented in human history. Many of the cities are sited on unconfined or semi confined aquifers, depend on groundwater for much of their water supply and apply to dispose of most of their liquid effluent and solid residues to the ground".

Nitrate is usually considered the end product from a series of biologically mediated reactions in which organic nitrogen compounds are oxidized. Nitrate and nitrite are considered together because conversion from one form to other occurs in the environment (Sial *et al*., 1992). The effects of nitrate on health are generally a consequence of its ready conversion to nitrite in the body.

It is well documented that in some countries, water supplies containing high levels of nitrate have been responsible for causes of infantile methemoglobinemia and death (USEPA, 1977; Steel, 1960). This disease causes "blue babies" which is fatal. Steel (1960) reported that nitrates in excess of 10 mg/l in groundwater cause blue babies in infants under 2 month age and this disease does not occur in older children or adults. It is caused by nitrates in water consumed by the infants below three months age. The nitrates are reduced in the body to nitrites, due to availability of less oxygen, which are blood soluble and react with blood and reduce oxygen supply.

The susceptibility of infants to nitrates has been attributed at their high intake relative to their body weight to the presence of nitrate reducing bacteria in the upper gastrointestinal tract and to the greater ease of oxidation of fetal hemoglobin present in this form for the first few months of life, if infants have gastrointestinal

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disturbances, there will be an increase in number of bacteria that can convert nitrate to nitrite.

This study has been carried out for the estimation of health hazard contamination of nitrate in groundwater. The focus of the study is to establish zones of high concentration of nitrate in shallow aquifer (45 to 85 feet) which is commonly used by a large population of the Wah town area. This study was performed as a part of Ph.D. research and partial results are being published through this article.

MATERIALS AND METHODS

Twenty seven dugwells were selected for water sampling from study area which were excavated by local inhabitants for drinking water supply. All the dugwells are located in between the depth of 45 to 85 feet which is unconfined shallow aquifer. Three tubewells from deep aquifer were also sampled for comparison to assess the vertical penetration of nitrate contamination. Multi layered aquifer system has been reported by Khan (1997) for Dhamarah kas basin which shows that there are two major aquifer, the shallow aquifer located at 45-85 feet depth and deep aquifer at the depth of 130-300 feet. The shallow aquifer is being exploited by the local population through dugwells and the deep aquifer is pumped out with tubewells installed by Pakistan Ordnance Factories (POF) Wah authority for municipal and industrial use. Sampling was made by glass sampler attached with string from open dugwells or collected from motor pump. The estimation of nitrate was made with standard German made kits.

RESULTS AND DISCUSSION

The results of estimation for nitrate from shallow aquifer which is receiving surface water recharge from industrial and urban effluents are given in Table 1. The amounts of contaminants are variable from different locations which are probably due to the nature of anthropogenic activity. Although POF authority is treating the industrial waste and passing sewage water through treatment plant but the system is over loaded and does not meet the standards which cause high level of contaminants in effluents.

The overall picture indicates that the range of nitrate is 3 mg/l to 25 mg/l with an average value of 8 mg/l. The horizontal distribution of the nitrate in groundwater of shallow aquifer has been plotted on the location map (Fig. 1).

It is clear from the nitrate distribution map that there are two prominent areas with high values of nitrate concentration, one in the northern part of the study area covering Gulshan and Lalazar colonies and the other in the south, Sarah Kala and Bani Mohallah. Therefore on the basis of the horizontal distribution two zones with high nitrate concentration have been identified which are given in Table 2.

In the northern part the area having residential colonies in private sector have crossed the limit of 10 mg/l for nitrate. Within this zone (Fig. 1) the value of nitrate is as high as 20 mg/l detected in DWC-07. There are three probable sources of this high level contamination of nitrate. Use of sewage water for irrigation during many years before construction of these colonies (Fig. 2). The second reason is leakage from sewage treatment plant, which is not working at full capacity since long time. The third and most important source of high level of nitrate is the sewage disposal through dugwells particularly in Lalazar and Gulshan areas reported by Khan and Malik (1995).

In the south zone, the nitrate level is again high and the highest level is 25 mg/l detected in DWC - 60. There may be two reasons for this high level. Firstly sewage lake (Fig. 3) in Bani area of Taxila, which receives a huge amount of sewage water and secondly house waste water which is ultimately recharged into the aquifer and enhances nitrate level of the groundwater. Another important source is cattle's excreta dumps which is normally disposed off in piles, during heavy rains the

Table 1: Result of estimation of nitrate level in shallow aquifer, 45-85 feet depth

Sample No	Location	NO_3 mg/l	Sample No	Location	NO_3 mg/l
DWC-01	Iqbal road Lalazar	9	DWC-34	Newlalazar Cantt Board	5
DWC-02	Ayub Azam Lalazar	3	DWC-36	Nazar hotel Wah Garden	3
DWC-03	Babra village	4	DWC-40	Gulshan colony	7
DWC-04	Babra village	9	DWC-41	Bodu road	4
DWC-05	Shahwali colony	5	DWC-43	Near railway crossing	4
DWC-06	Shahwali colony	10	DWC-56	Mora choak2	3
DWC-07	Lalazar colony	20	DWC-58	Youth hostel Taxila	4
DWC-08	Lalazar colony	5	DWC-60	Sarah e kala Taxila	25
DWC-09	Wapda office Lalazar	14	DWC-61	Aslim workshop Nawababad	5
DWC-10	Dr. Zaman garden	10	DWC-63	Shahwali Wah Cantt	4
DWC-11	Shairshah Soori garden	10	DWC-69	Malikanwali mosque Loser shirfo	5
DWC-12	Nawababad	5	DWC-83	Bani Mohallah Taxila	17
DWC-28	Gulshan colony	11	TWC-14	Tubewell in Sir Syed College	5
DWC-29	Lalarukh GT road	4	TWC-31	Tubewell in Rai Memorial Hospital	3
DWC-32	Persian well Newlalazar	5	TWC-84	Tubewell in Gulistan Colony	8

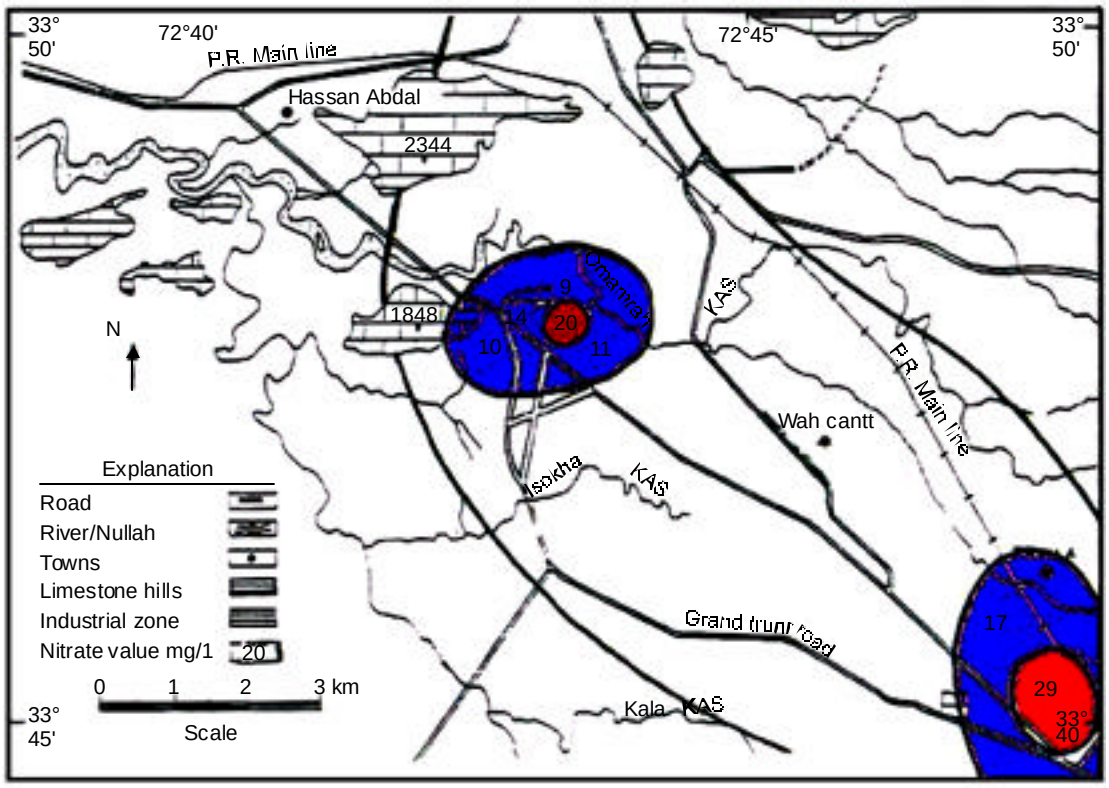

Fig. 1: Horizontal distribution of nitrate contamination in shallow aquifer, indicating zones of high concentrations in Gulshan and Gulistan colony and surrounding areas

Table 2: Zones of high values of nitrate identified on the basis of horizontal distribution

Zone status	Location	NO_3 mg/l	Remarks
Uncontaminated	Main Wah town	1-9	Most of the study area is within permissible limit of WHO guidelines
Contaminated	Gulshan and Lalazar colonies	10-19	Increase is due to recharge from sewage water irrigation and sewage disposal through dugwells.
Highly contaminated	Sarah Kala and Bani Mohallah	20-25	Increase is due to recharge from sewage lake

Fig. 2: Flood irrigation from sewage water, which is major cause of high level nitrate contamination in Gulshan and surrounding area

Fig. 3: Banni sewage lake with suspended organic and plastic material, which is a major source of nitrate contamination of shallow aquifer

seepage water from these heaps enters in open dugwells, ultimately increasing the nitrate level of the groundwater (Lerner and Tellam, 1992).

The results of nitrate estimation from tubewells revealed that the deep aquifer is still safe and the range is 3-8 mg/l which is within permissible limits recommended by

WHO. To protect the local population from health hazard contamination of nitrate in groundwater, the pumping of shallow aquifer be stopped forth with and alternate supplies from deep tubewells be arranged.

Conclusion and Recommendations: The shallow aquifer of the study area is contaminated in respect of nitrate with two zones of high concentrations. It is suggested that pumping from shallow aquifer in Lalazar, Babra and Gulshan area through dugwells should be stopped forth with and periodic monitoring of all the groundwater wells is recommended with elimination of nitrate point source contamination.

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REFERENCES

Foster, S.S.D., B.L. Morris and P.J. Chilton, 1999. Groundwater in urban development, a review of linkages and concerns. Proceedings of the International symposium by IAHS. Publication No. 259, pp: 3-12.

Khan, M.S., 1997. Estimation of groundwater contaminants and establishment of protection zones in Wah Cantonment area, Ph. D. thesis University of the Punjab.

Khan, M.S. and M.H. Malik, 1995. Elaboration of subsurface hydrogeology and its application for protection of groundwater in Dhamrah Kas Basin, Pakistan. Bangl. J. Environ. Sci., 1: 31-45.

Lerner, D.N. and J.H. Tellam, 1992. The protection of urban groundwater pollution. J. Inst. Water Environ. Manage., 6: 28-37.

Oliver, T.N.S., 1999. Groundwater contamination by organic chemicals in industrializing countries, the unseen threat. Proceedings of the International symposium by IAHS. Publication No. 259, pp: 23-28.

Sial, J.K., M.A. Rana, M. Ahmad, A. Shah and S. Mahmood, 1992. Nitrate nitrogen management for groundwater quality. Procd. of all Pakistan Science Conference Khanispur, Science International, pp: 82-84.

Steel, E.W., 1960. Water supply and sewage, McGraw Book Company Inc, pp: 204-224.

USEPA, 1977. United States Environmental Protection Agency. Toxicology of water Environmental health effects research series Vol. II Washington, DC., USA.

USEPA., 1975. United States Environmental Protection Agency. Quality criteria for Water. Washington, DC., USA.

Whitehead, E., K. Hiscock and P. Dennis, 1999. Evidence for sewage contamination of the Sherwood sandstone aquifer beneath Liverpool, Uk. Proceedings of the International symposium by IAHS. Publication No. 259, pp: 179-185.

WHO, 1984. World Health Organization, Guidelines for drinking water quality. Recommendations, Vol. 1, Geneva, pp: 1-127.