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Sewage Water Intrusion in the Groundwater of Lahore, its Causes and Protections

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Abstract: Lahore is the second largest city of Pakistan with population of about ten million where almost 100% population depends for their nutrition need on groundwater supplies. Hence the water quality plays controlling role in the health of local population. To determine the groundwater quality of the Lahore, 33 water samples were collected from tubewells, shallow wells and four samples from Lahore canal which is recharge source. The water samples were analyzed for *E-coli* by standard multiple tube method as per guideline of WHO. The results indicate that 100% water samples collected from injector pumps installed at shallow depth 120 to 150 feet are polluted due to intrusion of sewage water. However the water samples from deep tubewells installed at 400 to 700 feet depth are free from any *E-coli*. Recommendations are made to over come contamination problem in shallow aquifer.

Key words: *E-coli*, biological contamination, sewage intrusion, nutrition, groundwater

INTRODUCTION

One of the most common and wide spread dangers associated with drinking waiter is caused by sewage water intrusion into water resources. The contaminated water may cause a number of diseases. The faecal coliforms are internationally accepted as indicator of faecal pollution and used for monitoring of water supplies (Hanan *et al*., 2010; Anwar *et al*., 2010; Khan, 1997).

The known pathogenic organisms cause disease from mild Gastroenteritis to severe and sometimes fatal dysentery, cholera, or typhoid. The coliform organisms especially *Escherichia coli* are the essential indicator of pollution by faecal material of human or animal origin (WHO, 1984; Khan, 1997). It is common that few coliform are present in the shallow unconfined aquifer but when the number of coliform bacteria increases from usual levels it is very serious and needs immediate attention to protect the lives of inhabitants from outbreaks of pathogenic diseases (WHO, 1984).

The municipal and Industrial effluents are one of the important cause of groundwater aquifer contamination. The microbiological and other contaminants are recharged from surface effluents into the unconfined shallow aquifer. Sometimes shallow aquifer provide easy window for migration of microbiological and other contaminants into the deeper horizons in unwisely designed tubewells wherein shallow and deep layers are simultaneously drained through single tubewell.

Many researchers have investigated water contamination due to urbanization and industrialization and also proposed remedial measures to protect water resources (Oliver, 1999; Khan and Malik, 2000; Whitehead *et al*., 1999; Foster *et al*., 1999). Khan *et al*. (2012) executed a study in Wah area with respect to water contamination and reported, "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".

Foster *et al*. (1999) 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".

This study has been performed to assess the groundwater quality of Lahore with respect to Faecal *E-coli* in shallow aquifer as well as in the deep aquifer with focus to assess water quality at low temperature during the months of February and early March.

MATERIALS AND METHODS

During the months of February and early March, 2012, thirty three samples were collected from shallow and deep aquifer and surface water from Lahore Canal (Fig. 1). These samples were analyzed for faecal *E-coli* in standard microbiological testing laboratories of Institute

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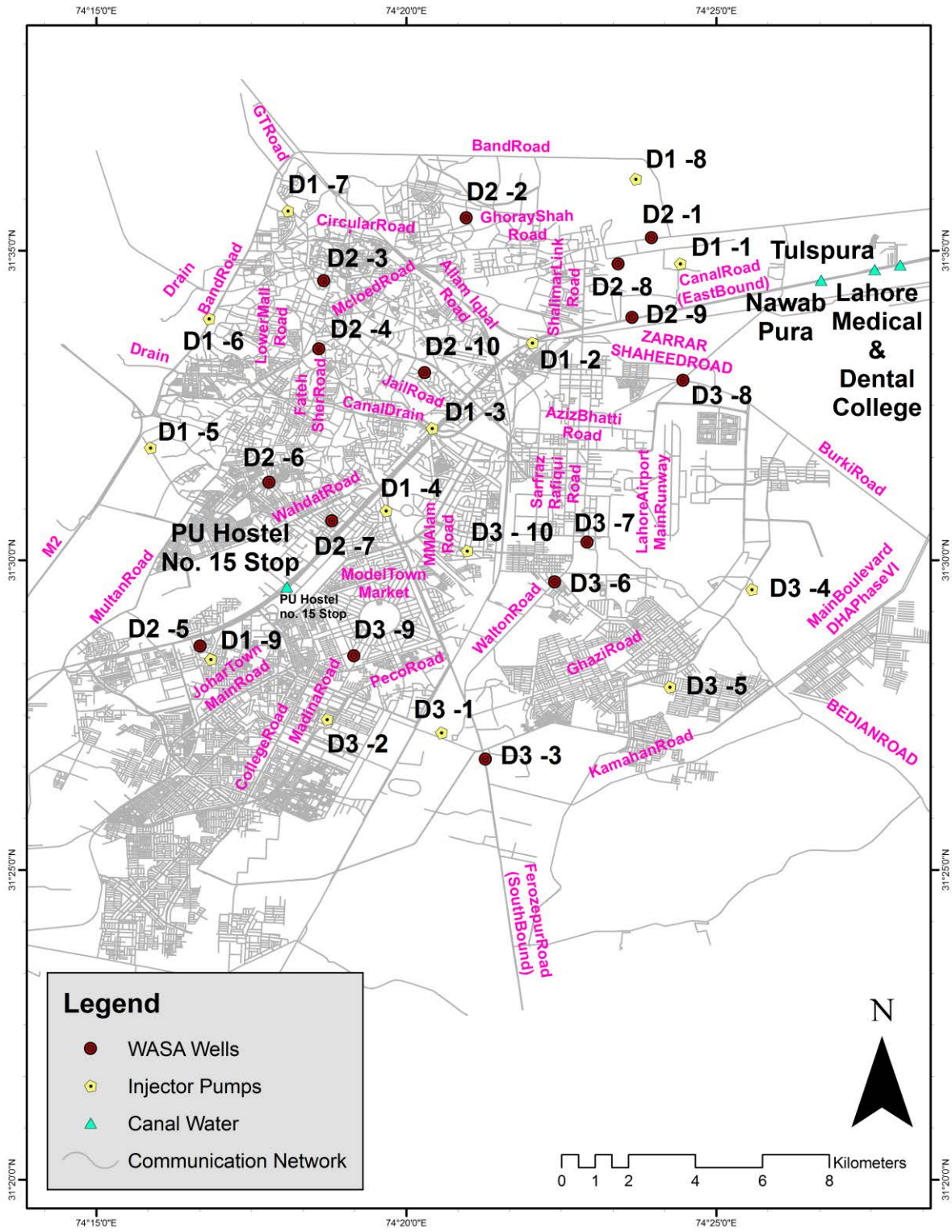

Fig. 1: Location map of Lahore area indicating the sampling points

of Public Health (IPH) and Department of Zoology, Punjab University, Lahore, adopting WHO recommended multiple tube method. The results are presented as most probable number as, MPN/100 ml.

Table 1: Results of the faecal *E-coli* analyzed from shallow depths (120-150 ft)

Sample No.	Location		Settlement	Faecal *E. coli* MPN/100 ml
	Northing	Easting		
D1-1	31°34'47.496"	74°24'24.84"	Bilal Park, Fateh Garr Road, Aziz Bhatti Town	11
D1-2	31°33'30.672"	74°22'1.596"	Office of Director ISRIP-WAPDA, Mughalpura, Lahore	17
D1-3	31°32'7.944"	74°20'24.648"	Cricket house, Jail Road	14
D1-4	31°30'48.168"	74°19'40.008"	Taj Mahal Banquet hall, Opposite Qaddafi Stadium	35
D1-5	31°31'48.972"	74°15'52.02"	Bismillah Oil and Service Station, Sabzazar, Allama Iqbal Town	15
D1-6	31°33'54.108"	74°16'48.684"	Akram Park, Chota Sandha Stop, Near Shahid Nadeem Pan Shop	50
D1-7	31°35'38.58"	74°18'5.04"	Khalid Shah Filling Station, PSO pump, Qasurpura, G.T. Road	93
D1-8	31°36'9.288"	74°23'41.712"	Mahmood Booti, Arif Steel Mills, Wahga Town	39
D1-9	31°28'24.2"	74°16'50.4"	G Block, Johar Town	90
D3-1	31°27'13.2"	74°20'33.8"	Senior Engineering Company, Punjab Small industrial state, Kot Lakhpat	9
D3-2	31°27'26.1"	74°18'42.9"	Govt. High School, B-1, Township Lahore	0
D3-4	31°29'31.776"	74°25'34.176"	Gohawa village, Near Bhatta stop	11
D3-5	31°27'57.312"	74°24'14.688"	Sector G, Phase 5, DHA	9
D3-10	31°30'09.2"	74°20'58.6"	TNT Office, Firdous Market 4J.	0

Table 2: Results of the faecal *E-coli* analyzed from deep tubewells (400-700 ft)

Sample No.	Location		Settlement	Faecal *E. coli* MPN/100 ml
	Northing	Easting		
D2-1	31°35'12.444"	74°23'57.192"	Jamshed Park, Singh Pura, Shalimar Town	0
D2-2	31°35'31.74"	74°20'57.78"	Lady Sofiya Park, Ravi Town	0
D2-3	31°34'30.72"	74°18'39.96"	Paisa Akhbar, Urdu Bazar Cattle Park. C.D.G high school	0
D2-4	31°33'24.66"	74°18'35.208"	Qureshi Muhalla Park, Lytton road	0
D2-5	31°28'36.8"	74°16'403"	Block G-1 Tubewell, near Johar Public School, Johar Town	0
D2-6	31°31'15.4"	74°17'46.9"	Tenki Ground, Chenab Block, Allama Iqbal Town	0
D2-7	31°30'38.2"	74°18'47.7"	Ayyubia Market, A-Block, New Muslim Town	0
D2-8	31°34'47"	74°23'24.9"	Kotli Pir Abdul Rahman, Borrh Wala Tubewell	0
D2-9	31°33'55.2"	74°23'38.3"	Aik Minaar Masjid, Maskeenpura, near Faysal Bank, Shalimar Town	0
D2-10	31°33'01.8"	74°20'17.6"	New Patiala House, GOR-I.	0
D3-3	31°26'47.4"	74°21'16.4"	New General, Chongi Ammar Saddhu, Nishtar Town	0
D3-6	31°29'39"	74°22'23.4"	Walton Road. Defence Morr. Tubewell No.15	0
D3-7	31°30'17.5"	74°20'54.8"	R.A Bazar, Cantonment board, Dispensary Tubewell No.13	0
D3-8	31°32'54.3"	74°24'27.6"	Jorray Pull Tubewell, Aziz Bhatti Town	0
D3-9	31°28'27.4"	74°19'09"	19-F Model Town, Near Link Road	0

RESULTS AND DISCUSSION

The results of water samples analyzed for shallow aquifer are given in Table 1. The results indicate that samples analyzed from 14 locations are mostly contaminated with respect to faecal *E-coli* except two locations. The range of the faecal *E-coli* is from 9-93 MPN/100 ml. This situation confirms the migration of faecal coliform from surface to the shallow depths of aquifer.

The results of the samples analyzed from deep aquifer are given in Table 2. All the samples collected from deep tubewells have faecal *E-coli* as 0 MPN/100 ml. Hence we can conclude that the groundwater of deep aquifer is still safe from sewage water intrusion in the deep aquifer of Lahore city.

As a matter of fact the major source of groundwater recharge for Lahore aquifer system is through Ravi River which is practically converted into effluent. The other recharge sources are surface drainage effluents and Lahore canal. To find out the probable effect of surface water, sampling was also made from one of the important freshwater recharging source for Lahore aquifer i.e. Lahore Canal. The water of Ravi River and other drainage effluents were not tested because these sources are confirmed polluted (Haider and Ali, 2011; Hayder *et al*., 2012). The results are given in Table 3.

All the samples from Lahore canal have more than 1100 MPN per 100 ml *E-coli* which shows sewage contamination into the canal. It has been observed that during the surface water sampling at few locations the

Table 3: Results of the faecal *E-coli* analyzed from surface water, Lahore canal

Sample No.	Location		Name of place	Faecal *E. coli* MPN/100 ml
	Northing	Easting		
C-1	31°34'46.1"	74°27'57.9"	Lahore Medical and Dental College	1100
C-2	31°34'41.7"	74°27'33.2"	Tulspura	1100
C-3	31°34'31.3"	74°26'41.5"	Nawab Pura	1100
C-4	31°29'34.4"	74°18'04.4"	PU Hostel no. 15 Stop	1100

Fig. 2: Water effluent entering into the Lahore Canal and contaminating fresh water recharge source

effluents are entering into the canal, as clear from Fig. 2. Probably these effluents contain sewage water which is causing increase of pollution with respect to *E. coli* of groundwater when recharged from canal take place.

Conclusion and recommendations: The results of this study indicate that shallow aquifer of the Lahore city has become highly polluted due to intrusion of sewage water. In all the samples from shallow aquifer the contamination level of Faecal *E. coli* has crossed the recommended limits of WHO. The deep aquifer is still safe from sewage water intrusion. However the Lahore canal is also polluted and recharging contaminated water into the shallow aquifer.

It is suggested that the water supplies from shallow contaminated aquifer should be stopped forth with and disinfection of drinking water should be made as recommended by WHO (2008). Special care in design of new tubewells to be installed should be made so that the ingress of shallow contaminated aquifer in tubewell is properly sealed.

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