Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

Vol. 9	No. 4	pp. 719-725	2010

Original Research Paper

Water Quality Assessment of the Chenab River, Flowing from Pul Doda to Baggar (J & K State), for Domestic Use

Amita Fotedar, Bashir Ahmad Loan* and B.K. Fotedar**
Department of Environmental Sciences, University of Jammu, Jammu, J & K, India
*Postgraduate Department of Geology, University of Jammu, Jammu, J & K, India
**Karam Chand Teachers Training Institute and Academy of Education, Talab-Khatikan, Jammu

Nat. Env. Poll. Tech.
ISSN: 0972-6268
www.neptjournal.com

Key Words:
Chenab river
Water quality assessment
Sanitation
Domestic use
Permissible limit

ABSTRACT

Twenty water samples of Chenab river in J&K State were subjected to chemical analysis for elements Si, Ca, Mg, Na, K, Mn, Ni, Cu, Pb, Zn and Fe. Out of these elements Si, Mn, Ni, Pb and Fe were found to be above permissible limits. Total Dissolved Solids (TDS) and pH were present below the recommended permissible limits, and hence the waters can be regarded non-toxic for domestic use. High Pb values in waters can be linked with bad sanitation existing on both the banks of the Chenab river and hence the mass awareness programmes are necessary for maintaining good sanitation throughout the belt to lower down the Pb values of the waters. Adequate forestation in the watershed areas and vetiver grass technology on the high repose slopes are also needed to lower down the high values of Si, Mn, Ni, Pb and Fe of the Chenab water. Vetiver grass will also control higher turbidity values of waters of the Chenab.

INTRODUCTION

Present study of Chenab river, flowing from Pul Doda to Baggar area in Jammu and Kashmir State, has been carried out for the potential surface water resource and its quality for various cations. In the area from Pul Doda to Baggar, there are not enough wells which could provide water for human consumption except a few edit pipes existing in the snow-clad cliffs. The growing population in this part of Chenab valley uses Chenab water for various purposes. A watershed forms an ideal unit for the optimum planning for sustainable development of water resources. Environmentalists every where have emphasized the need for surface water quality assessment in order to overcome water-borne diseases of the people who depend on river water for their consumption. Water chemistry of Chenab waters with respect to some cations is carried out in order to evaluate its suitability for domestic use.

STUDY AREA

Study area lies in the west of Doda area in the Jammu region. The Chenab river flows 38 km from Pul Doda to Baggar (Fig. 1). This area during the last 10 years has speedily grown in urbanization. This route has become important on a National Highway NHIB from Jammu to Doda. The river stretch is flanked in north and south by granite bosses such as Lal Draman granite, Piparan granite, Dal Draman granite and Ramsu granite in the north and Bhala granite, Dedni granite, Khal granite and Kaplas in south. In the west of the area, there are two important thrusts, Panjal thrust and Murree thrust constituting Lesser Himalayan Zone. Baggar is amidst these two thrusts and the rocks are more puckered in this zone. The whole zone represents a terraced valley. Though there occur supplies of water naturally flowing from ice-fed mountains, yet the local people use Chenab water for human consumption.

The watershed of Chenab river consists mainly of crystallines but in the north and northeast, there occurs granite bosses, lime stones (Eocenes) and volcanic in the west. The bulk rocks that form the watershed in the study area are Salkhala group of rocks compositionally constituting slates, phyllites, pebbly slates, quartzites and limestones. In the west, lies the Murree thrust and Panjal thrust, and so sand stones and shales of Murree rocks are found rich in ferromagnesian minerals (Wadia 1970, Vaidyanathan & Ramakrishnan 2008). In presence of two narrowly thrusts present, Lesser Himalayan rocks have become tectonically unstable and from the cliffs, big lumps of eroded material roll down into the Chenab waters. A huge debris gets generated due to erosion of the high cliffs and these contribute large quantities of cations finding way into the solution of Chenab waters.

In the whole area of watershed, many nallahs flow from south to meet the River Chenab. From west, the nallahs, namely Patnitop nallah, Shabgarh nallah, Ragi nallah, Nagin nallah, Dedini and Khol nallahs, and Neru nallah from southeast join waters of Chenab. In the north, Garrsi nallah, Chuchutar nallah and Kothi nallah flow towards south. In rainy season, landslides become common and these are responsible to make waters of the river turbid. In the north of the area, the highest relief is that of Lal Draman (2554 m) and in the south Khol granite is situated 2746 m above mean sea level, which is the highest peak on this side.

MATERIALS AND METHODS

For the present study, 20 samples from Chenab waters from Pul Doda to Baggar were collected in cleaned polythene bottles after rinsing them with triple distilled water. The samples were collected twice (during pre-monsoon and post-monsoon in April, 2009 and August, 2009) at the same sites. The determination of pH was undertaken on spot in the field by means of a field kit. Trace elemental analysis was carried out on Atomic Absorption Spectrophotometer (AAS) Model 902, GBC make Australia. GBC Manual Methods (1982) were followed strictly. The samples were collected on the lines given by Raghunath (1987) and Ramakrishna (1998). Most of the major elements were also checked by titrimetric methods as given by Trivedy et al. (1987) and Ramakrishna (1998). Potassium and sodium were determined on flame photometry (EEL Model) by the method as given by Vogel (1980).

RESULTS AND DISCUSSION

The chemical characteristics of water are presented in Table 1. The water quality parameters were compared with the water quality standards for drinking purposes (Rodier 1975, Kudesia 1983, WHO 1984, BIS 1991). The comparison for convenience is presented in Table 2.

The perusal of Table 1 shows concentration of Calcium to lie between 3.80 and 4.13 ppm with an average value of 3.98 ppm. Calcium concentration in all the samples is within permissible limit. The calcium concentration of water is controlled by limestones present in reasonable levels in Salkhalas (Dhar et al. 1996, Fotedar & Fotedar 2008b, Fotedar & Raina 2009). Calcium in bulk quantity has been contributed by Salenite crystals and marbles present in older metamorphic rocks (Fotedar & Fotedar 2009c). Volcanics too contain abundant calcium in the ground water (Fotedar et al. 1990, Fotedar et al. 2008a).

Magnesium concentration lies between 0.88 and 1.00 ppm with an average value of 0.90 ppm and is below the permissible limits for domestic use (Table 2). The host rocks for Mg in the area are Payal volcanic and Salkhalas (Fotedar & Raina 2009). Magnesium values are lower than that of calcium in the Chenab waters, although Salkhalas and volcanic are rich in both Ca and Mg (Fotedar & Raina

Table 1: Chemical analysis for water samples of Chenab river flowing from Pul Doda to Baggar area, Jammu and Kashmir state.

S. No.	Si	Ca	Mg	Na	K	Fe	Mn	Cu	Zn	Pb	Ni	pH	TDS	Turb-idity
1.	33.10	4.01	0.98	2.03	2.15	0.54	0.19	0.10	0.01	0.05	0.06	7.7	6.4	6.2
2.	33.16	3.99	0.96	1.88	2.25	0.62	0.29	0.09	0.05	0.06	0.05	7.6	64	6.4
3.	33.14	3.88	0.88	1.87	2.15	0.51	0.37	0.07	0.10	0.08	0.04	7.7	65	6.8
4.	23.09	4.02	0.77	1.99	2.14	0.53	0.22	0.06	0.02	0.08	0.06	7.8	64	6.8
5.	26.08	4.03	0.76	1.88	2.23	0.58	0.32	0.04	0.03	0.08	0.09	7.6	64	6.9
6.	27.10	3.89	0.97	1.87	1.88	0.60	0.31	0.03	0.12	0.09	0.09	7.7	66	6.2
7.	27.26	3.80	0.94	2.03	1.06	0.55	0.22	0.10	0.10	0.09	0.06	7.8	65	7.8
8.	27.30	4.00	0.94	2.02	1.08	0.45	0.20	0.11	0.10	0.06	0.07	7.9	65	8.0
9.	27.00	4.22	1.00	2.01	1.81	0.56	0.21	0.07	0.09	0.09	0.08	8.0	67	8.2
10.	28.00	4.10	0.78	2.02	1.78	0.56	0.30	0.06	0.07	0.07	0.07	7.4	70	8.2
11.	34.10	3.80	0.96	1.06	1.76	0.57	0.32	0.07	0.06	0.05	0.06	7.2	69	7.3
12.	34.00	3..81	0.95	1.87	1.74	0.57	0.30	0.07	0.04	0.06	0.05	7.6	76	8.2
13.	24.31	3.87	0.95	1.77	1.86	0.53	0.28	0.07	0.04	0.06	0.06	7.7	74	6.2
14.	34.16	3.83	0.87	1.78	1.83	0.39	0.32	0.07	0.03	0.08	0.07	8.5	67	6.1
15.	33.28	4.00	0.76	1.77	1.78	0.54	0.32	0.06	0.06	0.10	0.07	7.6	66	5.9
16.	32.18	4.05	0.94	1.76	1.68	0.44	0.19	0.04	0.04	0.12	0.06	7.4	69	6.2
17.	36.20	4.12	0.94	1.82	1.70	0.32	0.20	0.01	0.04	0.08	0.06	7.6	67	6.4
18.	36.24	4.10	0.90	1.84	1.70	0.40	0.20	0.02	0.03	0.10	0.06	7.7	70	6.5
19.	36.36	4.13	0.88	1.83	1.73	0.42	0.20	0.01	0.01	0.11	0.09	7.5	74	6.7
20.	33.12	4.11	0.88	1.82	1.69	0.44	0.32	0.02	0.11	0.12	0.10	7.4	70	7.2
Mean	30.9	3.98	0.90	1.84	1.80	0.50	0.26	0.05	0.05	0.08	0.06	7.2-8.5	71.10	6.1-8.2

Note: All cations, anions and TDS are in ppm.

2009). It points to the fact that Mg dissolves more rapidly than calcium during silicate weathering (Wedepohl 1978). Also, Mg values may have partly come down in Chenab waters due to high gradient.

Fe, Ni and Mn are found to be present in more than permissible limits and hence Chenab waters can be regarded unsuitable with respect to these three cations (Table 2). In earlier studies (Fotedar et al. 1990, Fotedar & Singh 1994a, 1994b) Fe, Ni and Mn were found to be present above the desirable limits. It needs to be mentioned here that on one hand, there are no industries in the area under study which could be thought to have contributed heavy elements like Fe, Ni and Mn to the waters, but reason for it is that there are rich pockets of Fe, Ni and Mn present in the phyllites, slates and traps in the watershed area of Chenab river (Wadia 1970). Further to this, Fotedar & Singh (1994a, 1994b), during the detailed study in the watershed area of Chenab valley at Kishtwar, Khilleni and Ramban areas, observed rich pockets of Fe, Ni and Mn in the rocks through which Chenab river flows. Hence, the rich pockets of Fe, Ni and Mn existing in the watershed area of Chenab in the present study also may have contributed all the three cations to the waters.

Heavies appear to have been carried by waters to the position of stabilized colloids in fine-grained particles in case of Chenab river (Fotedar et al. 2008c). Jenne et al. (1980) also has corroborated the same mechanism holding true for the transport of Fe, Ni and Mn in many river sediments of the world. Erosion due to silicate weathering in the area of study may have resulted in accumulation of more clay particles in their detrital matter responsible for transporting sufficient quantity of Fe, Ni and Mn in them as coatings.

Silica (Si) concentration in the waters ranges from 33.10 to 36.20 ppm with an average of 30.9 ppm. The permissible limit of Si in water for domestic use is 15 ppm (BIS 1991), and hence all the samples of water can be said to be harmful for consumption. More corrosion in northern and southern terrains has caused turbidity in all the samples of water and so the waters of Chenab in this area from Pul Doda to Baggar cannot be used for human consumption. As the rocks in the area are granitic in composition and Salkhalas are also mostly acidic in nature, both types of rocks, therefore, have high amount of Si in them. This is the reason of Chenab waters containing high amount of silica, which enters in the solution of waters.

The concentration of copper (Cu) in Chenab river lie between 0.01 and 0.11 ppm with an average value of 0.05 ppm, and hence with respect to Cu, Chenab waters are suitable for human consumption. In granites, mineralization has been noticed at number of places like Dal Draman, Assar and Khilleni (Fotedar & Raina 2009). These might have contributed Cu to the Chenab waters.

Zinc concentration of Chenab waters was between 0.01 and 0.012 ppm with an average value of 0.05 ppm. The permissible limit of Zn in potable waters is 5 ppm (WHO 1984), and therefore, Chenab waters with respect to Zn are suitable and not harmful for domestic consumption.

Lead concentration in potable waters should be less than 0.05 ppm (Rodier 1975). In all the water samples of Chenab waters, the concentration is more than recommended value. Hence, with respect

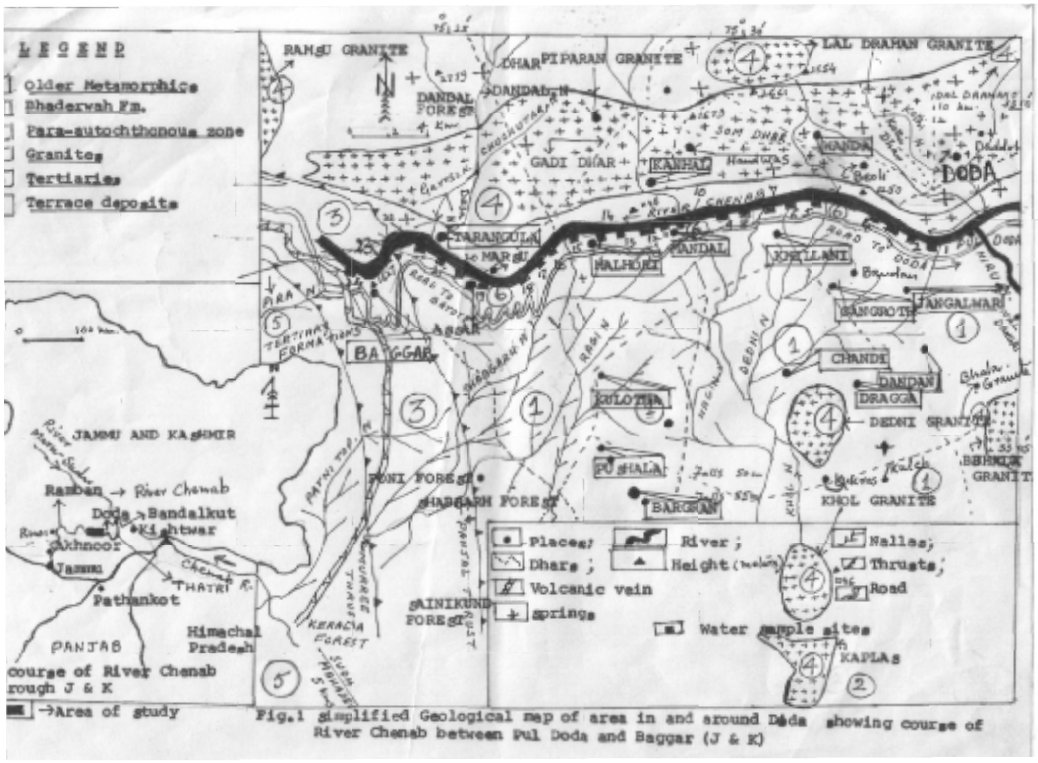

Fig. 1 : Simplified geological map of the area in and around Doda showing course of River Chenab between Pul Doda and Baggar, J&K State.

Table 2: Average concentration values of different cations and some other parameters for Chenab river flowing from Pul Doda to Baggar, J&K State.

Element/Parameter	Average conc. sample	Conc. recommended for human consumption	Reference	Toxic/Non-toxic
1	2	3	4	5
Ca	3.98 ppm	75 ppm	BIS, (1991)	Non-toxic
Mg	0.90 ppm	30 ppm	-do-	-do-
Si	30.90 ppm	15 ppm	Kudesia (1933)	Toxic
Na	1.84 ppm	-	-	Such a low concentration cannot be considered toxic for domestic use
K	1.80 ppm	50 ppm	BIS (1991)	Non-toxic
Fe	0.50 ppm	0.3 ppm	BIS (1991)	Toxic
Mn	0.26 ppm	0.1 ppm	WHO (1984)	Toxic
Cu	0.05 ppm	1 ppm	BIS (1991)	Non-toxic
Zn	0.05 ppm	5 ppm	WHO (1984)	Non-toxic
Pb	0.08 ppm	0.05 ppm	Rodier (1975)	Toxic
Ni	0.06 ppm	0.05 ppm	Rodier (1975)	Toxic
pH	7.2-8.5	6.5-8.5	Kudesia (1983)	Normal
TDS	71.10 ppm	500 ppm	BIS (1991)	Non-toxic
Turbidity	6.1-8.2	5 units	Kudesia (1983)	Toxic

to Pb, Chenab waters are not suitable for human consumption. In the present area, the higher Pb values may be due to vehicular traffic which has increased manifold during the last two decades. In spite of this, it can logically be accepted that major source of Pb in Chenab waters is lead mineralization as reported by Wadia (1970) and later by various other workers (Fotedar & Fotedar 2008). Fotedar & Loan (2004) has reported higher Pb values in Jajjar Kotli waters of Jammu region. Again, Gupta (2005) has associated higher Pb values in various aquatic systems in Jammu and Kashmir state with increase in vehicular traffic. The higher values of Pb in the Chenab waters are also ascribed to Pb sanitation occurring near both banks, from where the water samples have been collected. A number of workers have reported bad sanitation being one of the important factors to have caused increase of Pb in various waterbodies in India such as Kudesia (1989), Fotedar et al. (1993b), Fotedar & Singh (1994a, 1994b), Fotedar & Singh (1995), Bukhari et al. (1999), Fotedar & Loan (2004), Fotedar et al. (2008a, 2008b, 2008c), Fotedar & Fotedar (2008), Fotedar & Raina (2009), Fotedar & Fotedar (2009a, 2009b, 2009c).

Sodium (Na) and potassium (K) are found to be present below permissible limits (Table 1). pH for all the water samples ranged from 7.2-8.5 units indicating the values below the permissible limits (Kudesia 1983). As such the Chenab waters flowing from Pul Doda to Baggar are not toxic for human consumption with respect to pH.

The permissible limit of TDS (total dissolved solids) in potable waters is 500 ppm (BIS 1991). In the present study, the values were far less than this, and hence the waters with respect to TDS cannot be regarded toxic for human consumption.

Turbidity values of Chenab waters ranged between 6.1 and 8.2 units, whereas recommended values for potable water are 5 unit. The Chenab waters are toxic with respect to turbidity, and hence objectionable. The higher values of turbidity can be linked to high index of weathering in the area and the area being locally deforested during the last three decades.

MANAGEMENT AND CONTROL

1. Forest in the watershed of Chenab river towards north and south has completely been removed by local people. There is lot of erosion occurring on the hill slopes. For checking erosion, the watershed of Chenab river should be provided with adequate forest cover as advocated by Gupta (2005). This will arrest many unwanted inorganic and organic materials to pass on into the solution of waters.
2. Also, on both the river banks from Pul Doda to Baggar, vetiver grass should be grown. It will efficiently check unwanted ions to move into the waters, especially Fe, Mn, Ni, Pb and Si, which are present above the permissible limits. Vetiver grass plantation is a tested technology having been used in Himalayan terrains at so many unstable sites for checking contamination of water and mass wastage from the slopes.
3. Higher Pb values can partly be ascribed to bad sanitation existing throughout the river course near the banks. Separate privacy corners in the whole belt need to be constructed so that with proper sewerage system all the drainage could be diverted off and not allowed to mix with the waters of Chenab river.
4. Proper filtration methods and disinfection with chlorine/bromine should be done to render the waters fit for human consumption.
5. Chenab valley has enchanting hill topography on its northeast and the whole basin has the scope of adding to its banks, parks and terraced gardens which are bound to attract tourists from all over India.
6. The whole area in and around Chenab river needs to have green cover, together with good sanitation all around and for this mass awareness programmes are needed to educate people to maintain the aesthetic and recreational value of the waters. The whole area is bouquet of landscape, virgin, serene and refreshing. The winding brooks, pure cool air and lasting treks are an extreme pleasure, loved, enjoyed and cared. Mass awareness programme is necessary to maintain the overall beauty of the area.

REFERENCES

BIS 1991. Drinking water specifications I.S. No: 10500, Bureau of Indian Standards, pp. 1-5.

Bukhari, S.K., Loan, B.A., Dhar, B.L. and Fotedar, B.K. 1999. Physicochemical studies of Banganga waters, Vaishnodevi hill area, Jammu Himalaya. Indian Journal of Geochemistry, BHU, Varanasi, 14: 19-32.

Dhar, B.L., Raina, A.K., Fotedar, B.K. and Singh, R. 1996. Petrology of Doda granites, Jammu Lesser Himalaya, India. Journal of Nepal Geological Society, 13: 49-56.

Fotedar, A. and Fotedar, B.K. 2009a. A note on water chemistry of Ranbir canal flowing from Akhnoor to Jammu (J&K State). J. Current Science, Jharkhand, 14(1): 37-46.

Fotedar, A. and Fotedar, B.K. 2009b. Assessment of water quality of Painthal nallah, Udhampur district, Jammu Himalaya. In: Bhat, G.M., Pandita, S.K., Singh, Y. and Loan, B.A. (editors), Geo-Environment-Challenges Ahead. McMillan Pub. India Ltd., New Delhi.

Fotedar, A. and Fotedar, B.K. 2009c. Water chemistry of Neeru river flowing from Bhaderwah to Pul Doda, Jammu and Kashmir State. J. Aqua. Biol., Hyderabad, 24(1): 61-70.

Fotedar, A. and Fotedar, B.K. 2009d. Water quality assessment of Basantar river in J&K for domestic use. The Ekologia, Jharkhand, 9(1-2): 19-28.

Fotedar, A. and Raina, A.K. 2009. Water chemistry about heavies of Sewa river, Kathua district, Jammu and Kashmir State. Indian Journal of Environment and Ecoplan, 16(1): 213-218.

Fotedar, A. and Fotedar, B.K. 2008. Water chemistry of Tawi river from Nagrota to Khanpur area, Jammu Himalaya, Jammu (J&K). J. Aqua. Biol., 23(2): 77-86.

Fotedar, A., Tikoo, V.J., Verma, R.K. and Fotedar, B.K. 2008a. Quality of Jajjar nallah and Painthal nallah waters of Udhampur district, Jammu Himalaya in relation to human consumption and agricultural use. The Andhra Agricultural Journal, 55 (2): 195-203.

Fotedar, A., Tikoo, V.J., Verma, R.K. and Fotedar, B.K. 2008b. Water chemistry of Chenab river flowing from Dhiangarh to Ambaran, Reasi area, J&K. Environment and Ecology, 26(4B): 2051-2060.

Fotedar, A., Verma R.K. and Fotedar, B.K. 2008c. Some major and trace element studies of Tawi river from Ban to Bellicharana, Jammu Himalaya, J&K State. Science and Culture, 74(3-4): 137-141.

Fotedar, B.K. and Loan, B.A. 2004. Physicochemical studies of Jajjar Kotli waters, district Udhampur, Jammu. Geohazards of North-West Himalaya. Seminar held in Geology Department, Jammu University, Jammu, 9-10th Oct, 2004 (Abstract).

Fotedar, B.K. and Singh, B.P. 1994a. Pollution studies-Jajjar Kotli and its environs. Kashmir Times, Sunday Magazine, May 22, p. 10.

Fotedar, B.K. and Singh, B.P. 1994b. Environmental pollution with respect to lead. Kashmir Times, Nov. 2, p. 10.

Fotedar, B.K. et al. 1990. Behaviour of trace elements in waters of Chenab river, Akhnoor area, Jammu. All India Seminar on Ground Water Investigation Management and Geophysical Techniques held at Lucknow under the sponsorship of Central Groundwater Board, 11-12 Dec., pp. 18-24.

Fotedar, B.K., Raina, A.K. and Dhar, B.L. 2000. Pollution studies of some important springs of Zabanwan mountains and their impact on Dal lake waters. In: Sinha, A.K. and Srivastava, P. (editors), Earth Resources and Environmental Issues. ABD Publishers, Jaipur, pp. 155-165.

GBC, 1982. Manual for Atomic Absorption Spectrophotometer, Model 902, Australian make. Operational methods for analyzing geological samples and water samples.

Gupta, R.D. 2005. Environmental Degradation of Jammu and Kashmir Himalayas and Their Control. Associated Publishing Co., New Delhi, p. 124.

Jenne E., Kennedy, V., Burchand, J. and Ball, J. 1980. Sediment collection and processing of selective extraction and for total metal analysis. In : Baker, R. (ed.), Contaminants. V-2. Ann. Abror. Science Publishers Inc.: 169-189.

Kudesia, V.P. 1983. Water Pollution. Praghati Prakashan, Meerut, pp. 328-330.

Lavania, U.C. 2004. Vetiver system ecotechnology for environmental protection and sustainable development. Curr. Science, 86(1): 11-14.

Raghunath, H.M. 1987. Ground Water. Wiley Eastern Limited, Delhi, India, pp. 563.

Ramakrishna, 1998. Ground Water Handbook of India. Wiley Eastern Limited, Delhi, India, pp. 556.

Rodier, J. 1975. Analysis of Water. John Wiley and Sons, New York.

Trivedy, R.K., Goel, P.K. and Trissal, S.L. 1987. Practical Methods in Ecology and Environmental Sciences. Enviromental Publications, Karad, India.

Vaidyanathan, R. and Ramakrishnan, M. 2008. Geology of India. Vol. 2. Geology Society of India, Bangalore Publication, pp. 889.

Vogel, I. Arthur 1980. A Textbook of Qualitative Inorganic Analysis. 6th edition. Tearsol Education Asia, Singapore Pvt. Ltd., Pratapgarh, Delhi.

Wadia, D.N. 1970. Geology of India. 6th edition, MacMilan and Co. Ltd., London, pp. 1-50.

Wedepohl, K.H. 1978. A Handbook of Geochemistry. Springer Verlag, New York.

WHO 1984. Guidelines for Drinking Water Quality. World Health Organisation, Geneva.