Bioscene

ISSN: 1539-2422 (P) 2055-1583 (O)

www.explorebioscene.com

Ground water quality in Malwa region of Punjab, India: a review

Kamal Mehta
Asst. Professor, P.G Department Of Zoology,
Jagdish Chandra D.A.V College, Dasuya (Punjab)-144205, India.

Abstract

Punjab is ornamented with a rich and vast diversity of natural resources, water being the most precious of them. Rapid industrialization and population explosion lay stress upon natural resources and hence, caused their deterioration. Ground water quality is slowly but surely declining everywhere in Punjab mainly due to geological as well as anthropogenic factors. Analysis of ground water in various parts of Punjab showed that majority of chemical constituents such as Na^{+}, Ca^{+2}, Mg^{+2},K^{+}, HCO_3^{-},Cl^{-},SO_4^{-2} and F^{-} along with the heavy metals such as Al, As, Pb, U, Cu, Zn are above the permissible limits. The ground water of Malwa region of Punjab has been found to be highly polluted due to excessive use of pesticides and chemical fertilizers, thus turning the nomenclature of Punjab state from bread basket to cancer bowl. Water quality monitoring programmes must be initiated periodically for both ground water and water bodies in order to improve the water quality of the region.

Key Words: Heavy Metals, Pesticides, Permissible limit, Physiochemical Parameters, Anthropogenic factors.

1. Introduction

Rapid industrialization and population explosion lay stress upon natural resources. This stress is manifested in the form of deterioration of natural resources and resulted into their contamination or pollution that rely negative impacts not only on human but on every living species. Ground water is primarily used for drinking purpose and irrigation of agricultural crops. The fitness of groundwater for drinking and other purposes is generally assessed by Physiochemical and biological quality parametric analysis and is greatly influenced by geological factors as well as anthropogenic activities. Its quality is determined by the concentration and composition of dissolved ions which are generally governed by geological factors such as lithology of subsurface, velocity and quantity of groundwater flow, nature of geochemical reactions, solubility of salts and various anthropogenic activities [1,2]. Majority of chemicals and minerals are found to occur above or below their threshold limits, hence, affecting health of the public as reported by the facts such as fluoride concentration less than 0.5 mg/l leads to the risk of tooth decay while higher concentration causes dental fluorosis. Methanoglobinemia, commonly referred as blue baby syndrome is caused to infants when the nitrate concentration is generally above 45 mg/l [3,4].Similarly, diarrhea and intestinal disorders may get induced by high concentration of sulphates in water. Elevated concentrations of iron in natural water resources can lead to several serious health problems like cancer, diabetes, liver and heart diseases as well as neurodegenerative diseases [5]. Chronic exposure to inorganic Arsenic (As) and Uranium (U) through contaminated water and food led to serious health problems including skin disorders, skin cancers, internal cancers of liver, bladder, kidney and lung, diseases of the blood vessels of the legs and feet, possibly diabetes, increased blood pressure, and reproductive disorders[6,7,8].

2. Biogeography of Punjab State

Punjab, an agriculture dominant North Western state of India of India covers 1.57 % of the total geographical area of the country with an area of 50,362 km^2 and a population of 27.98 million [9]. For irrigation and drinking purpose, groundwater is predominately used in the state. The groundwater quality in Punjab is deteriorating due to anthropogenic pollution that involves excessive use of chemical fertilizers and pesticides. The state of Punjab has been divided into three geographical regions- Majha, Malwa and Doaba and each biogeographical region possess unique ground water qualities.

2.1 Ground water quality in Malwa region of Punjab

Malwa region of Punjab is located in the south west of the state. The soil of this region is loose, sandy, calcareous and alluvial, which is an admixture of gravel, sand, silt and clay in varying proportions [10].Since, the soil of southwestern districts in Malwa region is almost sterile therefore; farmers of these districts use comparatively more fertilizers and a pesticide in order to enhance their crop productivity. This situation is accountable for groundwater pollution in these districts. Peoples of this area of Punjab are commonly suffering from variety of cancers approximately 108.9 patients per lakh making Punjab as cancer capital of India. As per 2005 records of Health Department of Punjab, there are more than 59 cancer patients in Bathinda only among one lakh persons [11]. This may be related to a 2007 epidemiological study that reveals contamination of surface water with arsenic, lead, cadmium, chromium, selenium and mercury primarily due to the discharge of untreated waste water from industries [12].This turns the Punjab state nomenclature from bread basket to Cancer bowl of India. More no. of female patients has been reported in the Malwa region in contrast to the male patients that suffered from cancers [13].A number of reproductive disorders and mental retardation cases have been detected due to excess use of banned and restricted chemical pesticides [14]. Cancer mortality rate has been found to be highest in the Malwa region (29.18 per lakh) as compared to Majha (20.24 per lakh) and Doaba region (27.28 per lakh). A special train has been started by the Government named 'cancer train 'carry the cancer patients from Bathinda Junction to Acharya Tulsi Das Regional Centre, Bikaner in Rajasthan state for getting aided treatment at economical rates [15].

2.2 Water Quality determinants of Malwa's Ground Water

Water in this region has been found to be saline as well as polluted with heavy metal elements like Lead, Zinc,Chromium,Uranium and Arsenic [16]. According to a report published by Government of India in 2013 entitled 'Water Logging in Punjab by Planning Commission' the Nitrate and Fluoride content is detected above the critical limits [17].In the Malwa area of Punjab, testing of water samples for physiochemical characteristics indicated almost normal pH within the permissible limits but high turbidity and hardness evident from the presence of high concentration of calcium as well as magnesium along with their salts such as carbonates, sulphates and chlorides [2,12]. High turbidity of water is often associated with high levels of disease causing organisms such as viruses, parasites and bacteria responsible for symptoms such as nausea, cramps and diarrhea [18]. Sodium ion (Na^+) was reported to be the dominant cation in the Muktsar district of Malwa region whereas the average concentration of potassium (K^+) in the groundwater of the region was found to be 15.32 mg/l in ground water samples collected in summer which was found to be more as compared to ground water samples collected in winter samples with an average value of 11.26 mg/ l due to the agricultural activities [19,20]. Anions such as Bicarbonates (HCO_3^{-2}), Sulphates (SO_4^{-2}), Chloride (Cl^-), Hydroxyl (OH^-), Carbonate (CO_3^{-2}), and Fluoride (F^-) were found to be dominating in the ground water of Malwa region of Punjab. A similar finding has been recorded in the other parts of Punjab which showed that Bicarbonates (HCO_3^{-2}) as the dominant anion in the region [9]. High fluoride content in groundwater is generally linked to the presence of fluoride bearing minerals in aquifers [21,22].The Mean Nitrate concentration was lower as previously reported in Muktsar and Patiala districts of Punjab but higher than those reported in Jalandhar and Kapurthala districts of Punjab [19,23,24]. It was found that about 33% and 75% samples collected during summer and winter seasons respectively, has arsenic concentration more than the safe limits of 10 µg/l set by WHO and BIS, thus are not suitable for drinking purposes. Mean arsenic concentrations (10.19 µg/l) found was higher than the arsenic concentrations reported previously in Bathinda and Amritsar but less than the concentrations reported in southwestern region of Punjab [12,16,25]. In 2012, Department of Water Supply and Sanitation, Govt. of Punjab reported arsenic in groundwater above permissible limit in 5 districts namely, Amritsar (0.099 mg/l), Taran taran (0.083mg/l), Ferozepur (0.055 mg/l), Gurdaspur (0.058 mg/l), Rupnagar (0.091 mg/l). According to a 2014 report on

groundwater analysis, out of 22 districts of Punjab, 13 are affected with arsenic concentration range 0.01-0.39 mg/l in groundwater. Amritsar, Taran Taran, Mansa, Kapurthala, Fazilka and Rupnagar district detected arsenic above the permissible limit (0.05mg/l). The highest concentration of arsenic more than 10 µg/l has been reported in Muktsar, Malout and Talwandi Sabo area lying in south west parts of Punjab state [26]. It was observed that groundwater samples taken from deep aquifers (more than 100m depth) reported arsenic above 0.05 mg/l. The elevated levels of arsenic in Malwa area of Punjab may be due to its evaporative environment since the climate of this region is arid which can lead to more loss of water by evaporation than its gain by rainfall [16]. Arsenic in groundwater is the result of weathering of rocks and sediments followed by subsequent leaching and run-off. High concentrations of arsenic tend to occur in sediments rich in sulphide minerals and metal oxides, especially iron oxides. Arsenic contamination can be strongly associated with high concentrations of iron, phosphate, and ammonium ions, and anthropogenic activities such as excessive groundwater withdrawal for agricultural irrigation [23,27]. Excessive use of arsenical pesticides on crops may be a source of arsenic contamination due to leaching process of fertilizers and pesticides from soils to groundwater. The major source of metal pollution in water is the use of pesticides in the form of calcium arsenate, lead arsenate, sodium arsenate and arsenic acid [28].Uranium biomagnifications through contaminated water has been reported in principal sites in human body such as kidneys, the liver and the bones. The permissible limit of Uranium in drinking water by WHO is 30 µg/l and 60 µg/l by AERB [29,30]. Overall, uranium concentration in the drinking water samples of Malwa region have been found to be varying between 0.5-579 µg/l with an average of 73.5 µg/l. Higher concentrations of uranium detected in ground water samples at some sites in Malwa area of Punjab might be due to leaching of uranium from underlying granite rich rocks [10].

3. Conclusion

This review study reveals that groundwater in Malwa region of Punjab is highly contaminated and polluted, hard with high TDS concentrations except for a few locations, hence not suitable for drinking or irrigation purpose. The majority of water samples were found to be beyond desirable limits as prescribed by WHO standards and Indian standards for drinking water. The safe limit of TDS in the drinking water samples is considered to be 600 mg/l [29].A wide variation in the TDS has been observed in samples during both the seasons indicating the influence of climatic factors including rock water interaction as well as anthropogenic activities, such as increase in pumping, excessive use of fertilizers, and discharge of industrial effluents on the hydrochemistry of the Malwa area. The abundance of major cations such as Na^{+}, Ca^{+2}, Mg^{+2}, K^{+} and anions such as HCO_3^{-}, Cl^{-}, SO_4^{-2}, F^{-} found during both the seasons. The ground water analysis conducted by various researchers in this area also showed high concentration of arsenic, uranium and iron in these areas which is higher than the safe limits set by WHO and BIS. Groundwater Contamination above acceptable limit of BIS drinking water standards is a major concern with majority of domestic and agricultural activities based on groundwater. Hence, there is urgent need of attention towards water quality enhancement and management programmes which implies implementation of laws as well as promotion of new technologies for water conservation and improving water quality in this area of Punjab.

References

[1] Tamma RG, Srinivasa RY, Mahesh J, Surinaidu L, Dhakate R,Gurunadha RVVS, Durga PM (2015) Hydrochemical assessment of groundwater in alluvial aquifer region, Jalandhar District, Punjab, India. Environ Earth Sci 73:8145–8153

[2] Kaur T., Bhardwaj R. and Arora S. (2016). Assessment of groundwater quality for drinking and irrigation purposes using hydrochemical studies in Malwa region,southwestern part of Punjab, India. Applied Water Science (2017) 7:3301–3316

[3] Thivya C, Chidambaram S, Rao MS, Thilagavathi R, Prasanna MV,Manikandan S (2015) Assessment of fluoride contaminations in groundwater of hard rock aquifers in Madurai district, Tamil Nadu (India). Appl Water Sci.

[4] Jain CK, Bandyopadhyay A, Bhadra A (2010) Assessment of groundwater quality for drinking purpose, district Nainital, Uttarakhand, India. Environ Monit Assess 166:663–676.

[5] Azizullah A, Khan Khattak MN, Richter P (2011) Water pollution in Pakistan and its impact on public health—a review. Environ Int 37:479–497.

[6] Chakraborti D, Rahman MM, Ahamed S, Dutta RN, Pati S,Mukherjee SC (2016) Arsenic contamination of groundwater and its induced health effects in Shahpur block, Bhojpur district, Bihar state, India: risk evaluation. Environ Sci Pollut Res

[7] Santra SC, Samal AC, Bhattacharya P, Banerjee S, Biswas A and Majumdar J (2013) "Arsenic in foodchain and community health risk: a study in gangetic west Bengal," Procedia Environmental Sciences, vol. 18, pp. 2–13, 2013, Proceedings of the International Symposium on Environmental Science and Technology (2013 ISEST)

[8] Blantz, R. C., Pelayo, J. C., Gushwa, L. C., Myers, R., & Evan, A. P. (1985). Functional basis for glomerular alterations in uranyl nitrate acute renal failure. Kidney International, 28(5), 733e743.

[9] Thakur T, Rishi MS, Naik PK, Sharma P (2016) Elucidating hydrochemical properties of groundwater for drinking and agriculture in parts of Punjab, India. Environ Earth Sci 75:467.

[10] Bajwa BS, Kumar S, Singh S, Sahoo SK, Tripathi RM (2015) Uranium and other heavy toxic elements distribution in the drinking water samples of SW-Punjab, India. J Radiat Res Appl Sci 1–9..

[11] . Kaur R. S, "Evaluation of DNA Damage in Agricultural Worker Exposed to Pesticides Using Simple Cell Gel Electrophoresis Assay". Indian J. Human Gene, 17(3), pp. 179-187, 2011

[12] Sharma R (2012) Analysis of water quality parameters of groundwater in Malwa region, Bathinda, India. IJAST 1(11):1–7.

[13] Singh B.P. (2008). Cancer Deaths in Agricultural Heartland: A Study in Malwa Region of Indian Punjab.International Institute for Geo – Information Science and Earth Observation Enschede, Netherland

[14] Mittal S., Kaur G. and Vishwakarma G.S. (2014). Effects of Environmental Pesticides on the Health of Rural Communities in the Malwa Region of Punjab, India: A Review. Human and Ecological Risk Assessment, 20, 366-387

[15] Kaur M. and Kaur P.(2016). Transformation of Punjab's Malwa Region from Cotton Belt to Cancer Belt. International Research Journal of social sciences,Vol. 5(9), 35-40.

[16] Hundal HS, Singh K, Singh D (2008) Arsenic content in ground and canal waters of Punjab, North-West India. Environ Monit Assess. www.springerlink.com.

[17] Government of India Planning Commission (2013). Report of the high level expert group on water logging in Punjab.

[18] Memon AH, Ghanghro AB, Jahangir TM, Lund GM (2016) Arsenic contamination in drinking water of District Jamshoro, Sindh, Pakistan. Biomed Lett 2(1):31–37.

[19] Kumar M, Kumari K, Singh UK, Ramanathan AL (2009) Hydrogeochemical processes in the groundwater environment of Muktsar, Punjab: conventional graphical and multivariate statistical approach. Environ Geol 57:873–884 Appl Water Sci (2017) 7:3301–3316.

[20] Sayyed JA, Bhosle AB (2011) Analysis of Chloride, Sodium and Potassium in groundwater samples of Nanded City in Mahabharata,India. Eur J Exp Biol 1(1):74–82.

[21] Handa BK (1975) Geochemistry and genesis of fluoride containing groundwater in India. Groundwater 13(3):275–281

[22] Wenzel WW, Blum WEH (1992) Fluoride speciation and mobility in fluoride contaminated soil and minerals. J Soil Sci 153:357–364.

[23] Kumar P, Kumar M, Ramanathan A, Tsujimura M (2010) Tracing the factors responsible for arsenic enrichment in groundwater of the middle Gangetic Plain, India: a source identification perspective.Environ Geochem Health 32:129–146.

[24] Purushothman P, Rao MS, Kumar B, Rawat YS, Krishan G, Gupta S,Marwah S, Bhatia AK, Kaushik YB, Angurala MP, Singh GP (2012) Drinking and irrigation water quality in Jalandhar and Kapurthala Districts, Punjab, India: using hydrochemistry. IJEE 5(6):1599–1608.

[25] Sidhu M, Mahajan P, Bhatt SM (2014) Highly sensitive and low cost colorimetric method for quantifying arsenic metal in drinking water of Malwa Punjab and comparison with ICAP-AES. Ann Biol Res 5(3):105–109.

[26] Singh KP, Kishore N, Tuli N, Loyal RS, Sharma M, Dhanda D, Kaur M and Taak JK (2015) Observations on Occurrence of Arsenic in Groundwater especially in Parts of South-West Punjab, In Workshop: Arsenic Contamination in Groundwater, CGWB (Chandigarh), Ministry of Water Resources, River Development and Ganga Rejuvenation, Govt. of India, 45-52

[27] Smedley PL and Kinniburgh DG (2002) A Review of the Source, Behaviour and Distribution of Arsenic in Natural Waters, Applied Geochemistry, 17(5): 517–568

[28] Rasool A, Xiao T, Farooqi A, Shafeeque M, Liu Y, Kamran MA,Katsoyiannis IA, Eqani SAMAS (2016) Quality of tube well water intended for irrigation and human consumption with special emphasis on arsenic contamination at the area of Punjab,Pakistan.

[29] WHO (2011) Guidelines for Drinking Water Quality, vol. 4, World Health Organization.

[30] AERB(2004). Drinking water specifications in India. Department of Atomic Energy, Govt. of India.