Eco. Env. & Cons. 28 (May Suppl. Issue) : 2022; pp. (S456-S460)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03s.065

Evaluation of underground water in Kangra, Solan and Una district of Himachal Pradesh: A Review

Vishal Rana*, Divya Gautam, Yogesh Kumar Walia and Vandana Sethi

Department of Chemistry, School of Basic and Applied Sciences, Career Point University, Hamirpur (H.P.), India

(Received 15 December, 2021; Accepted 27 January, 2022)

ABSTRACT

Ever increasing population, urbanization and modernization are posing problems of sewage disposal and contamination of underground water sources like bore well and hand pump. Natural water resources get contaminated due to weathering of rocks, leaching of soils and industrial waste disposal etc. Underground water quality can be assessed by various parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), temperature, nitrate, sulfate, chlorides, total alkalinity etc. Heavy metals such as Pb, Cu, Fe & Hg etc. are of special concern because they produce chronic poisoning for living beings by using water with high concentration of such heavy metals. In this review author aimed to find out the level of contamination in Kangra, Solan and Una District of Himachal Pradesh. In this review author also discussed some serious issues related to improving the quality of underground water in the above said areas.

Key words: *Contamination, Industrialization, Underground water, Physico-chemical, Kangra, Solan, Una, Heavy metals.*

Introduction

The major source of drinking water is ground water in both urban and rural India. Ground water constitutes 97% of global fresh water. Many regions of world, ground water sources are the single largest water supply resources for serving drinking water to the community (Bharti *et al.*, 2011). Over many years, an unscientific exploitation of these resources is due to increasing population. Increasing population is the major factor for urbanization and expansion in agriculture. The quality of water refers to its physical, chemical and biological characteristics (Sharma and Walia, 2016; Sharma, 2012). The underground water is an important source of water for the agricultural, drinking as well as for the industrial sector . The ground water is found in underground cracks, spaces in soil, sand and rocks. Ground water quality parameters depend on factors like as climate, slope, drainage conditions and residence time of groundwater (Pandey and Tiwari, 2009). Practically pure water is considered as one, which has low dissolved solids required only for drinking purposes but in case of agriculture and industry uses, the quality of water can be quite flexible (Joshi *et al.*, 2009). The demand for water has increased over the years and this leads to water shortage in many parts of the world, especially in India. This can be considered as alarming calls for cost and time effective techniques for proper evaluation of groundwater resources. The ecological balance can be disturbed by over exploitation and unplanned development of ground water. The assessment of concentration of pollutants in different components of ecosystem, especially groundwater is very important in order to prevent the risk to natural and public health. The deteoration of groundwater quality due to heavy metal contamination responded by industrialization and urbanization is a matter of great concern (Mance, 1987; Amajor, 1986; Calderon, 2000; Jha *et al.,* 1990; Ramesh *et al.,* 2000).

Tanzania, Morocco, India, Kenya and South Africa were selected as case studies to understand the practical issues that arise in groundwater and implementing these frameworks at the aquifer level by world health organization (WHO). According to correlation among water quality parameters, it concluded that groundwater should not be used without any prior treatment (Bhargava *et al.,* 1978). The water resource potential or annual water availability of India in terms of natural runoff in rivers is about 1,869 Billion Cubic Meter (BCM)per year as reported by Rupal Suhag in the report of ground water of India in April, 2015. However, the usable water resources of the country have been estimated as 1,123 BCM/year. This is due to constraints of topography and uneven distribution of this resource in various river basins, which makes it difficult to extract the entire availability of water resources. Out of which the distribution of water into surface water and ground water is 690 BCM/year and 433 BCM/year respectively.The net annual ground water availability for the entire country is 398 BCM. The overall contribution of rainfall to the country's annual ground water resource is 68% and 32% shared by other resources such as canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures.By increasing population in our country, the national per capita annual availability of water has reduced from 1,816 cubic metre to 1,544 cubic meterduring 2001 to 2011. Many other observations revealed that public water supply system in rural area is limited and majority of population is forced to use groundwater through hand pumps or bore wells (Bashir, 2012). Most of the groundwater samples were characterized with low pH value in okitipura south-east belt of the bituminous sands field of Nigeria (Aiyesanmi *et al.,* 2004).

As the water quality has great influence on human health, interest in quality control of water has increased considerably (Memon *et al.,* 2011; Gadgil, 1998; Dixit and Rana *et al.,* 2022). In current review paper authors want to draw the attention of readers towards increase in contamination of underground water in Himachal Pradesh (H.P) especially Kangra, Solan and Una districts. Authors also discuss various mode and methods to improve the quality of underground water.

Literature Review

Contamination of underground water in district Una: In district Una groundwater is the main source of potable water. Water supply for drinking purposes in Una district is underground water through Public Welfare Department (PWD) and also from ground water through pipelines. In maximum areas of Una district, all the major irrigation and drinking water requirements depend on ground water viz., open wells, bore wells and tube wells. Most of the ground water issues and problems in the district are localized and need to be treated independently, by taking the micro level studies in a particular area. In the region of district Una, the depth of underground water level varies widely. The average rain fall during pre-monsoon period ranged from less than 1.00 to 65.00 m bgl (meter below ground level). Deeper water levels are confined mainly in south west (Beet area) and localized patches in north eastern and central part of Una valley (Sullivan *et al.,* 2010). Central ground water board, September 2013, has mentioned that in major parts of Una valley, depth of water level ranged between 2.00 to 10.00 m bgl. Some areas in discharge zone along the river Soan, shows water logging conditions, where water level is less than 1.5 m bgl. Seasonal fluctuation rise up to 3.56 m between pre and post monsoon period in year 2012. Long term water level fluctuation was analyzed for the period of May, 2012 with respect to decadal average of 2002 - 2011. In general, fall in water level up to 2 m is observed in most part of the valley .Chemical quality data of ground water from shallow as well as deep aquifers in the district indicates that ground water is generally alkaline in nature and suitable both for domestic and irrigation use. Hydrological cycle includes rain water and groundwater as major components. The quality of rain water can be deteorated due to human's activities and significant variations in physico-chemical parameters affects the quality of water resources For the good hygiene and sanitation, there is central need of easily assessible and potable water supply for household welfare (Sajjad *et al.,* 2013). In valley area, extensive development has resulted in depleting water levels and there is need to conserve and augment water resources by adopting appropriate recharge measures. In Una valley due to extensive ground water development for irrigation and for industrial units, the water levels are likely to show depleting trend. One of main reason for toxicity in groundwater is natural geological weathering of rocks and soil. The contamination of groundwater due to heavy metals is also imposing phytotoxicity on plant health adversely (An, 2006). Various physico-chemical parameters of water like as temperature, pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) fluctuated with the seasons and sites. Various parameters indicated that maximum Chemical oxygen demand value of groundwater (20.00mg/l), maximum mean BOD value of groundwater (2.80mg/l), maximum mean Dissolved Oxygen (8.00mg/l), maximum mean TDS (723.33 mg/l) and maximum mean Electrical Conductivity (725.33 µS/cm) (Sharma and Bhattacharya, 2017). Therefore these reports resulted that maximum mean of BOD, COD and TDS was found higher in pre monsoon season as compared to post monsoon season. While as mean values of rest all parameters were found within permissible limits in both seasons in reference to WHO, (2012) standards. Assessment of the water quality in this area by calculating water quality index (WQI) is a very useful attempt providing awareness among the public for knowing surface water quality status and control of pollution in terms of treatment required at different levels (Sharda and Sharma, 2013).

Contamination of Underground Water in District Kangra: Kangra is hilly and mountainous district with few valleys. In these areas, traditional ground water sources played a major role in water requirement of the district. The Beas is one of the larger rivers of this district and contributes to the fertility of agricultural land. There are many sources of water in these areas including springs and Chasma for irrigation purposes. Public Health Department constructed number of small depth bore wells, fitted with hand pumps in different areas of Kangra district for ground water use. Extraction of ground water through dug wells, hand pumps, tube-wells and springs are the major sources of water for both rural and urban areas. Large scale development for ground water was seen in the valley areas of this district from last few years. Yet remained many areas of study district, where exploration of ground water is required on large scale in future.

Precipitation is the principal source of ground water recharge to aquifer systems in the district. Most of the rainfall goes runoff due to hilly and mountainous geography of this area.

Rainfall is the major source of groundwater to recharge the level of underground water and toirrigatethe fields, whereas discharge from ground water mainly takes place from underground water resources like borewells and tube wells.In the Indora and Nurpur valley of Kangra district, the ground water resources and irrigation potential have been computed as per the GEC-97 methodology (Ground water resource estimation methodology) and the data for the same resources, 2011, as mentioned in Table 1.

The stage of ground water development in Indora and Nurpur valley in Kangra district is 50.03% and 39.55 % respectively and falls under "Safe" category. Beside all these there is still a scope for the development of ground water sources.

In the report mentioned by Rachna Bhatti in the year of 2012, the chemical analysis of twenty eight national hydrograph network stations'swater samples were collected from ground water monitoring stations located in Kangra district. The minimum and maximum ranges of the results are tabulated below. Data revealed the permissible limit of safe drinking water as set by Bureau of Indian Standards(BIS: IS: 10500, 2012).

Overall, ground water quality in the district is

	pH	EC µS/cm at 25°C	HCO_3	Cl	SO_4	NO_3	F mg/ml	Ca	Mg	Na	K	Total Hardness as $CaCO_3$
Min.	7.55	120	37	7.09	Tr	Tr	Tr	10	30.	6.3	6.6	45
Max.	8.46	910	513	110	71	28	0.54	112	56	105	38	370

Table 1. Data computed by GEC-97 of Nurpur and Indora valley

Indora valley(26,545 ha)		Nurpur Valley (23,775 ha)	
Annual Ground Water Availability	10,520.18 Ham	Annual Ground Water Availability	7,639.43 Ham
Annual Ground Water Draft	5,263.72 Ham	Annual Ground Water Draft	3,021.53 Ham
Stage of Ground Water Development	50.03 %	Stage of Ground Water Development	39.55 %

good for both irrigation and domestic purposes. From the samples collected from shallow and deeper aquifers, the ElectricalConductivity (EC) in ground water is generally below 1000 µS/cm at 25^{O} C, except at a few locations. The other chemical parameters are also within the permissible limits.

Contamination of Underground Water in District Solan: Solan is considered as top industrial and commercial district of Himachal Pradesh. The Solan district of Himachal Pradesh has emerged as a hub for various types of industries from last few years. Due to the industrialization of Solan district, lots of economic developments have been made. This economic development leads to increase in the pollution of Solan (Rana and Walia, 2020). This may further increase heavy metal pollution in surface and underground water sources. The hydro geomorphic setup provides low groundwater potential in this area. Groundwater is the only water source for domestic, agricultural and industrial uses. From the past few years the demand of water sources has been increased due to rapid growth of population in Solan. Appropriate measures should be undertaken for sustainable management of water resources, especially ground water resources (Rana and Walia, 2019). But the quality of groundwater in this district is deteriorating with increasing industrialization. The main reason for groundwater contamination in this area is disposal of untreated effluents from industries. The heavy metal analysis suggests high concentration of Fe, Cu, Pb and Mn in groundwater of concerned area. There is a close relationship between the land use type and quality of water (Kamaldeep *et al.,* 2011; Huang *et al.,* 2013; Chauhan *et al.,* 2015). Groundwater aquifers, which are critical sources of both drinking and irrigation water were also affected due to poor land use practices (Buck *et al.,* 2004). The impact of agriculture, urban and forest land use on surface water quality as well as ground water quality reported by many studies. Surface as well as ground water from Solan area is suitable for irrigation and some studies indicated that low sodium hazards and permissible electrical conductivity (EC) values. There was found variation in groundwater quality in Solan area due toseason and it depends upon land use practices also (Gupta *et al.,* 2014). Some studiesin Solan district indicates that various parameters like pH (7.58), Electrical Conductivity (264.74 µS/cm), temperature (17.33°C), BOD (0.75 mg/l), COD (11.11 mg/l), Ca (64.51 mg/l) and Mg (11.69 mg/l) of ground water sources under urban land use, whereas Cl (3.19 mg/l) and NO_3 (3.50 mg/l) were found maximum under agriculture land use. Maximum pH (7.64), temperature (17.42°C), BOD (0.69 mg/l), COD (11.08 mg/l), Ca (64.61 mg/l), Mg (11.64 mg/l) and Cl (4.06 mg/l) in ground water samples were recorded during summer season, whereas electrical conductivity (261.06 µS/cm) and NO_3 (3.37 mg/l) were found maximum during the rainy season. Whereas some reported that the presence of Arsenic (As) in ground water sources in Solan district Some studies of heavy analysis in Solan district indicated that heavy metal is within maximum admissible limit of Bureau of Indian Standards(BIS: IS: 10500, 2012). These studies indicate the maximum concentration of Cd (0.06 ppb), Pb (0.02 ppb) and Fe (0.03 ppb) under urban land use, whereas As (0.15 ppb), Pb (0.02 ppb) and Zn (0.15 ppb) were recorded under agriculture land use for ground water sources in Solan area(Chauhan *et al.,* 2016). As per the studies it can be concluded that common land uses in Solan district did not influence the surface and ground water quality adversely but urban land use affected adversely (Rana *et al.,* 2016).

Conclusion

From the above review author concluded that the major source of the drinking water in the above said districts is groundwater and underground water sources are going to be contaminated in future due to the rapid industrialization. Natural water resources are contaminated with different cations, anions and different hazardous heavy metals likelead (Pb), Arsenic (As), Mercury (Hg) and Iron (Fe) etc. From research studies it has been observed that contamination of underground water is much higher in Solan district of Himachal Pradesh due to the high industrialization of chemical and pharmaceutical companies. The level of contamination of ground water in Kangra and Una is comparatively less but considerable. From above review study, authors suggested to take the issue of contamination in water resources as a wake up alarm. This review suggests the necessity to take some serious steps to save water resources from the contamination, especially in the Solan district. Some useful reforms should be undertaken to control the quality of underground water.

References

Aiyesanmi , A. F., Ipinmoroti, K. O. and Adeeyinwo, C. E. 2004. Baseline geochemical characteristics of groundwater within okitipura south-east belt of the bituminous sands field of Nigeria. *Int. J. Environ. Studies.* 61 (1) : 49-57.

An, Y. J. 2006. Assessment of comparative toxicities of lead and copper using plant assay. *J. Chemosphere. 62* (8): 1359-1365.

Bashir, M. 2012. Health Effects from Exposure to Sulphates and Chlorides in Drinking Water. *Pakistan J. medical and health sciences*. 6(3) : 648-652.

Bharti, D., Sayyad I. A., Gaikwad, G. G., Taikar, D. R. and Dhore, J. 2011. Physico-chemical characteristics of Bore well water quality in Nagpur region (South zone). *J. Chem. Pharm. Res*. 3(2) : 922-927.

Buck, O., Niyogi, D. K. and Townsend, C. R. 2004. Scale dependence of land use effects on water quality of streams in agricultural catchments. *J. Environm. Poll.* 130(2) : 287-299.

Calderon, R. L. 2000. The epidemiology of chemical contaminants of drinking water. *J. Food Chem. Toxicol.* 38(1): 13-20.

Chauhan, A. and Verma, S. C. 2015. Impact of Agriculture, Urban and Forest Land Use on Physico-Chemical Properties of Water A Review. *Int. J. Curr. Microbiol. App. Sci.* 4(10): 18-22.

Chauhan, A., Verma, S. C., Bharadwaj, S. K. and Gupta, K. 2016. Monitoring of Heavy Metals in Surface and Ground Water Sources Under Different Land Uses in Solan, Himachal Pradesh. *Int. J. Agri. Environ. & Biotech.* 7(3) : 613-619..

Dixit, S. and Tiwari, S. 2008. Impact assessment of heavy metal pollution of Shahpura lake, Bhopal, India. ý*Int. J. Environ. Res.* 2(1): 37–42.

Dev, R. and Bali, M. Evaluation of groundwater quality and its suitability for drinking and agricultural use in district Kangra of Himachal Pradesh, India 2019.*J Saudi Soc. Agricult. Sci.* 18 : 462–468.

Gadgil, A. J. 1998. Drinking water in developing countries. *J.Annu. Rev. Environ. Resour.* 23(1) : 253–286.

Gupta, K., Verma, S. C., Thakur, M. and Chauhan, A. 2014. Impact of land uses on surface water quality and associated aquatic insects at Parwanoo area of Solan district of Himachal Pradesh, India. *Int. J. Bio-resource Stress Manag.* 5(3) : 427- 431.

Huang, J., Zhan, J., Yan, H., Wu, F. and Deng, X. 2013. Evaluation of the impacts of land use on water quality: A case study in the Chaohu lake basin. *J. Scienti. World.* 1- 7.

Joshi, D. M. and Kumar, A. 2009. Agrawal, N. Assessment of the Irrigation water quality of River Ganga in Haridwar district. *Rasayan J. Chem*. 2(2): 285-292.

Kamaldeep; Rishi, M. S., Kochhar, N. and Ghosh, N. 2011. Impact of industrialization on groundwater quality - a case study of baddi-barotiwala industrial belt, distt. Solan, Himachal Pradesh, India.*J. Ind. Poll. Contrl.* 27(2) : 153-159.

Mance, G. 1987. Pollution threats of heavy metals in aquatic environment. *London: Elsevier* Applied Sciences. 6th Edition.

Memon, M., Soomro, M. S., Akhtar, M. S. and Memon, K. S. 2011. Drinking water quality assessment in Southern Sindh (Pakistan). *Environ. Monit. Assess*. 177: 39–50.

Rana, A., Bhardwaj, S. K., Thakur, M. and Verma, S. 2016. Assessment of Heavy Metals in Surface and Ground Water Sources under Different Land Uses in Mid-hills of Himachal Pradesh.*Int. J. Bio-Resou. & Stress Manang.* 7 (3): 461-465.

Rana, V. and Walia, Y. K., Gautam, D. and Sethi, V. 2022. Impact of Seasonal Variation on Underground Water Quality in BBN area, Himachal Pradesh, India. *Poll Res*. 41 (2): 310-317.

Rana, V. and Walia, Y. K. 2019. Heavy metals analysis of underground water of BBN area, Solan, Himachal Pradesh. *J. Poll. Res.* 38(4) : 170-175.

Rana, V. and Walia, Y. K. 2020. Investigation and analysis of physico-chemical parameters of underground water of Baddi-Baroutiwala-Nalagharh (BBN) area, India. *J. Eco. Env. & Cons.* 26(2): 715-722.

Sajjad, H., Rashid, S., Prasad, S. and Suddin, R. 2013. Assessment of Groundwater Quality in Meerut City, India. *Int. J. Environ. Protect.* 3 : 20-26

Sharda, A. K. and Sharma. M. P. 2013. Water quality assessment of Swan River in Himachal Pradesh, India. *Int. J. Environ. Sci.* 4(3) : 402-414.

Sullivan, A. B., Synder, D. M. and Rounds, S. A. 2010. Controls on biochemical oxygen demand in the upper Klamath River, Oregon. *J. Chem. Geol.* 269 : 12-21.