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GROUND WATER QUALITY AND LEVEL IN HARYANA, INDIA: A REVIEW

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Abstract

The quality and level of ground water in Haryana state of India is reviewed in this paper. As concentrations of harmful ions and micro-organisms in some part of Haryana was found to beyond the maximum allowable limit for drinking water in India. Due to industrialization and urbanization, there is a maximum demand of water in Haryana. To fulfil this demand maximum population was found to depend heavily on groundwater, as surface water resources in Haryana are limited and fully utilized. The analysis done by different researchers proved that, the quality and level of ground water in Haryana is continuously declining due to industrialization, urbanization, microbial contamination and impact of weather. The present review aims to summarize the status of ground water level and quality, challenges and need of research to improve groundwater level and quality in Haryana, India based on available literature.

Key words: *Ground water, level, irrigation, contamination, Haryana.*

Introduction

Water is one of the essentials of 'Panchatattva' required to build up the human body. Almost 75% by weight of living plants and animals constituted by water. It plays major role in every life function like-digestion, circulation, excretion etc. The water available on the earth can be classified into two categories 1) Surface water and 2) Ground water. The water which percolates through soil, sand and rock and is stored below the ground is called ground water. Statistical data shows that total fresh water available on the earth in liquid form is 10.7 K km^3 , out of which ground water constitute about 98% i.e. 10.5 K km^3 [1]. Water plays important role in the development of any country. Generally, surface water is used in agriculture and irrigation sector. But in past few years surface water is get polluted by both natural as well as man-made activities. The waste produced by industries contains harmful toxic chemicals and pollutants like mercury, sulphur and lead. Many industries do not have proper effluent treatment system and drain the waste into fresh water bodies such as lake, canal, river and sea. The toxic chemicals have capability to change the physico-chemical properties of water.

Volcanic eruptions and earthquakes have also known to alter the properties of water and contaminate it. When such polluted water come into main stream of drinking water it causes severe health hazards. Besides this, polluted water also degrades the soil fertility and decreases crop productivity [2-4]. Due to pollution hazards and irregularities of rainy season, the ground water is an economic resource since last few years. The ground water is one of the most important factor in increasing food production and achieving food security in India. Moreover, statistical data revealed that about 60% of food production depends on groundwater [5]. Therefore quality of ground water plays a major role in controlling water quality, public health and environment.

The general cropping pattern of Haryana is rice and wheat. For cultivation of paddy, flooding method of water irrigation is generally used, which requires large amount of water. The result of which there is continuous depletion of ground water level. Moreover, chemical fertilizers were used to increase productivity, which deteriorate quality of water and fertility of soil. Therefore in order to meet quality fresh water for diverse purposes, it is necessary to monitor the ground water quality time to time. The physico-chemical analysis of ground water on drinking water standards and the problem of pollution due to presence of heavy metals have been studied by several researchers (Manchanda H. R. 1976; Manchanda et al. 1978; Kakkar 1981; Tanwar B.S. 1988; Chand et al. 1993; Sharma D.R. 1998; Yadav R. P. 1999; Yadav A. K. 2000; Kumar M. 2003; Phogat et al. 2004; Singh D. 2005 [6-16]. The secondary data available in the literature was studied in the present work in which an attempt have been made to analyze the impact of urbanization, pollution, cultivation of water hungry crops on ground water level and its quality in the Haryana state of India.

Description of the study area

The geographical location of the Haryana state in India is shown in figure 1.

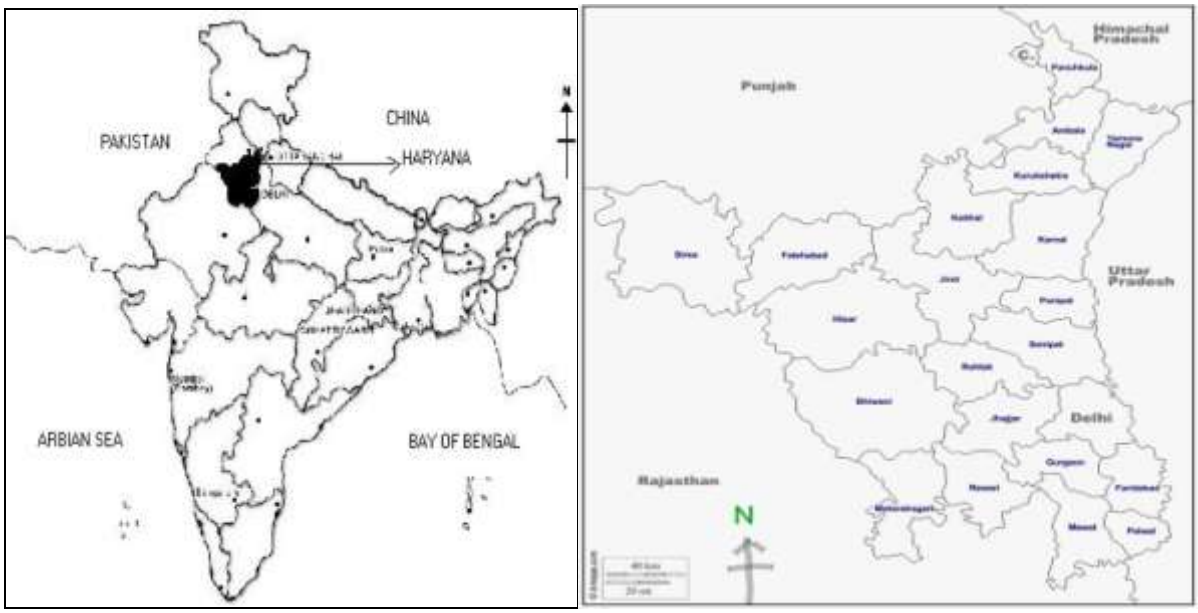

FIGURE. 1.Location mapsof study area

Haryana is a land-locked state in the northwest of India and is located between $27^{o}39^{'}$ and $30^{o}35^{'}$ N latitude and between $74^{o}27^{'}$ and $77^{o}36^{'}$ E longitude with just 1.37% of the total geographical area. Ground water has significant role in the growth of irrigated agriculture development in the state of Haryana. About 98% of the cultivated land is irrigated through tube-wells. Statistical data shows that about 50% of the total geographical area is severely affected by the problems of accretion, salinity and waterlogging.

Ground water development

The amount of ground water available for actual use is indicated by the term "Ground water development". More the ground water development less will be the ground water availability. The ratio of the annual ground water extraction to the net annual ground water availability is called ground water development [17].

$$\textbf{Ground water development} = \frac{\textbf{The annual ground water extraction}}{\textbf{The net annual ground water availability}}$$

During the year 2009, the total ground water availability in Haryana was9.80 lakh hectare meter [18]. Figure 2 illustrates the unequal availability of ground water among the districts of Haryana. Out of this annual available ground water the district wise availability and consumptionof ground water in agriculture, domestic and industrial sector is shown in the table 1.

FIGURE 2:District wiseground water availability in Haryana.

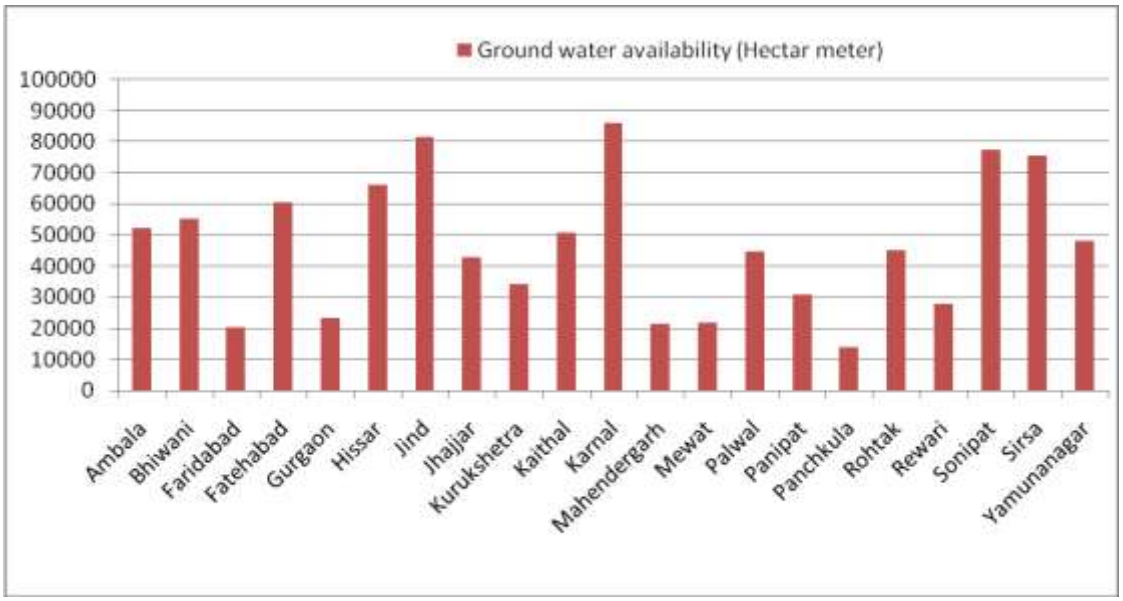

TABLE 1.District wise ground water development in Haryana.

District	Ground waterAvailability (Hectare meter)	Ground waterConsumption for Irrigation (Hectare meter)	Domestic and Industrial consumption of Ground water (Hectare meter)	Total consumption of Ground Water (Hectare meter)	Ground water development (%)
Ambala	52244	41583	7710	49293	94.35
Bhiwani	55138	43068	756	43824	79.48
Faridabad	20228	14118	2232	16350	80.83
Fatehabad	60605	107316	1403	108719	179.39
Gurgaon	**23261**	**35777**	**18150**	**53927**	**231.83**
Hisar	66249	59836	449	60285	91.00
Jhajjar	42718	40751	192	40943	95.84
Jind	81714	77363	3510	80873	98.97
Kaithal	**50783**	**101504**	**6242**	**107746**	**212.17**
Karnal	85904	118899	1244	120143	139.86
Kurukshetra	**34323**	**67904**	**6732**	**74636**	**217.45**
Mahendragarh	21437	22453	388	22841	106.55
Mewat	21623	13280	1173	14453	66.84
Palwal	44771	45892	999	46891	104.74
Panchkula	13876	9072	2790	11862	85.49
Panipat	30865	50961	494	51455	166.71
Rewari	27999	31255	116	31371	112.04
Rohtak	45017	28446	2297	30743	68.29
Sirsa	75452	115634	776	116410	154.28

Sonipat	77426	90622	3913	94535	122.10
Yamuna Nagar	48199	55077	10215	65292	135.46
Haryana	**979832**	**1170811**	**71787**	**1242598**	**126.82**
Source: BVAAP, June 2015.					

The statistics given above reflect that, ground water development is too much high in the districts of Gurgaon, Kaithal and Kurukshetra, where ground water development is more than 200%. In future, if precautions are not taken to reduce the use of ground water then these three districts will face the problem of scarcity of water. The observed ground water development in the districts of Fatehabad, Karnal, Mahendragarh, Palwal, Panchkula, Rohtak, Sonipat, Sirsa and Yamunanagar is more than 100%. In the districts of Ambala, Faridabad, Hisar, Jind, Jhajjar and Panipat the ground water development is 80% and above. In the rest of districts, the ground water development is below 80%. Overall, the ground water development in the state of Haryana is 126.82%. This indicates that in the state of Haryana, the annual ground water extraction is more than annual ground water recharge. This has resulted in declining water table in various regions of the state and now become a serious threat in socio-economic development. The cultivation of water hungry crops like paddy and sugar cane in certain regions of the state continuously declines the ground water level. Apart from cropping pattern, the ground water extraction through tubewells is equally responsible for declining ground water level.

Ground water quality and contamination

The quality of ground water mainly depends upon the climatic conditions particularly rainfall as well as composition of parent rocks and soils. Table 2 shows the observations by the different researchers when they have assessed the physico-chemical properties of ground water from different parts of Haryana to study its quality status.

TABLE 2. Physico-Chemical characteristics studies of ground water in Haryana.

Authors	Area	Physico-chemical characteristics	Observations
Manchanda H.R. (1976)	Gurgaon	pH, Fe, Mn, Al, F, SO_4^{2-}, NO_3^-, TDS and hardness	Reported that the processing of metal ore and fuel contaminates both surface and sub-surface water with Fe, Al and SO_4^{2-} in Arawali and Dhosi hill. Also observed that the ground water in parts of Gurgaon contains excessive concentrations of Mn, F^-, nitrates and TDS. The water from Mewat areas shows increase in hardness due to $CaCO_3$ composition in rock.

Manchanda et al. (1978)	Rewari	NO_3^-	Observed the huge concentration of nitrates due to anthropogenic activities and noted that sub-surface water from Pataudi is permeable to pollution.
Kakkar Y. P. (1981)	Southern and S-W Haryana	NO_3^-	Concluded that ground water from Farukhnagar city was acidic in nature and was greatly contaminated by nitrates.
Tanwar B.S. (1988)	South Haryana	Hardness, Alkalinity and Salinity Hazard	Reported that the quality and quantity of ground water in southern part of Haryana shows larger deviation along horizontal and vertical direction depending on rainfall pattern and composition of parent rock. Also noted that about 34% of total area in Haryana irrigated with tube well water.
Chand et al. (1993)	Rewari	EC and SAR	Comparatively studied the ground water quality among the five villages of Rewari district and reported that 52% water belonged to the sodic category in Aslwas followed by Shahpur (43%) and Bawal (27%). The proportion of saline and sodic waters was maximum in Kasanwas (100%) followed by Bawal (19.4%) and Aslwas (9.5%).
Sharma D.R. (1998)	Kaithal	EC and SAR	Surveyed, assessed and classified underground water resources in Kaithal district as 29.6% good, 13.9% marginally alkali, 22.8% alkali and 17.8% highly alkali.
Yadav R. P. (1999)	Mahendragarh	pH, EC, RSC, ESP and SAR	Observed that majority of ground water were good (34.4%), marginally saline (5.4%), saline (8.9%), high SAR-saline (2.6%), marginally acidic (4.9%), acidic (12.7%) and highly acidic (14%) in nature.
Yadav A.K. (2000)	Hisar	EC and SAR	The electrical conductivity and SAR of the underground water samples found to range between 0.45-3.35 dS/m and 0.15-22.40 $(m/ML)^{1/2}$ respectively.
Kumar M. (2003)	Jind	EC and RSC	The ground water from Safidon block of Jind district was found to have EC and RSC ranged from 0.5-10.9 dS/m, 0.4-10.0 me/L respectively and also reported that among poor quality water samples, 9% saline, 19% sodic and 20% were saline-sodic.
Phogat et al. (2004)	Hisar	Na^+, Ca^{+2}, Mg^{+2}, Cl^-, CO_3^{2-}, HCO_3^- and EC	Concluded that the concentrations of Na^+, Ca^{2+} and Mg^{2+} ions generally increased with increase in electrical conductivity. The water samples were found to have appreciable amount of Cl^- and HCO_3^- while CO_3^{2-} was found in traces.

Singh D. (2005)	Karnal	EC, RSC and SAR	Observed that EC, RSC and SAR for water of a sand block of Karnal district of Haryana was ranged from 0.48-6.52 dS/m, 0-18.10 me/L and 0.26-19.86 $(m/ML)^{1/2}$ respectively.

EC = Electrical Conductivity, **RSC** = Residual sodium carbonate index,

SAR = Sodium adsorption ratio, **ESP** = Exchangeable sodium percentage.

The quality of ground water is greatly affected by contamination. Ground water contamination is the presence of certain pollutants in ground water that are in excess of the limits prescribed for drinking water [19]. The commonly observed contaminants include iron, fluoride, arsenic and nitrate which are a result of geological processes that happen within the earth crust. Other contaminants include fertilizers, pesticides, heavy metals and bacteriawhich are a result of human activities like agricultural practices, domestic and industrial effluents. The Central Ground Water Board (CGWB) in 2013 evaluated and reported characteristics of ground water in Haryana and observed that the levels of iron, chromium, copper, cadmium, nickel, lead, arsenic and nitrate exceeded the BIS and WHO guide limit for drinking water. CGWB also reported that the concentration of As, Pb, Fe and Zn was found to be high in both surface and sub-surface water spring in Yamunanagar. This increase in concentration of heavy metals is due to contamination of ground water by industrial processes such as manufacturing of fertilizers, pesticides, dyes, electroplated metal parts, batteries and alloys.

Conclusion

Haryana is an agrarian economy primarily requires good quality ground water for fast growing industry, tourism and urbanization. In the present work an attempt has been made to focus the issue of declining ground water quality and level in Haryana. The study noticed that, quality and level of ground water in Haryana is declining rapidly. In last four decades, the rising demand for ground water from agriculture sector is one of the causesof over-exploitation. The cropping pattern and cropping intensity didn't take into account of ground water availability. Over the years the amount of domestic and industrial effluents increased and resulted in contamination of ground water. It is seen from the collected data that nearly 76% of all district in the state of Haryana have issues related to either quality of ground water, or availability of ground water, or both. So, steps should be taken to conserve and to monitor ground water continuously in the state of Haryana. Ground water level can be increased by roof top harvesting and by enriching annual recharge capacity. The technology related to sustainable use of ground water should be developed. The policies related to sustainable management of ground water resources should be implemented by the local governing bodies. To control extraction and pollution of ground water, penalties need to be

levied for violations of water quality standards. Overall, the efforts towards conservation, development and management of ground water resources should have to be taken to control the issues such as over-exploitation, depletion and pollution of ground water in Haryana.

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