Journal of Advances in Science and Technology
Vol. III, No. V, May-2012, ISSN 2230-9659

Review Article

Status of Groundwater Level in Catchment Area of Yamuna River in Haryana

Vijay Singh

Associate Professor Deptt. Of Geography Govt P. G. College, Ambala Cantt

---

INTRODUCTION

There is no doubt about the importance of water in life. No water means no possibility of life. Hence water is considered as the lifeline of any organism or plant. Due to heat, water evaporates and goes to atmosphere, then comes back in the form of shower on earth, some amount of this water percolates in the ground while rest of it drains off. This amount of percolated water recharges the underground water level but due to unpredictable rain and exploiting of more ground water, the recharging of ground water is not uniform all over the world. The water level is going downward very speedily with the advancement of time. Most of the parts of India are facing the same kind of situation. Haryana is one of the states where drinking and irrigation water scarcity is taking place and going miserable day by day. At a glance population of Haryana has increased drastically in a short span of time. In 1971 it was 1,00,36,431, which has increased to 1,29,22,119 in 1981 and 2,11,44,564 in 2001 showing a growth of 111%. The area sown under different agricultural crops has increased from 1176 thousand hectares in 1966-67 to 2854 hectare in 2008-09 showing a growth of 42%. Hence water requirement is increasing continuously for agriculture.

To keep the right combination between demand and supply of water to the public sector, industrial and agriculture sector, the digging/installing of new tube well is very common all over the state. Up to 1975 there were no tube wells in Haryana and exploitation of ground water started in 1975 when 682 th. hec. area was irrigated by thousand tube wells only. The exploitation of groundwater started after this era and the area irrigated by tube wells reached up to 1561 th.hec. during 2008-09 registering a growth of 129%. Besides it, there were only 100 public water supply and sewage in 1980-81 this number has increased upto 8975 in 2004-05. Due to exploitation of ground water and less recharging rate, the water availability in the upper soil strata has been almost over. People have shifted from wells, ponds, lakes and canals to groundwater in last two decades. At present the situation is becoming very critical because to meet the water requirement, the submersible pumps are installed consequent upon failure of shallow fitted pumps

GLOBAL GROUNDWATER SCENARIO:

In the past, wars have been fought between countries over gold, black gold (petroleum), land and sea. But now it has been predicted that the wars of the coming millennium will be fought over water because this vital resource has become increasingly scarce and threatened. Water is becoming a scarce commodity all over the world. Due to its scarcity, it is often the source of conflicts among neighbours, disputes among sovereign states, confrontations among countries and even war among larger groups. United Nations has clearly recognized the importance of fresh water as one of the critical resources under threat from environmental degradation all over the world. Despite recognition and promises made by all countries the situation has not improved. While in 1950 the council estimated that only 12 countries with a total of 20 million people suffered from water shortages but this figure increased more than two folds and affected 26 countries in 1990 with the suffered population increasing to more than 300 million. During this period of 40 years, the suffered population has increased by 15 folds. The council has projected that by 2050 about 65 countries will be hit by water supply problems with a total of 7 billion or 60 percent of the world's population affected. This is alarming considering the fact that water is a basic necessity in life.

There is no life without water. Approximately 71% of the earth's surface is covered with water, of this, 97.3% is ocean water and balance 2.7% is fresh water, 77.2 % of the freshwater is frozen in the polar ice caps and in the glaciers. Groundwater and soil moisture constitute 22.4 % of global freshwater. This is the situation at global level.

GROUNDWATER SCENARIO IN INDIA:

When the availability of this scarce resource is analyzed in India, it is unlike any other countries of the world as rainfall is highly erratic, uneven and inadequate. Nearly 75 % of the total annual rainfall occurs during 4 to 5 months of rainy season and rests of the months remain dry. The annual rainfall is 1150 mm equivalent to 4000 cu kms and most of which occurs during the month of rainy season. The rivers flowing in from neighbouring countries contribute 20 mham. Net evaporation losses are nearly 200 mham and 135 mham is available on the surface and the remaining recharges groundwater. Thus there is a shortage of water for irrigation, power generation and industries in remaining period of the year. As the use of water is increasing, the demand is also increasing, so water is very scarce in many states of India. More than 70% population lives in rural areas, arid and semi-arid regions where they suffer from scarcity of water year after year. At the time of independence, only 6 percent of rural people had access to safe water which has gone upto 85%. But the per capita availability of renewable freshwater in the country has fallen drastically over the last 50 years. The annual per capita availability of renewable freshwater in the country has fallen from around 5277 cu meters in 1955 to 2245 cu. meters in 2001 and the projected value in 2025 will be 1000 cu meters. The situation is labelled one of water scarcity. By 2025, water scarcity in India will be acute. Accordingly to Prof Falkcumark, 100 liters a day is the minimum per capita water requirement for our basic human needs. Agriculture, industries and energy is roughly 5-20 times that of human requirements. Though there is plenty of water in nature in rural areas, it cannot be used directly due to pollution. The polluted water is one of the main problems of using water directly from the nature in both rural and urban areas. So there is too much of dependency on groundwater for drinking and other purposes. This is also preferred due to its easy availability at the point of consumption. Thus, pressure on groundwater has increased many folds during the past few decades. In many parts of India, groundwater is being used excessively and indiscriminately for years and hence there has been a rapid depletion of groundwater and water table has gone down substantially.

Although, India is endowed with sufficient water, there are significant variations in the spatial and temporal availability. There were 1, 50,000 villages where potable water was not available in 1972, this rose to 2,31,000 in 1980 and in 1997, there were 61,747 problem villages in the country where potable water was not available. According to latest statistics about 15,000 villages are still without any source of potable water, 2,00,000 villages are partially covered by drinking water schemes and 2,17,000 villages reported problems with the quality of water.

At the time of first five years plan, 6 percent of rural population and 48 percent of the urban population had access to safe drinking water and in 1994-95; about 82 percent of rural population was covered. In 2001, about 81% of the country's total population had access to safe water. As the table.1 reveals that economically exploitable groundwater share were about 45 percent of total water budget in India and the percentage already being used was more than 20 percent in 2001. Rivers share about 35 percent to the total water budget but the flow of water in the rivers vary widely. The catchments area of rivers get benefited as the water table is high in this area but the areas situated far from catchments areas remain dry as India has limited water storage facility or reservoirs.

TABLE.1: WATER BUDGET 2001 IN INDIA

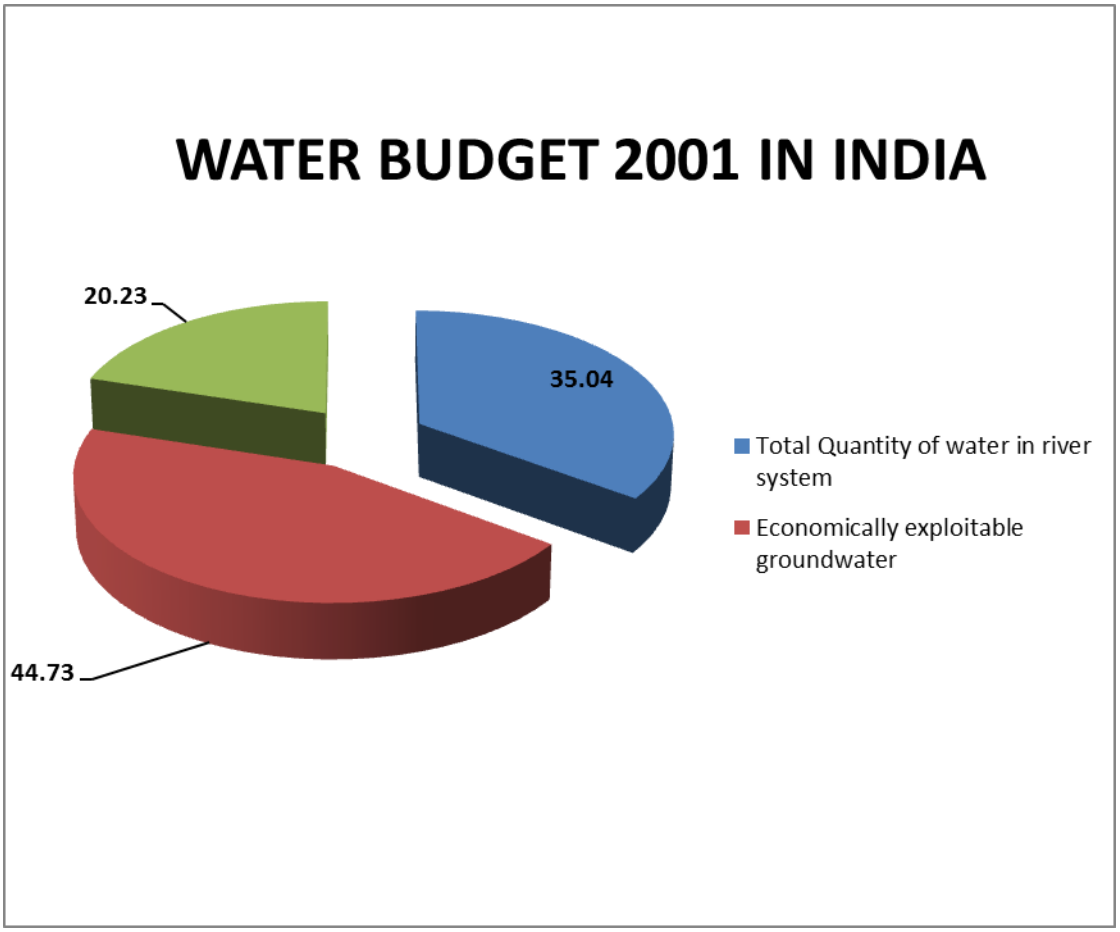
Sr. No.	Items	Water resource (millions cu m)	Percentage to total
1	Total quantity of water in river system	1,64,500	35.04
2	Economically exploitable groundwater	2,10,000	44.73
3	Groundwater already being used	95,000	20.23
Total		**4,69,500**	**100.00**

Source: Water Resource in India and Its Sustainable Management

GROUNDWATER SCENARIO IN HARYANA:

When this scarce resource is studied in haryana, its use is increasing due to high growth of population, increasing number of residential areas, increasing its use in agriculture and rapid industrial development. Based on yield potential characteristics of aquifers, the state can be divided into three zones. Haryana state consisting of 21 districts/119 blocks, covering an area of 44, 212sq.km, experiences an average annual rainfall of 573 mm whereas

the national average is 1150 mm during the period from 1991-2008.



Source: water resource in india and its sustainable management

The first aquifer comprises of 26,090 sq.km in parts of sirsa, hisar, bhiwani, mahendergarh and jind districts where tube well can yield between 50-100 m3/hr. The second aquifer falls in parts of hisar, kurukshetra, karnal, bhiwani and gurgaon districts, covering an area of 7100 sq.km. Tube wells in this zone, can yield between 50-150 m3/hr. The third one extends by 9200 sq.km. In parts of ambala, kurukshetra, karnal and sonipat districts, where the yield varies between 150-200 m3/hr. An area of 1660 sq.km in parts of gurgaon, bhiwani and mahendergarh districts is underlain by consolidated formations, where the yield prospects of aquifers are limited. The state experiences an average annual rainfall which is half of national average and it is only 325 mm in south-west part of haryana. The area selected for the study is a part of second segment of yamuna river lies between hathnikund/tajewala barrages to faridabad. The districts along yamuna river are yamunanagar, ambala, kurukshetra, karnal, panipat, sonipat and faridabad forming a catchment area.

Table.2: district wise water availability from rainfall in catchment area of Yamuna River in haryana (on the basis of normal rainfall)

Sr. No. (1)	Districts (2)	Rainfall (mm) (3)	Area in Sq. km (4)	Total Precipitation (BCM) (5)
1	Yamunanagar	1108	1768	1.959
2	Ambala	1078	1574	1.697
3	Kurukshetra	702	1530	1.074
4	Karnal	724	2538	1.838

5	Panipat	621	1268	0.787
6	Sonipat	624	2122	1.324
7	Faridabad	603	2151	1.297
	Total of the Catchment	**780**	**12951**	**9.976**
	area			
	Total of state	**613**	**44212**	**24.6**

District wise water availability from rainfal in catchment area of river Yamuna

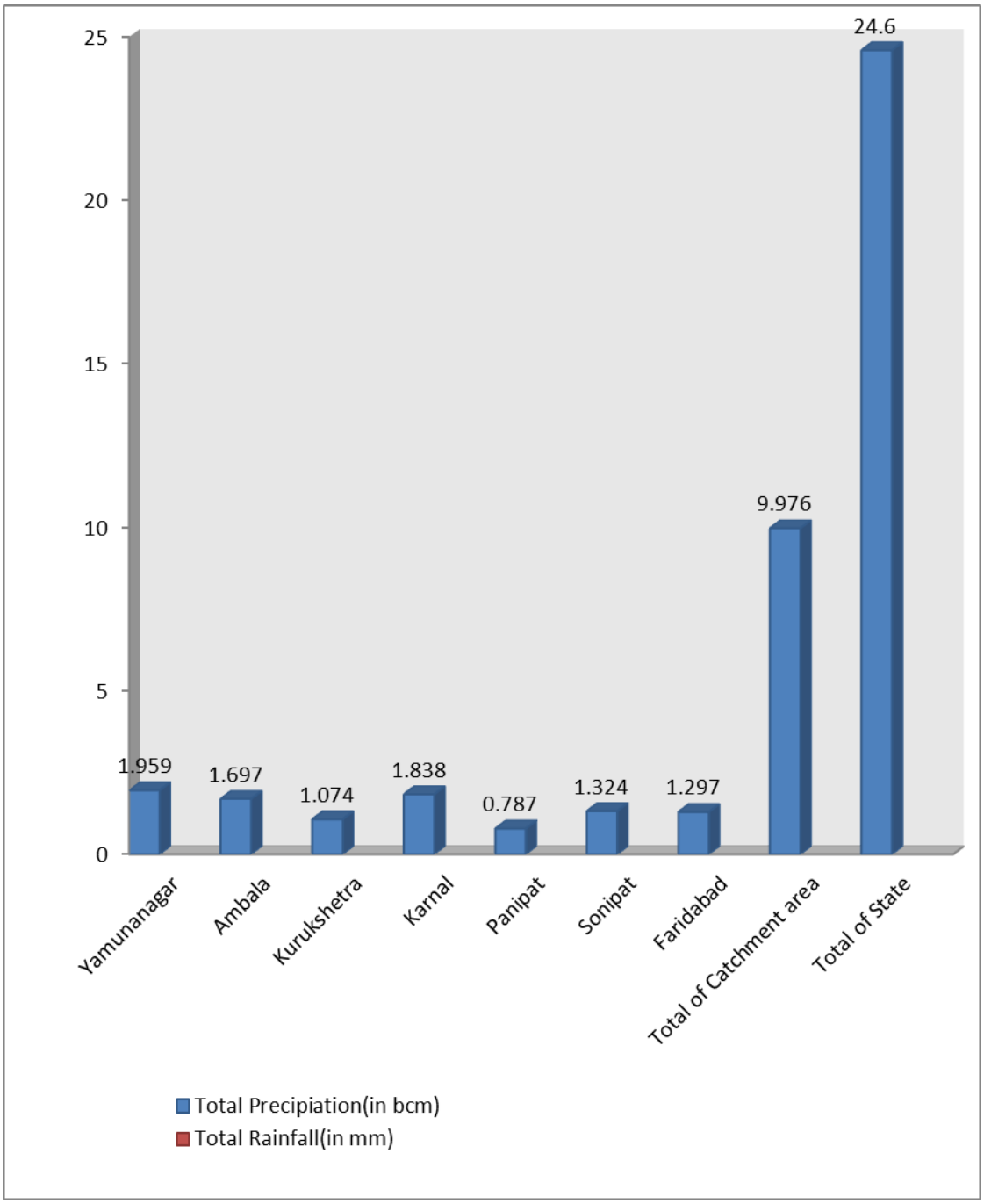
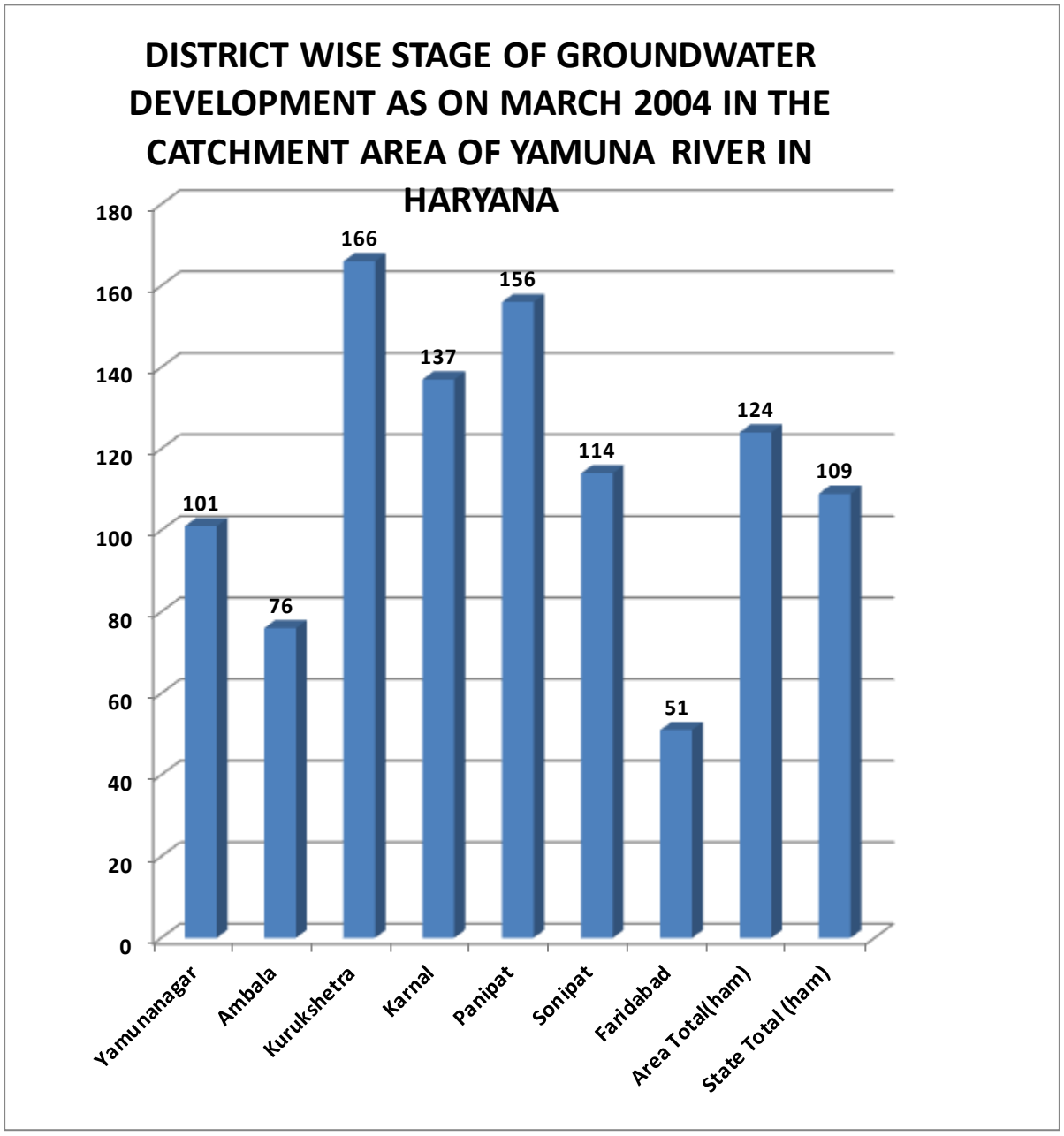


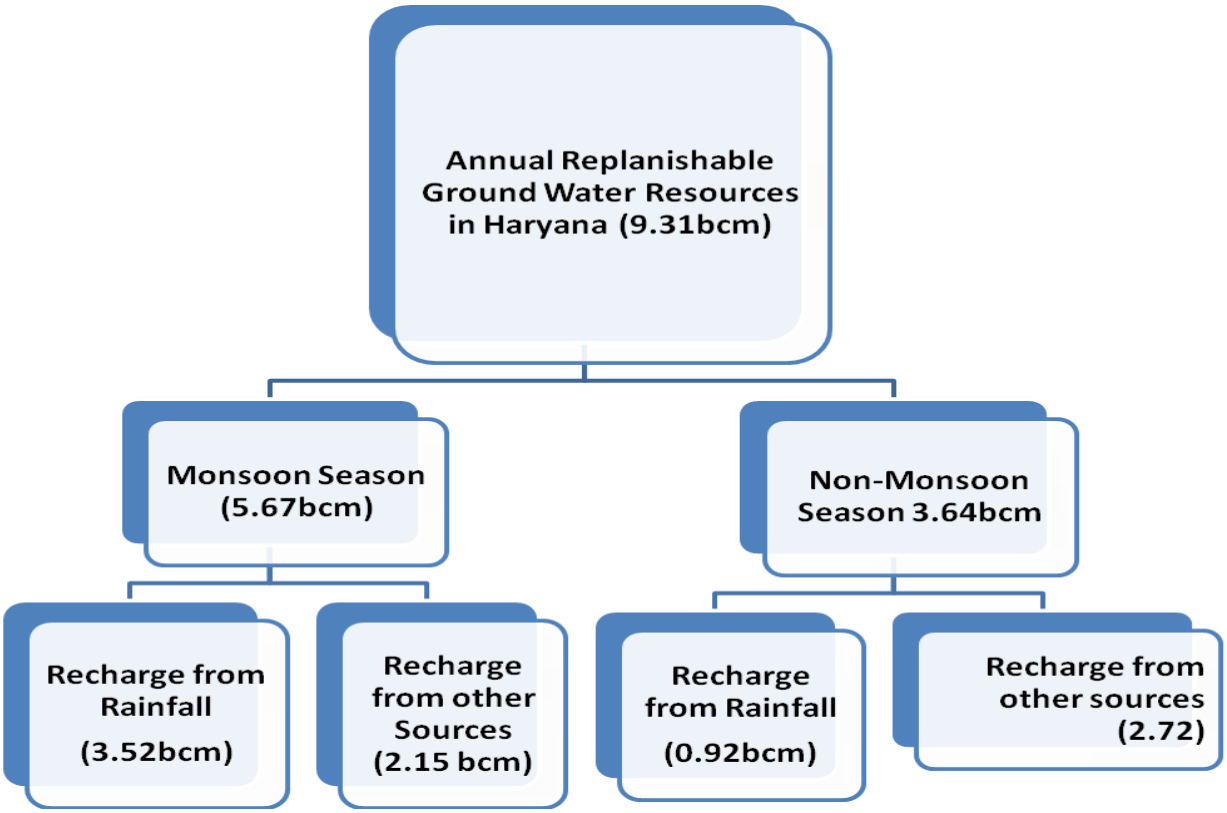
Table 2.3: District-wise Groundwater Resources: Availability, Utilization and Stage of Development in the catchment area of Yamuna River

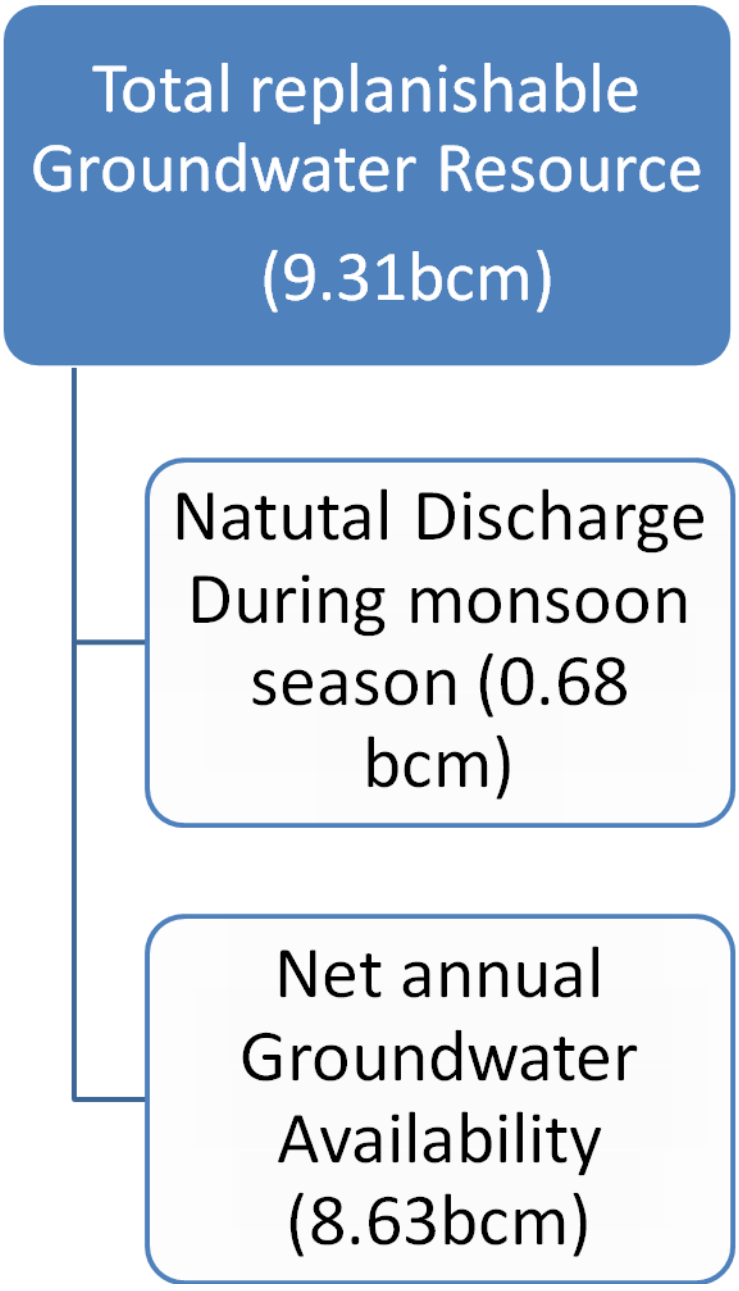
Districts	Annual Replenish able Ground Water Resource				Total	Natural Discharge During monsoon season	Net annual Groundwater Availability	Annual Groundwater Draft			Projected demand for domestic and industrial uses up to 2025	Groundwater availability for future irrigation	Stage of ground water development %
	Monsoon Season		Non Monsoon Season										
	Recharge from Rainfall	Recharge From other Sources	Recharge from Rainfall	Recharge From other Sources				Irrigation	Industrial and Domestic Use	Total			
Yamuna nagar	30404	9086	9165	8151	56806	5681	51125	48333	3315	51648	4841	-2048	101
Ambala	30521	8483	9196	6328	54528	4481	50047	33975	3840	37815	5914	10157	76
Kurukshetra	16818	12111	4588	9717	43233	2795	40439	64196	2778	66974	4167	-27924	166
Karnal	35242	26543	5316	26371	93476	5621	87850	119235	1245	120479	1854	-33238	137
Panipat	14810	8454	2609	10260	36132	3189	32942	50939	496	51435	897	-18894	156
Sonipat	15126	11589	5507	15101	47324	2366	44958	48179	2913	51110	4309	-7531	114
Faridabad	19817	12563	4576	21025	57972	2899	55074	26811	1002	27813	2023	26239	51
Area Total (ham)	162738	88829	40957	96953	389471	27032	362435	391668	14687	407274	24005	-53239	124
Area Total (bcm)	1.7	8.9	0.5	0.97	3.90	0.28	3.62	3.92	1.47	4.08	0.2	-0.53	1.24

State Total (ham)	35179	214904	92441	271902	931038	67862	863177	909732	35353	945085	60000	-106555	109
State Total (bcm)	3.52	2.15	0.92	2.72	9.31	0.68	8.63	9.1	0.35	9.45	0.6	-1.07	1.09

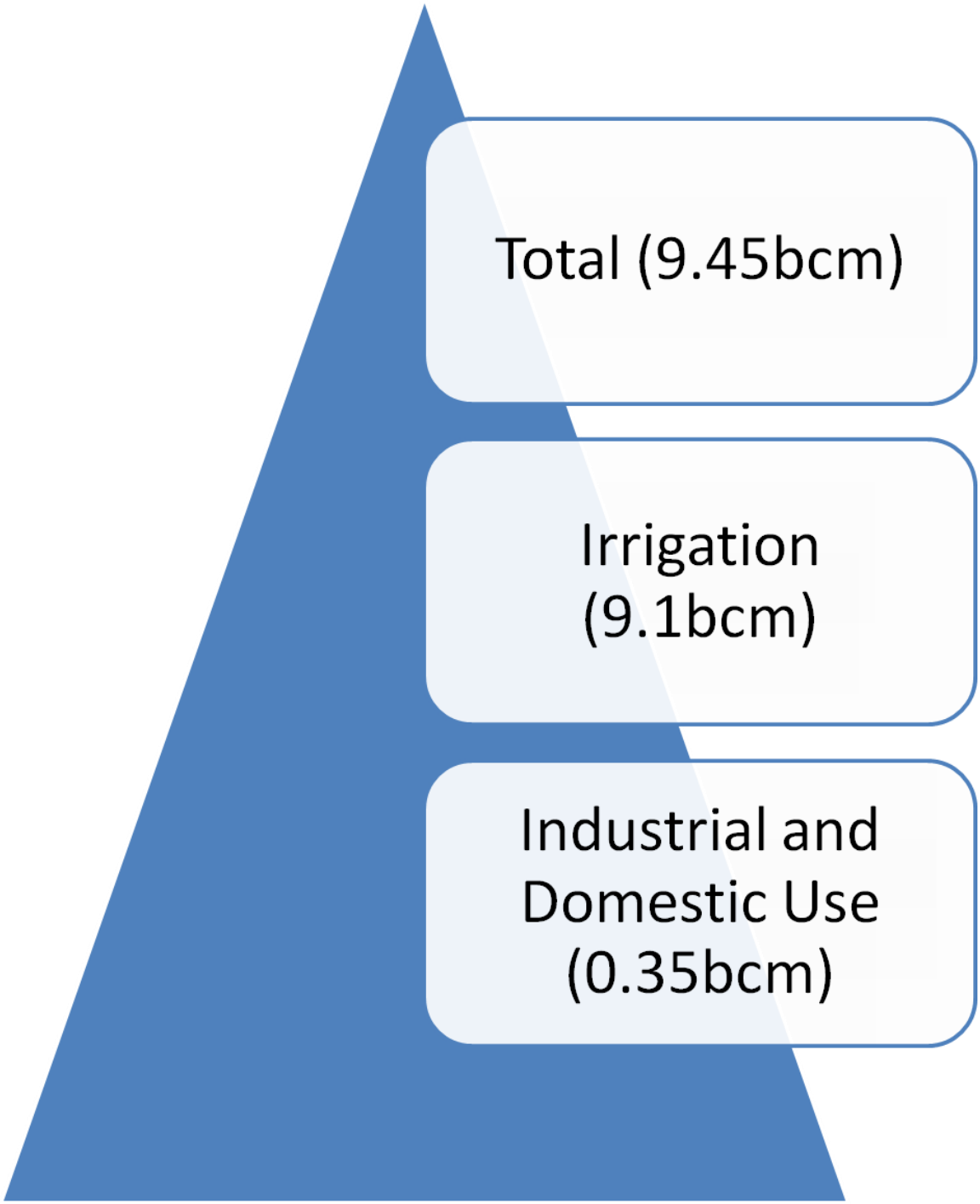


Annual replenishable ground water resources in Haryana


Annual Replanishable Ground Water Resources in Haryana (9.31bcm)
Monsoon Season (5.67bcm)
Non-Monsoon Season 3.64bcm
Recharge from Rainfall (3.52bcm)
Recharge from other Sources (2.15 bcm)
Recharge from Rainfall (0.92bcm)
Recharge from other sources (2.72)



Annual replenishable groundwater resource in Haryana



Annual replenishable groundwater resource in haryana

When water availability is analyzed in the form of rainfall, table 2 shows that faridabad, karnal, kurukshetra, panipat, sonipat districts have experienced rainfall of less than 1000 mm followed by yamunanagar and ambala experiencing more than 1000 mm rainfall but this is still less than the national average, hence this entire belt of haryana is facing water scarcity.

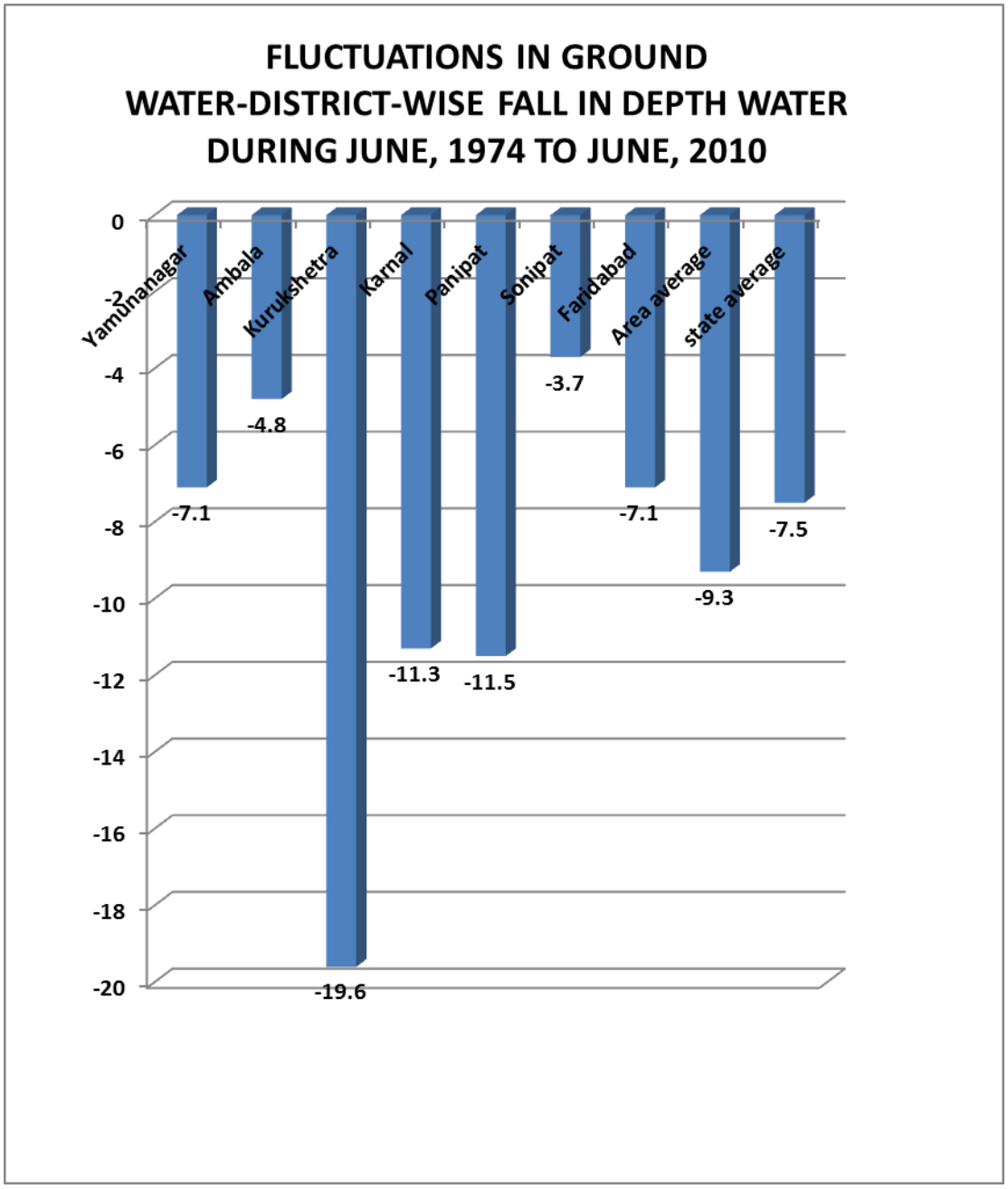
Table.3 shows that the annual replenish able groundwater resource n haryana is 9.31b.c.m, whereas the natural discharge is 0.68bcm hence the net annual groundwater availability is 8.63bcm in haryana. Annual groundwater

draft is 9.45bcm which includes 9.10bcm for irrigation and 0.35bcm for industrial and domestic use. When annual replanishable groundwater resource is analysed in catchment area, it is 3.9bcm, whereas the natural discharge is 3.62bcm in this area. Annual groundwater draft is 4.08bcm which includes 3.9bcm for irrigation and 1.6bcm for industrial and domestic use. Which shows that 96% ground water is utilized for irrigation in catchment area. When stage of groundwater development is analyzed in catchment area it is more than 100 percent in karnal (137), kurukshetra (166), panipat (156), sonipat (114), and yamunanagar (101). Most of the blocks in these districts are over exploited and declared dark zones. Though the stage of groundwater development is less than 100 percent in ambala and faridabad, but facing groundwater quality problems.

Table.4 fluctuations in ground water-district-wise average depth to water during june 1974, june-2010 and october-2010(in mtrs)

Sr. No.	Districts	Jun-1974	Jun-2010	Oct. 2010	June 1974 to June 2010	Seasonal fluctuation June - Oct. 2010
1	Yamunanagar	6.3	13.3	10.2	-7.1	3.2
2	Ambala	5.8	10.6	8.4	-4.8	2.3
3	Kurukshetra	10.2	29.8	30.0	-19.6	0.0
4	Karnal	5.7	17.0	15.1	-11.3	0.8
5	Panipat	4.6	16.0	15.4	-11.5	0.6
6	Sonipat	4.7	8.3	6.6	-3.7	1.7
7	Faridabad	6.4	13.6	12.9	-7.1	0.65
	Area average	6.2	15.5	14.8	-9.3	1.3
	State Average	9.2	16.7	15.4	-7.5	1.3

Source: - department of agriculture, Haryana



The table.4 shows that average depth to water has gone down by 20 meters in kurukshetra, during the period from june, 1974 to june, 2010, followed by karnal (11.0m), panipat (11.5m), where it has gone down by 10 to 15meters. Ambala (4.8m), yamunanagar(7.1m), sonipat (3.7m) and faridabad (7.1m) districts have experienced average depth to water upto 10 meters. Out of 21 districts in haryana, the entire seven districts in the catchment area of yamuna river have shown fall.

The table.5 shows that as per report of cgwb 2004 out of 113 blocks assessed 55 blocks (49%) were over exploited, followed by 11(10%) blocks critical and 5 blocks (4.4%) semi critical. Yamunanagar, faridabad, karnal, kurukshetra, panipat and sonipat districts though lying in catchment area of yamuna river but out of 37 blocks assessed, their 22 blocks were declared over exploited/dark zones. The reason of over exploitation of ground water is multiple water intensive crops grown in this area and heavy industrial use in panipat and yamunanagar. 100% need of

drinking water is met from groundwater. The table also shows that 63% blocks in haryana are facing water crisis. In the catchment area, out of 37 blocks assessed 22 blocks are over exploited followed by 3 blocks critical and 2 blocks semi-critical. People are withdrawing excess water from the ground which has led to the declining water levels, going further deep by using submersible pumps has even brought fluoride concentration in underground water(1). A study conducted in some villages of haryana (2) & (3) prove that the fluoride concentration in groundwater of villages varied from 0.3 to 6.9 mg/l in jind district and 0.034 to 2.09 mg/l in rohtak district. Various other quality parameters such as ph, electrical conductivity, total dissolved salts, total hardness, total alkalinity, sodium, potassium, calcium, magnesium, carbonate, bicarbonate, chloride and sulphate, the analytical results indicated considerable variations among the analyzed samples with respect to their chemical composition. Majority of the samples do not comply with indian as well as who standards for most of the water quality parameters measured. Overall water quality was found unsatisfactory for drinking purposes upto first aquifer. Hence, haryana state is facing acute water scarcity due to uneven, unpredictable rainfall, over exploitation of ground

1. The Hindu, 16th October, 2007
2. Meenakshi, Garg V.K., Kavita, Renuka, Malik. Groundwater quality in some villages of Haryana, India: focus on fluoride and flurosis.
3. Bishnoi M, Arora 3, 'Potable groundwater quality in some villages of Haryana, India: focus on fluoride'

Water, pollution of groundwater. Serious water quality problems are faced due to application of over dose of chemical fertilizer, pesticide/weediside and existence of hard metals due to submersible pumps.

Table.5: block wise status of ground water development in the catchment area of river yamuna in haryana as on 31-03-2004.

Categorization/Development of Ground water in % age					
Sr. No.	**Name of Districts**	**Safe (70)**	**Semi Critical (70-90)**	**Critical (90-100)**	**Over –exploited (> 100)**
1	**Yamunanagar**	1)Bilaspur	1) Chachraul l 2) Sadhaura	-	1)Jagadhari (2)Mustafabad (3) Radaur
2	**Ambala**	1Shahzadpur 2.Ambala 3Naraingarh	-	1)Barara	
3	**Kurukshetra**		-	-	(1)Babain (2) Ladwa (3)Pehowa (4)Shahbad (5) Thanesar
4	**Karnal**		-	-	1) Assandh 2) Gharaunda 3) Indri 4)Karnal

					5) Nilokheri 6) Nissing
5	**Panipat**		-	-	1)Bapoli 2) Israna 3) Madlanda 4) Panipat 5) Samalkha
6	**Sonipat**	1. Mundhlana 2. Khrkhoda 3. Kathura	-	-	1) Gannaur 2) Gohana 3) Rai 4) Sonepat
7	**Faridabad**	1.Hodal 2.Ballabgarh 3.Palwal	-	1Faridabad 2Hasanpur	
Total	**Assessed** **Blocks in catchment area-37**	**Safe 10**	**Semi - critical** **Blocks 2**	**Critical** **Blocks 3**	**Over-exploited** **Blocks 22**
	Assessed Blocks in Haryana-113	**Safe 42**	**Semi - critical** **Blocks 5**	**Critical** **Blocks 11**	**Over – exploited** **Blocks 55**

Source: central ground water board, report 2004

The table.6 shows that salinity of groundwater in arid and semi arid agro climatic zone is high. High salinity is the major problem in sonipat where more than 30% of groundwater is with ec more than 3000 while in the districts of karnal, kurukshetra, yamunanagar, it is below 3000. High concentration of fluoride in groundwater is common in semi-arid region of the state. Fluoride content is more than 1.5mg/l in faridabad, kurukshetra, panipat, and sonipat. Fluoride in minute quantity is an essential component for normal mineralization of bones and formation of dental enamel but when fluoride is taken up in excessive amount, it proves toxic to plants and on feeding may cause clinical disturbances in animals and human beings such as fluorosis, marked by changes in teeth and skeletal system. According to who, permissible limit for fluoride in drinking water is 1.5mg/l. Fluorine being a highly electronegative element has extraordinary tendency to get attracted by positively charged icons like calcium.

Hence the effect of fluoride on mineralized tissues like bone and teeth leading to developmental alternations are of clinical significance as they have highest amount of calcium and thus attract the maximum amount of fluoride that gets deposited as calcium flour apatite crystals. Water with iron more than1.0mg/l is not suitable for domestic use, whereas desirable concentration of iron in water for domestic use is below 0.30mg/l. Water with iron ranging

between 0.30 and 1.0 mg/l is permitted for use only when there is no other suitable source of water available.

Table.6: groundwater quality problems.

Sr. No.	Contaminants	Districts Affected (in part)
1	Salinity (EC>3000 µs/cm at 25^0 c)	Sonipat.
2	Fluoride (> 1.5 mg/l)	Panipat, Kurukshetra, Sonipat.
3	Iron (> 1.0 mg/l)	Ambala, Faridabad, Karnal Kurukshetra, Panipat, Sonipat. Yamunanagar
4	Nitrate (>45mg/l)	Ambala, Faridabad, Kurukshetra Karnal, Sonipat, Panipat, Yamunanagar

High concentration of iron is generally observed in areas of high rainfall, e.g. Iron content above 1.0 mg/l is found in the wells of ambala, yamunanagar, faridabad, kurukshetra, panipat and sonipat of the state. Use of waters with iron contents above 1.0 mg/l cause staining of utensils and clothing.

Considering the harmful effect of arsenic on human health, central ground water board devoted international water year, 2003, towards determination of arsenic in ground water and conducted a study which concluded that only 4 wells located at balana in district ambala, chorpur and garhi ka rajan in district karnal and samain in district fatehabad have been reported having arsenic more than the permissible level of 0.05 mg/l in haryana. Out of these 4 wells, 3 wells exist in catchment area of yamuna river. Central ground board conducted a study on groundwater pollution in haryana which reflects that there are about 8804 medium and large industrial units and bulk of them are concentrated in six cities namely yamunanagar, panipat, sonipat, gurgaon, faridabad and ballabhgarh which covers the catchment area of yamunanagar. When quality of groundwater vis-à-vis industrial activities are analysed, it is concluded that ambala city is an important industrial town of haryana and houses about 200 small and medium scale industries. The major industries are of metal (127) and food processing (46). Groundwater is heavily exploited for domestic and industrial use. It is observed that the ground water occurring at shallow depth is alkaline and is of na-hco3 type. Some of the samples of well waters have been found with high no3 due to contamination exceeding the permissible levels for fe and mn have been found at few places in the city.

Panipat is another major industrial town of haryana, thermal power plant, sugar mill, national fertilizer and panipat oil refinery are some important units located in and around the city. There are more than 175 handloom and textile units that use large amount of chemicals for processing and dyeing of the textile. Huge water is used during the processing, consequently, a large quantity of waste/effluent are released in groundwater. The shallow groundwater has been polluted due to discharge of effluent either in ponds or cesspools or in ganda nala flowing through the city. Heavy metals like mn, pb and fe are present exceeding the permissible levels. At some places saline groundwater with objectionable fluoride concentration has been found in the city.

The shallow groundwater is found polluted due to sewage contamination as the well water showed high concentration of nitrate and chloride. The ground water at deeper depths have much low concentration of these constituents, which indicates that the pollution of ground water is restricted to shallow depths only. The shallow groundwater has also been found polluted due to industrial effluents as the water contained relatively high concentration of heavy metals such as cu, pb, mn and fe.

Faridabad and ballabgarh are major industrial towns and there are about 500 registered factories housed in these towns some of them generate hazardous waste. The industries causing pollution are related to electroplating works, manufacture of textile, fertilizer, plastic etc. Which are rich in toxic trace metals. Besides industrial effluent, discharges of untreated sewage in the roadside channels pollute the ground water due to seepage. High concentration of fluoride, chloride, nitrate, sulphate has caused pollution of shallow ground water. This has happened due to release of sewage and discharge of industrial effluents on the surface. In haryana, there are sugar mills with attached distilleries at yamunanagar, panipat and rohtak. Soils in the nearby areas have turned acidic due to continuous release of spent wash on the soil during irrigation and mud in the fields by these units. Groundwater at shallow depth has turned light yellow in colour and has become unfit for human consumption.

At many places pollution due to bio-medical waste from hospital and nursing homes is very common. The waste dumped in open area, emits foul smell and becomes a potential breeding ground for flies, mosquitoes and other insects. The rain water carries downwards the bacterially decomposed soluble material to the ground water. Bacteria, viruses and other microorganisms, some of them may be pathogens, also move down and pollute groundwater.

Even the river and canal water in haryana is polluted. Pollution in yamunanagar starts from tajewala in the upper segment. Here two canals, the western yamuna canal (wyc) and the eastern yamuna canal (eyc), divert river water-saved in three monsoon months into haryana and u.p. the wyc crosses yamunanagar, karnal and panipat before reaching delhi, receiving waste water from yamunanagar and panipat. Drain nos ii and viii branch off the wyc at yamunanagar and rejoin the canal about 80km downstream at karnal. All domestic and industrial discharge from yamunanagar is let out into this canal. Water from the augmentation canal is used for irrigation. However when excess water from the wyc is let into it, pollutants are flushed into the wyc downstream at karnal. Furthermore, at panipat, discharges from the panipat sugar mill and distillery are let out into a disused canal, when the effluents cross the dam; it results in a major increase in biological oxygen demand (bod) loads in wyc. A cgwb inspection reports estimated that there were 1, 00,000csm of effluents in the disused canal, having a bod level of 1380 mg/l. According to the report, when this water enters the wyc, it carries with it a total of 125t of bod levels reach 17 mg/l at haiderpur in delhi, the acceptable bod levels for rain water meant for treatment are three mg/l. Haryana's vast agricultural fields are also significant contributors to pollution. The consumption of pesticides in haryana in the year 1995-96 was to the tune of 5100t. Out of this, benzene hex chlorides (bhc) accounted for 600.24t. The state department of agriculture estimates that 12.5 percent of yamuna basin has forest cover, 27.5 is waste lands, 53 percent is agricultural land; the rest are villages, towns, cities and roads. There are plans to bring 27.5 percent more under agriculture which means more intensive use for commercialized agriculture and subsequent run off of fertilizers and pesticides.

CONCLUSION:

Water is one of the most important national resources and its use is increasing due to high growth of population, increasing number of residential areas, increasing agricultural land, cropping of water intensive commercial crops and rapid industrial development in haryana. Due to climatic changes, the rainfall pattern is also changing. The average annual rainfall in haryana is 573 mm whereas the national average is 1150 mm causing scarcity of water. As the main source of water is rainfall, which is erratic, uneven, unpredictable, rainwater harvesting is one of the important alternatives to recharge over exploited groundwater. The catchment area of yamuna river covers seven districts of haryana and experiences 5460m rainfall which is 41 percent of state rainfall. The catchment area experienced green revolution in past and still predominantly rice and wheat belt which are water intensive crops. The annual groundwater draft of irrigation in the region is 96 percent whereas only 4 percent is available for industrial and domestic use. The region has experienced 109 percent stage of groundwater development hence the entire catchment area is declared dark zone. Average depth to ground water during 1974 to 2010 has gone down by more than 10 meter in the region. Out of 22 are over-exploited followed by 3 critical and 2 semi-critical. In this emergency situation of water scarcity, the issue of water management is thus a matter of urgent attention due to its continuous increase in demand. Recycle of water in industrial sector, rational utilisation of water in agriculture sector by switching over from water intensive short duration crops to drought resistance crops, needs to be practised to avoid future crisis. If the resource is not protected from indiscriminate exploitation and from excess use of chemical fertilizer and pesticides, the polluted water will not only affect food production both quantitatively and qualitatively but also it will cause irreparable ecological imbalance. Since water is a state subject, mass awareness is required to use water rationally to avoid future crisis.

REFERENCES:

1. Water resources development in the yamuna river basin in india by kapil k. Narula, frank wendland, d.d. bhujanga, rao and n.k. bansal.

2. Ground water resources of india, 1991, new delhi, ministry of water resources, 56 pp.

3. Ground water resources of india, 1991, new delhi, ministry of water resources, 64 pp.

4. Anon 199, 'water an overview – issues and concerns', national commission on integrated water resources development plan iwrdp, new delhi, pp 67.

5. Anon 199, water availability and requirements, national commission for integrated water resources development plan, (iwrdp), new delhi, p. 38.

6. Anon 2000, 'flood of promises to deal with lack of water', times of india, new delhi, april, 20 p.12.

7. H.s. bartwal 2000, centre readies rs. 550 crore plan to recharge water level, the hindustan times, new delhi, may, 5, p.12.

8. S. Ramakrishna 200, ap set to revamp watershed project, the indian express, april, 30.

9. Water resources development in the yamuna river basin in india by kapil k. Narula, frank wendland, d.d. bhujanga, rao and n.k. bansal.

10. Ground water resources of india, 1991, new delhi, ministry of water resources, 56 pp.