DISTRICT GROUND WATER INFORMATION BOOKLET

HARDA DISTRICT

MADHYA PRADESH

Ministry of Water Resources

Central Ground Water Board

North Central Region

BHOPAL

2013

HARDA DISTRICT AT A GLANCE

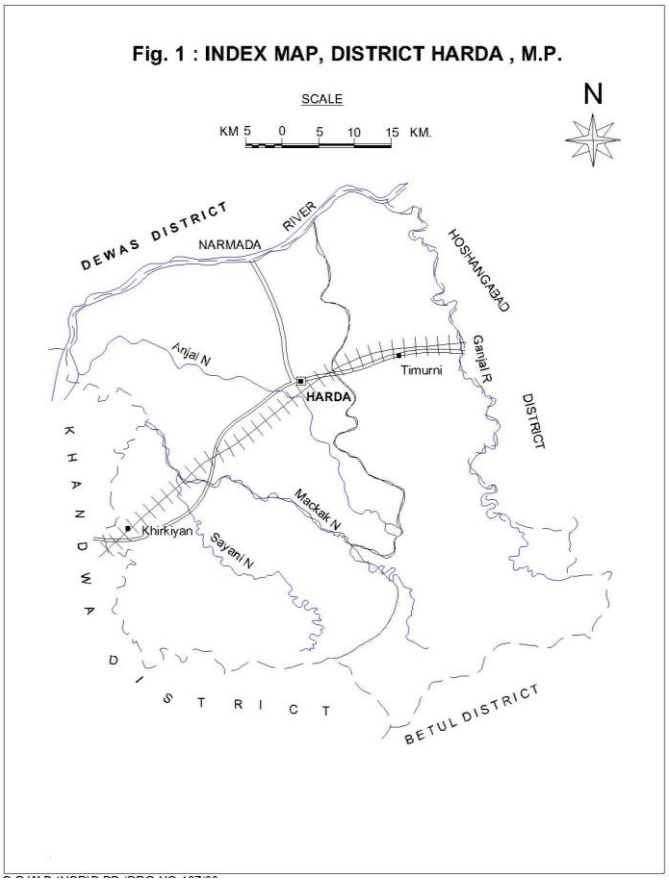
S. No.	ITEMS	STATISTICS	
1.	**GENERAL INFORMATION**		
	i) Geogeaphical area	3330 Sq.Km.	
	ii) Administrative Divisions (As on 2012) Number of Tehsils	6	
	Number of Blocks	3 (Harda, Khirkia, Timarni)	
	Number of Panchayats	211 village Panchayats	
	Number of Villages	573	
	iii)Population (As per 2011 census)	570302	
	iv)Average Annual Rainfall (mm)	1374.5 mm	
2.	**GEOMORPHOLOGY**		
	i) Major Physiographic Units	1. Satpura range and extension of Malwa Plateau in the south 2. Ridges (equivalent to Aravalli) 3. Alluvial plain in the north-east and central part	
	ii) Major Drainage	Narmada river and its tributaries, namely Ganjal river, Ajnal river, Sukni nadi, Midkul nadi, Dedra nadi, Machak nadi, Syani nadi and Kalimachak river.	
3.	**LAND USE**		
	i) Forest area:	780.92 Sq. Km.	
	ii) Net area sown:	1797.87 Sq. Km.	
	iii) Cultivable area:	1845.32 Sq. Km.	
4.	**MAJOR SOIL TYPES**		
		Black soils and ferruginous red lateritic soils, Sandy clay loam, sandy loam and clay loam. (	
5.	**AREA UNDER PRINCIPAL CROPS**		
6.	**IRRIGATION BY DIFFERENT SOURCES**		
		Number of Structures	**Area (sq km)**
	Dugwells	8140	307
	Tube wells/Bore wells	1894	142
	Tanks/Ponds	1	1
	Canals	1	795
	Other Sources		169
	Net Irrigated Area		1414
	Gross Irrigated Area		1414
7.	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (31.3.2013)**		
	No. of Dug Wells No. of Piezometers	9 3	
8	**PREDOMINANT GEOLOGICAL FORMATIONS**		
		Archaean Granite; Porcellanite/ quartzite/ schist (equivalent to	

		Aravallies); Deccan Trap basaltic lava flows and older dolerite dykes/ sills and Recent laterite and alluvium
9	**HYDROGEOLOGY**	
	Major Water Bearing Formation **Pre-monsoon** depth to water level during 2012 **Post-monsoon** depth to water level during 2012 Long Term water level trend in 10 years (2003-2012) in m/yr	Alluvium, Deccan Trap and weathered granite. 3.81 to 16.27 m.bgl 0.30 to 17.8 m.bgl 0.04 to 0.73 m fall/annum During Pre-monsoon 0.02 to 0.38 m rise/annum (Post-monsoon)
10.	**GROUND WATER EXPLORATION BY CGWB (As on 31.3.2013)**	
	No of wells drilled (EW,OW,PZ,SH, Total)	1 EW, 3 PZ
	Depth Range (m)	32.61to 98.45 m.bgl
	Discharge (litres per second)	meagre to 10 lps.
		-
		-
11.	**GROUND WATER QUALITY**	
	Presence of Chemical constituents more than permissible limit (eg EC, F, As,Fe)	High Nitrate (> 45 mg/l) recorded in 5 water samples
	Type of Water	Calcium Bicarbonate type
12	**DYNAMIC GROUND WATER RESOURCES (2009) in MCM**	
	Net Ground Water available	540.72
	Gross Annual Ground Water Draft	134.34
	Projected Demand for Domestic and Industrial uses up to 2035	13.47
	Stage of Ground Water Development	24%
13.	**AWARENESS AND TRAINING ACTIVITY**	
	Mass Awareness Programmes Organised	Nil
	Water Management Training Programmes Organised	Nil
14.	**EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING**	
	Projects completed by CGWB	Nil
	Projects under technical guidance of CGWB	Nil
15.	**GROUND WATER CONTROL AND REGULATION**	
	Number of OE Blocks	Nil
	Number of Critical Blocks	Nil
	Number of Blocks notified	Nil
16.	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	
		Ground water level in declining in Khirkiya block and parts of Timarni block.

INTRODUCTION

Harda district has predominantly an agricultural based economy. It is situated in the eastern part of Madhya Pradesh. Prior to 1998-99 District Harda was a part of Hoshangabad District. Harda District was created in 6th July 1998, when it was divided from Hoshangabad District. After the division of the district, the area of Harda district is 3330 Sq. Km. The district is bounded by Dewas and Sehore districts in the North, Hoshangabad district in the east, Betul in the south and Khandwa district in the west and south. Harda district lies between north latitudes 21^0 54' and 22^0 36' and east longitudes 76^0 46' and 77^0 30' in parts of Survey of India toposheet Nos, 55B & F. Harda is the district headquarters and Khirkiya and Timarni are some of the major towns. Harda lies on Delhi-Mumbai and Kolkata-Mumbai railway routes. State Highway No. 15, linking Bhopal to Khandwa and National Highway No.59 A, linking Indore to Betul, pass through the district. The villages in the district are approachable by fair weather motorable tract.

The district is divided into three Tehsils and three development Blocks, namely Harda Block, Timarni Block and Khirkiya Block. (Plate-I). As per 2001 census, the total population of the district is 474174 persons in 571 villages, as per 2001 census.



Drainage

The entire district is drained by Narmada River and its tributaries. Thus the area falls in the Narmada Basin. The river Narmada flows along the northern boundary of the district. The Ganjal river is the major tributary of the Narmada river and flows from south to north along the eastern boundary of Harda district before

merging into the Narmada river. The other major tributary of the Narmada river draining the district are Ajnal river, Sukni nadi, Midkul nadi, Dedra nadi, Machak nadi, Syani nadi and Kalimachak river.

Irrigation

Table 1. : Irrigation

S. No.	Sources of Irrigation		Number and Area Irrigated in Hectare
1	Dugwells	Number of Structures	Area (sq km)
		8140	307
2	Tube wells/Bore wells	1894	142
	Tanks/Ponds	1	1
3	Canals	1	795
	Other Sources		169
4	Net Irrigated Area		1414
	Gross Irrigated Area		1414

Cropping Pattern

District is very rich in the field of agriculture due to good sources of irrigation and fertile alluvial and black cotton soil. Wheat and gram are the main crops grown during Rabi season. Cotton, Soyabean, Mustard, Til and Groundnut are the main oilseeds produced here. The farmers have started the production of Sunflowers.

CGWB Activites

Preliminary hydrogeological studies in parts of Harda district were carried out by the erstwhile ground water wing of geological survey of India in co-ordination with the erstwhile exploratory tube wells organization from 1953 to 1963 (P.G. Adyalkar, 1975). A comprehensive hydrogeological study of the alluvial area of the district was carried out by Central Ground Water Board, during the Narmada Project period from 1971 to 1978. During the above mentioned studies, besides hydrogelogical, hydrological and hydrometeorological studies, exploratory drilling was also carried out covering the entire Narmada upland alluvial valley. Systematic hydrogeological survey has been carried out by Shri K. Srinivasan, Junior Geologist of the GSI in 1969-90, by Shri A. K. Jain, Asstt. Hydrogeologist of Central Ground Water Board in the southern part of the district in 1984-85 and by Shri S.N.Bangar, Asstt. Hydrogeologist in 1987-88. Reappraisal Hydrogeological Survey was taken up by Shri R. M. Verma, Asstt. Hydrogeologist during AAP 1991-92 to assess the scenario of ground water regime.

Rainfall & Climate

The climate of Harda district is characterized by a hot summer and general dryness except during the south west monsoon season. The year may be divided into four seasons. The cold season, December to February is followed by the hot season from March to about the middle of June. The period from the middle of June to

September is the southwest monsoon season. October and November form the post monsoon period.

The normal rainfall of Harda district is 13.74.5 mm. It receives maximum rainfall during southwest monsoon period. About 90.5% of the annual rainfall is received during monsoon season and only 9.5 % of the annual rainfall takes place during October to May period. The surplus water for groundwater recharge is available only during the southwest monsoon period.

The normal maximum temperature occurs during the month of May i.e. 42.1^{o}C and minimum during the month of January i.e. 11.7^{o}C. The normal annual mean maximum and minimum temperature of Harda district is 32.8^{o}C and 19.8^{o}C respectively. During the southwest monsoon season the relative humidity generally exceeds 91% (August month). Rest of the year is drier. The driest part of the year is the summer season, when relative humidity is less than 33%. April is the driest month of the year. The wind velocity is higher during the pre-monsoon period as compared to post monsoon period. The maximum wind velocity 7.7 km/hr is observed during the month of June and minimum 2.9 km/hr during the month of December. The average normal annual wind velocity of Harda district is 5.0 km/hr.

Geomorphology & Soil Types

Physiographically, the district can be divided in three major divisions:-

1. Satpura range and extension of Malwa Plateau in the south,
2. Ridges (equivalent to Aravalli Hills) in the north-west,
3. Alluvial plain in the north-east and central part

The district is bounded by Satpura ranges in south and by Narmada river in the north. The area slopes north west towards the Narmada river. The slope is generally steep at the foothills of Satpura but moderate to gentle towards Narmada river. The land surface attains a maximum altitude of 734 m above mean sea level at Kaoti (77^{0} 19’30”: 22^{0}03’00”), and minimum altitude of 240 m above mean sea level at confluence of Machak river with the Narmada (76^{0}46’50”: 22^{0}19’00”). A large number of north westerly flowing tributaries originating from the Satpura join the Narmada River along the left bank. The area is mainly drained by Narmada river and its tributaries - namely Ganjal river, Ajnal river, Sukni nadi, Midkul nadi, Dedra nadi, Machak nadi, Syani nadi and Kalimachak river.

Soils of the area are characterized by black grey, red and yellow colours, often mixed with red and black alluvium and ferruginous red gravel or lateritic soils. These soils are commonly known as black soils. About 15% of the area is covered by sandy loam soils immediately on the banks of rivers. Remaining part is occupied by clay loam with big pockets of sandy clay loam and sandy loam. The permeability of the soil is low when the clay contains montmorillonite. They swell intensively when wet and shrink with deep cracks when dry. Intake of water is very rapid till the cracks disappear after complete wetting. The soils have been classified as Ustocherpts/Ustorthents/ Haplustalfs/Haplusterts as per pedological taxonomy as per pedological classification.

GROUND WATER SCENARIO

HYDROGEOLOGY

Aquifer System and Aquifer Parameters

The rocks occurring in the district range in age from Palaeoproterozoic to Quaternary. About 40 % of the district, in the eastern, central and northern (adjoining the Narmada river) part, is covered with alluvium. Ground water occurs under phreatic as well as confined conditions. The water bearing properties of different hydrogeological units occurring in Harda District are described below. Hydrogeology of the district is shown in Plate-II.

Archaeans and Metamorphic rocks equivalent to Aravallis

The Archaean Group of rocks, comprising granite, phyllite, dolomite, quartzite, chert breccia etc are exposed in the north-western part and are faulted near the Narmada River. Weathered and fractured Granite forms a potential aquifer in the area.

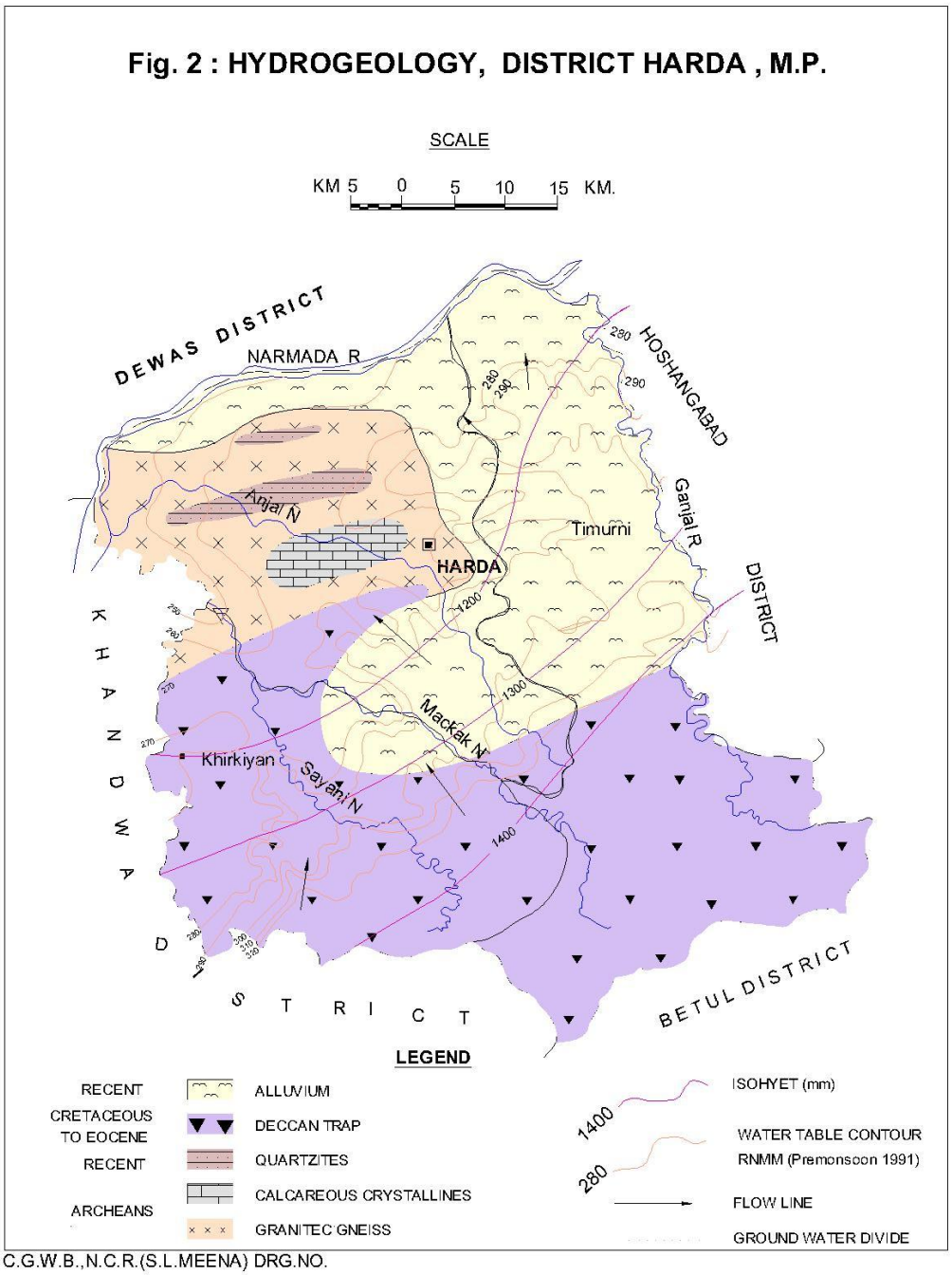
Deccan Trap

Deccan traps, which makes for about 50% of the entire district occur as lava flows in the western and southern part of the district. The phreatic aquifer in weathered/vesicular basalt are tapped by dugwells while the deeper confined aquifers are tapped by drilling tubewells. The yield of dug wells ranges from 120 to 180 litres per minute, but in the canal command area, due to substantial recharge from canal seepage, sustains a good discharge.

Alluvium

The alluvial aquifer system in the district is highly potential. Two to three granular zones and at places more number of potential granular zones comprising of fine to medium to coarse grained sand, gravel and pebbles and laterite are encountered in alluvium. The top phreatic aquifer range in thickness from 2 to 10m and is encountered in the depth range of 4 to 20 mbgl.

It appears that all the alluvial aquifer zones constitute a single aquifer system - the unconfined aquifer and a number of deeper aquifer zones separated by thick clay zones. The deeper aquifers are of semi-confined to confined nature with varying potentiometric heads. The yield of alluvial aquifers ranges from 180 to 900 litres per minute.



C.G.W.B.,N.C.R.(S.L.MEENA) DRG.NO.

GROUND WATER EXPLORATION

During Narmada Project period between 1971 to 1978 one exploratory well was drilled in the District at Timarni site and 3 Peizometers were drilled during Hydrology Project period between 1997 to 2000.

S. No	Location	Depth Drilled/ Well Completion depth	Geological Formations	Aquifer Zones	Discharge	Depth to water level
		(In mbgl)			(litres/sec)	(mbgl)
1	Timarni 22°23' 77°14' 55 F/3	32.61	0-28.35 Alluvium Basalt at 28.35			
2	Handia(S) 22°29'02" 76°59'10"	36.86	0-14 Alluvium Granite at 14.0	14.43-17.86 23.86-30.86	1.0	9.43
3	Harda(D) 22°20'29" 77°05'27"	57.50				10.46
4	Khirkiya(D) 22°09'45" 76°51'34"	98.45	0-0.6 Soil Basalt at 0.6	8.5-12.19		4.58

Well Design

Exploratory wells were drilled by direct rotary method in the alluvial area of the district. Since the area is highly potential, mostly 305 mm (12”) or 357 (14”) housing has been used to the desired depth depending upon expected discharge and draw-down vis-a-vis depth to water level. The water bearing zones were tapped by placing slotted pipe of 1/8” or 1/16” opening against these zones and the annular space was filled up by gravel of suitable size.

It has been observed that the State Govt. and the individual farmers in the district are getting the bore holes drilled by DTH rigs which is most unsuitable.Geophysical logging facilitates design the production wells properly.

In hard rocks DTH rig can be utilized. Bore hole can be left naked below the surface casing. However, in the basaltic terrain suitable assembly can be lowered to avoid collapsing of strata.

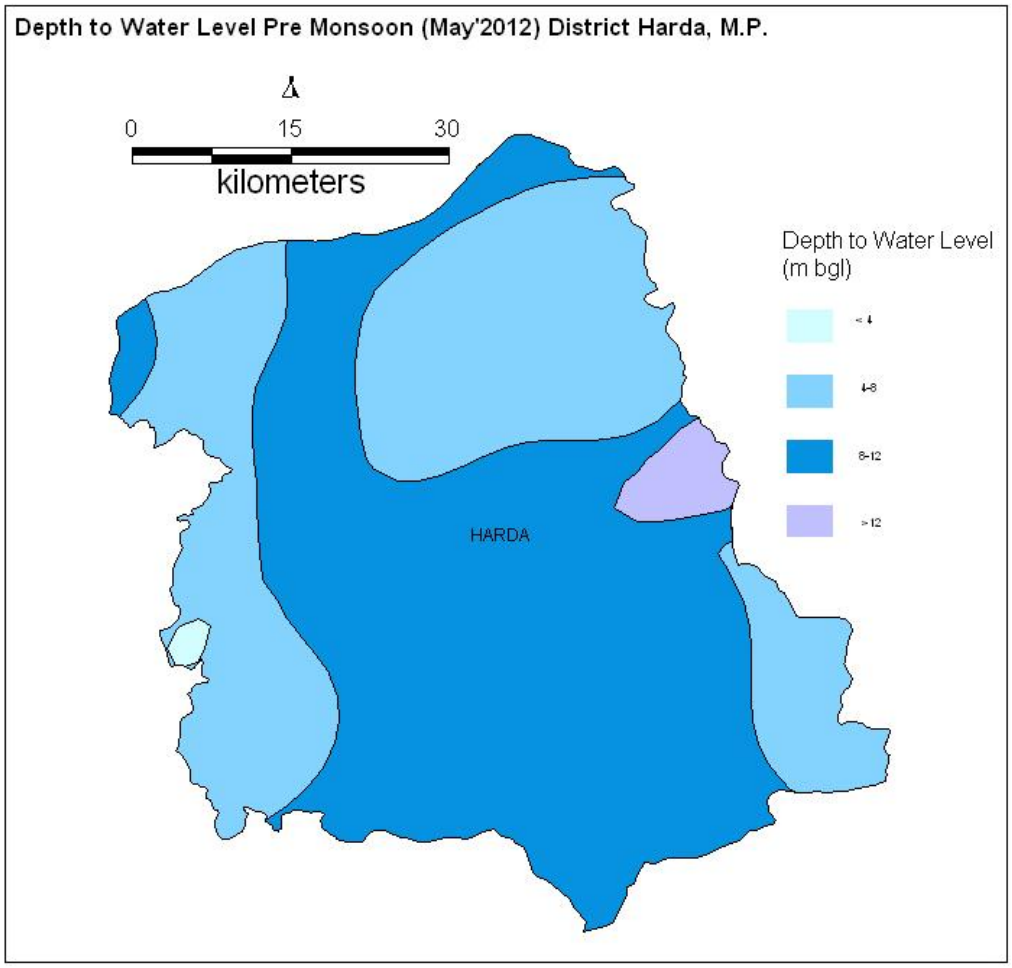
WATER LEVELS

Ground water level form a very important parameter of the ground water system. The groundwater balance expresses itself in the change in water levels; hence a continuous record is important and useful. CGWB has 10 Ground Water Hydrograph Monitoring wells and 3 Peizometers in Harda district.

Pre Monsoon Depth to Water Level (May-2012)

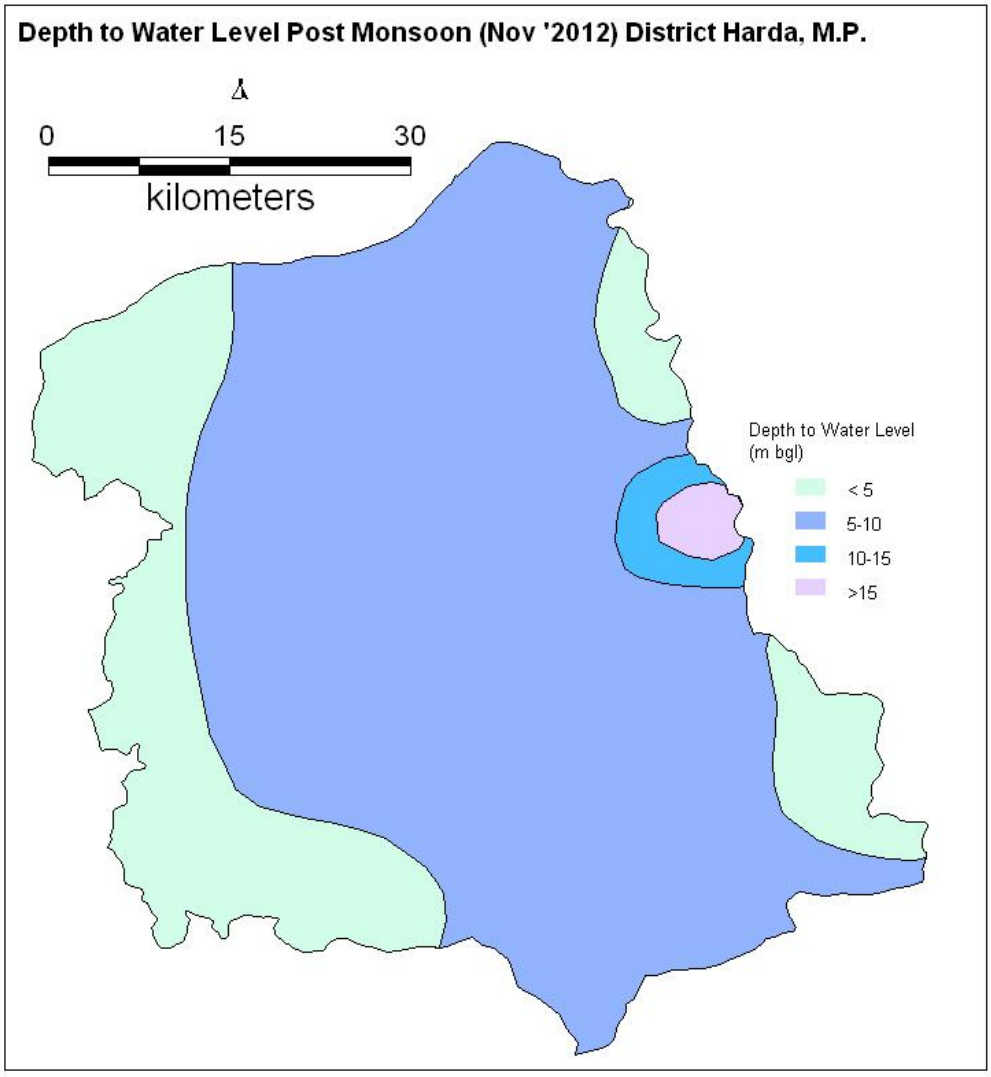
In general depth to water level in the area ranges from 3.81 to 16.27 m. below ground level. Shallow water level of less than 6 m has been recorded at Chhidgaon

and Morgarhi. Depth to water level between 9 to 12 m. bgl. is occurring in major part of the district and recorded at Magardha, Mandla, Handia, Harda, Timarni and Mohanpur. Deep water level more than 12 m. bgl. is recorded at Chhipawad and Temagaon.



Post Monsoon Depth to Water Level (November-2012)

In general, during post-monsoon period, depth of water levels in the district ranges between 0.3 to 17.8 m. below ground level. Very shallow water level of less than 3 m is recorded in an isolated monitoring well at Chhipawad. Depth to water level between 3 to 6 m bgl. is occurring in major part of the district has been recorded at Chhidgaon and Mandla. Depth to water level between 6 to 9 m bgl. is observed at Morgarhi, Handia, Timarni, Mohanpur and Temagaon. Deepest water level of 11.5 was recorded at Harda.



CHANGE IN GROUND WATER LEVELS

Water Level Fluctuation between Pre and Post-Monsoon 2012

It is observed that there is 0.04 to 0.73 m fall/annum During Pre-monsoon and 0.02 to 0.38 m rise/annum (Post-monsoon) in the Harda district.

GROUND WATER RESOURCES

The groundwater resource of the District are under-developed and under-utilised. 1894 number of tubewells and 8140 number of dugwells facilitate to irrigate an area of 439.94 Sq.Km. of agricultural land as against 1797.87 Sq.Km. of net sown area in the district.

Dynamic ground water resources of the district have been estimated for base year -2009 on block-wise basis. All blocks of the district are categorized as safe blocks, with highest stage of ground water development of 57 %. in Khirkiya block The net ground water availability in the district 54,072 ham and ground water draft for all uses is 13,034 ham, making Stage of Ground water development 24 % (28 % in 2003/04) as a whole for district. After making allocation for future domestic and industrial supply for next 25

years, balance available ground water for future irrigation would be 40,663 ham at 50 % stage of ground water development's safe limits in the district.

There is ample scope for development of groundwater for irrigation, industrial and domestic purposes.

Table 6: Ground Water Resources of Harda district

S. No	District/ Assessment Unit	Sub-unit Command/ Non-Command/	Net Annual Ground water Availability (ham)	Existing Gross Ground water Draft for Irrigation (ham)	Existing Gross Ground water Draft for Domestic & Industrial water Supply (ham)	Existing Gross Ground water Draft for All uses (ham)	Provision for domestic, and industrial requirement supply to next 25 year (2033) (ham)	Net Ground water Availability for future irrigation development (ham)	Stage of Ground water Development (%)	Category
	Harda									
1	Harda	Command	7324	664	101	764	120	6540	10	Safe
		Non-Command	7439	3655	216	3871	257	3528	52	Safe
		Block Total	**14763**	**4318**	**317**	**4635**	**376**	**10068**	**31**	Safe
2	Khirkiya	Command								
		Non-Command	8012	4235	326	4561	513	3264	57	Safe
		Block Total	**8012**	**4235**	**326**	**4561**	**513**	**3264**	**57**	Safe
3	Timarni	Command	20520	384	93	477	165	19971	2	Safe
		Non-Command	10777	3126	235	3360	292	7359	31	Safe
		Block Total	**31297**	**3510**	**328**	**3838**	**457**	**27330**	**12**	Safe
		District Total	**54072**	**12063**	**971**	**13034**	**1347**	**40663**	**24**	Safe

GROUND WATER QUALITY

Ground Water quality of Harda district has been assessed by CGWB on the basis of water samples collected from the ~~**six**~~ numbers of hydrograph (groundwater monitoring) stations for the year 2011. The hydrogen ion concentration i.e. pH in groundwater ranges from 7.08 to 7.92. The pH of ground water shows neutral to marginal alkaline in nature. Ground water salinity is low to high as electric conductivity values vary between 748 to 1865 µS/ cm at 25°C. As per BIS recommendation the EC value in drinking water towards Total Dissolve Solids (TDS) i.e. 750 µS/cm at 25°C is minimum desirable limit and 3000 µS/cm at 25°C is maximum permissible limit for drinking purposes. If the EC value more than 3000 µS/cm at 25°C; the water is not suitable for drinking purposes. The EC of ground water of Harda district does not exceeded maximum permissible limit. The highest EC was recorded at Mandla village i.e. 1865 µS/cm at 25°C.

Constituents like Chloride, Sulphate and Calcium were within the safe limit for drinking water as per BIS standards. Nitrate concentration in the ground water of district varies from 30 to 213 mg/l. As per BIS recommendation nitrate more than 45mg/l was found in four villages namely Harda (58 mg/l), Chhipawad (60 mg/l), Mohanpur (74 mg/l), Morgarhi (85 mg/l) and Mandla (213 mg/l). High nitrate in

ground water may be due to the excessive use of fertilizers etc. The fluoride concentration in the ground water of Harda district recorded in the ranges 0.04 to 1.68 mg/l. The maximum concentration of fluoride i.e. 1.68 mg/l recorded in the ground water of Handia village which is more than maximum permissible limit recommended by BIS i.e. 1.50 mg/l. Total hardness of ground water have been recorded in the range of 180 to 700 mg/l. The total hardness of 700 mg/l recorded at Mandla village which is more than BIS recommendation i.e. 600 mg/l. The magnesium concentration was recorded in the range of 6 to 46 mg/l. As per BIS recommendation the maximum permissible limit of magnesium concentration in drinking water is 30 mg/l. The villages namely: Mandla (38 mg/l), Chhidgaon (39 mg/l), Handia and Timarni (45 mg/l) and Mohanpur (46 mg/l) are recorded magnesium concentration more than BIS recommendation.

Quality of water for Irrigation:-
High SAR is not good for irrigation as it lead to sodium hazards. Water samples falls in C_2S_1 and C_3S_1 classes of US Salinity classification. The ground water in the district is safe for irrigation purpose but proper drainage system is required where EC is high i.e. more than 1500 $\mu S/cm^2$.

GROUND WATER MANAGEMENT STRATEGY

Harda comes under safe category from ground water development point of view. Due to easy availability of surface water for irrigation, after the construction of major irrigation Tawa project (1975), the development of ground water for irrigation has been negligible in the area falling under the Tawa Command Project. The ground water development is confined only in non-command area in the district i.e. in Khirkiya block and parts of Timarni block where ground water being the main source of irrigation, ground water level is declining.

Scope of Conjunctive utilization of surface and ground water

Indira Sagar Project on Narmada river has the largest reservoir in India and second largest in Asia has been completed and a number of villages on the bank of Narmada river in Harda district will come under submergence as the water in the reservoir attains its full reservoir level.

By 2008 monsoon, Donglighat-Jhalwa village in Harda district submerged. The effect of the reservoir on groundwater levels will be seen in the coming decade and the benefits/problems will be seen then. To deal with the situation, the possibilities of conjunctive use of surface water and ground water should be considered immediately.

RECOMMENDATIONS

Based on the hydrogeological studies the following recommendations are made for proper development and utilization of the available groundwater resources and management of ground water resources.

Once the Indira Sagar reservoir attains its full reservoir level, all existing ground water structures should be put to their fullest use. All the tube wells

constructed in the area should be run to their fullest capacity. This will also cause induced recharge from the reservoir to the ground water aquifers. Water from tubewells/dugwells should be used for irrigation and excess water, if any, may be put into distributaries and minors. More number of tube wells could be sunk in the demarcated productive areas and individual command per tube well can be increased for efficient and appropriate irrigation.