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Mapping of Dry Wells in Karnal District Using High Resolution Imagery & GIS Techniques

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By

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PREFACE

The emergence of GIS and its development over the last two decades have revolutionized the planner's mode of working and their art of decision making. The field of GIS is currently expanding at a tremendous rate and it has been found applicable in a number of natural resources, urban & infrastructure planning and environmental management task like utility planning, facilities location, landuse,Transportation, site selection and land suitability analysis. The system supports different types of analysis and provides agencies, organizations and institutions with a more powerful decision support tool to make more informed decisions regarding natural resources, infrastructure and environmentl management.

The primary responsibility entrusted upon HARSAC is the evolution of the databases on natural resources, infrastucture and environment in the state to ensure their management for sustainable use. HARSAC has already developed a lot of database on various themes using remote sensing and GIS techniques.

For quick visualization and appreciation of an area, maps are the best source of information. Keeping in view the importance of spatial data, the present, "Mapping of Dry wells in karnal District Using High Resolution imagery and GIS Techniques"has been brought out by HARSAC. I hope this study will serve as a very good reference material for the administrator, planner, researchers and the students.

(Dr. V. S. Arya)
Director, HARSAC

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We extend our sincere thanks to Smt. Dheera khandelwal additional chief secretary Environment & Climate Change, Sh. Vijayendra Kumar, IAS, Director General, Dr. R. K. Chauhan, Joint Director, Environment & Climate Change Haryana for imposing trust in the state-of-the-art technology and providing financial assistance for the study.

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EXECUTIVE SUMMARY

The ground water development in all the blocks of the district has exceeded the available recharge and thus all the blocks have been categorized as over exploited.Water for irrigation in the district is based on both ground water and canal surface water. Ground water contributes 95 % of the total need for agriculture. Ground water is being extracted through a large number of shallow tubewells and dug cum bore holes which tap unconfined layer up to the average depth of 60-80m. Entire drinking water supply to all rural as well as urban parts of the district is based on ground water only. This is basically due to the fact that the quality of ground water is fresh and potable all over.Therefore, most of water wells have been converted into dry wells. Drywells can be used to facilitate stormwater infiltration and groundwater recharge in areas where drainage and diversion of storm flows is problematic. Historically, drywells have predominantly been used as a form of stormwater management in locations that receive high volumes of precipitation; however the use of drywells is increasingly being evaluated as a method to supplement groundwater recharge, especially in areas facing severe drought.

Department of Environment & Climate Change, Haryna approached HARSAC to provide the spatial as well as statistical information on dry wells in Karnal District using high resolution imagery and GIS techniques. The present report describes the methodology and results of locations of dry wells in different blocks of karnal distict.

An Android based Mobile App was developed for GPS based dry well mapping.GIS Mapping of Dry wells in Karnal was conducted using the mobile based App.A team was deployed block wise to map all the dry wells in a village. Attributes such as Diameter, Depth to

water table and type of well (lined or unlined) etc. were also be collected during field survey. All this data collected were individually processed and analysed in GIS environment.

Total no of dry wells in district were observed to be 514.Study indicates that the maximum of dry wells are in Nilokheri block and minimum no of wells in the Karnal block of the district.It was also observed that the all of wells were lined and dried. All the blocks fall under over-exploited category which leads to constant decline of water level over past years in whole district except some of the area. There is no scope for further ground water development. Only measures should be taken to reduce dependency on ground water and to enhance the ground water recharging resources. Excess rain water in agricultural field, surplus canal water and rooftop rain water can be injected to ground water system. Recharging shafts and injection wells are recharging structures suitable for the district.

1. Introduction

Dry wells are bored holes completed in alluvial deposits above the water table, designed to efficiently dispose of storm water into the subsurface. Dry well is a storm water runoff reduction tools that can be used to achieve the goals of minimizing hydrologic changes associated with urbanization. As impervious surfaces expand with urbanization, rain is unable to penetrate the soil. This creates large volumes of runoff that are typically directed into piped storm water conveyance system which increases the volume of runoff and the speed in which it reaches local waterways. This change in the urban hydrograph reduces the potential for groundwater recharge and damages aquatic habitat in creeks and rivers. Dry wells can help minimize these effects by allowing storm water to bypass soils with poor infiltration rates to reach more permeable layers.

These qualities of dry wells make them a useful tool to help meet storm water management requirements. Dry wells also provide a sustainable and environmentally friendly drainage solution that avoids costly, underground mechanical devices and can serve as a Low Impact Development tool. They can incorporate pretreatment features such as grassy swales and sedimentation basins for additional storm water treatment. Dry wells can protect waterways from erosion caused by direct storm water discharge and reduce the harmful effects that traditional storm water management practices have had on the aquatic ecosystem. Dry wells not only aid in storm water runoff reduction and increase groundwater recharge, but they can also minimize the risk of flooding, are economical and have minimal space requirements.

Dry wells can be used to reduce the increased volume of stormwater runoff caused by roofs of buildings. While generally not a significant source of runoff pollution, roofs are one of the most important sources of new or increased runoff volume from land development sites. Dry wells can also be used to indirectly enhance water quality by reducing the amount of stormwater quality design storm runoff volume to be treated by the other, downstream stormwater management facilities. Dry well use has been limited in some places by the concern that dry wells could contaminate groundwater, including drinking water, by reducing the distance contaminated stormwater must travel through sediment in order to reach groundwater. Surface soil and underground sediment remove contaminants by acting as a natural filter, but dry wells allow stormwater contaminants to bypass many underground layers.

Efficient management of land and water resources requires comprehensive knowledge on many variables including climate, soil, land use, crops,water availability, water distribution networks, management practices, etc. Most of these data are spatially distributed and their integration and use in ground water requires widespread utilization of Geographic Information Systems (GIS) and other modern information technologies. GIS technology in conjunction with Remote Sensing has proved to be effective for land use and water management. Effective decision making on water use and ground water management, calls for generation of spatial and non-spatial database in GIS platform. In fact, the employment of geo-referenced databases enables faster exchange and aggregation of information coming from different sources, and easier interaction of those data with models and decision support tools. Therefore, the present study is planned with the following objectives:

1. Development of an Android based Mobile App for GPS based dry well mapping.
2. GIS Mapping of Dry wells in Karnal using the mobile based App.
3. Measurement of Diameter and depth to water table of dry wells.
4. Identification of Dry wells (lined or unlined).

2. Description of the study area

Karnal district lies on the western bank of the river Yamuna, which forms its eastern boundary and separates Haryana from Uttar Pradesh and is bounded by North latitudes $29^0$25’05”& $29^0$59’20” and East longitudes $76^0$27’40”& $77^0$13’08” is shown in Fig.1, Its height above sea level is around 240 meters The district covers 5.69% area of the state and is bordered by Kurukshetra District on its northwest, Jind & Kaithal Districts on its west, Panipat District on its south and Uttar Pradesh state on the east. The district is well connected by roads and railways. The SherShah Sri Marg (NH No.1) runs through the entire length of the district. A broad gauge railway line connecting Delhi with Ambala runs almost parallel to the NH No.1. Karnal is the district headquarters. The main townships are Karnal, Indri, Assandh, Nissang, Nilokheri and Gharaunda. Administratively the district comes under Rohtak division and it has five Tehsils, three Sub-Tehsils and Six blocks. The district is one of the most densely populated districts of the state. The total population of the district as per 2011census is 15,06,323. The district has a population density of 587 per square kilometer (1,550 /sq mi). Its population growth rate over the decade 2001-2011 was 18.22%. Karnal has a sex ratio of 886 females for every 1000 males, and a literacy rate of 76.4%.

The district is a part of the Indus-Ganges plain (Upper Yamuna Basin) and has a well-spread network of western Yamuna canals. Its geographical area has been divided into three agroclimatic regions: Khadar, Bangar and Nardak belt. The river Yamuna which marks the eastern boundary of the Haryana State as well as Karnal district provides the major drainage in the area. Irrigation in the district is done by surface water as well as ground water. 70% of the net irrigated area is covered through ground water. Karnal district was covered under water balance studies of Upper Jamuna Project by CGWB during 1971-1978. The district was also covered under Reappraisal hydrogeological studies during field season programme of CGWB during 1981-82 , 2004-05.

2.1 Ground water scenario of the study area

2.1.1 Hydrogeology

The area falls in the Upper Yamuna Basin and the principal ground water reservoir in the area is unconsolidated alluvial deposits of Quaternary age. Ground water in near surface zone occurs under water table conditions and occurs under semi confined to confined conditions in deeper aquifers. Rain fall and seepage from the river Yamuna, canal networks and irrigation is the principal source of ground water recharge in the area.The study of exploratory boreholes drilled in the district during the Upper Yamuna Project of Central Ground Water Board indicated presence of three tier aquifer groups upto 463 m depth below ground level.

Aquifer group-I: The Aquifer group I is composed of different sand and clay lenses and extends from surface downwards to different depth varying down to 90m to 180m at different places and occurs all over the area. This is composed of relatively coarser sediments. This group of aquifers is underlain by a clayey horizon 10-15m thick which is regionally extensive. The average transmissivity of this group was calculated by the Upper Yamuna Project of CGWB to be of the order of 2200 m^2/day, lateral permeability of the order of 24m/day and average storativity as 0.12.

Aquifer group-II: This group is composed of different sand and clay lenses and lies below aquifer group-I and occurs at varying depths ranging between 115m and 195 m to 215m and 285m. The sediments of this group are less coarse and are mixed with some kankar. This group is underlain by another clayey horizon, which is considerable thick at places and appears to be regionally extensive. The average transmissivity of this group is 700m^2/day, the average lateral permeability is 7.2m/day and the average storativity is 1x10^{-3}.

Aquifer group-III: The aquifer group III is composed of thin sand layers alternating with thicker clay layers and occurs at variable depths ranging between 314 m to 405m.bgl. The granular material of this group is generally finer and more so in the southerly direction. This group has an average transmissivity value of 525m^2/day, and average lateral permeability and average storativity values of the order of 7.1m/day and 4.5x10-4 respectively.

2.2 Rainfall & Climate

The climate of the district is characterized by the dryness of the air with an intensely hot summer and a cold winter. The year may be divided in to four seasons. The cold season starts by late November and extends to the middle of March. It is followed by hot season which continues to the end of June when the southwest monsoon arrives over the district. July to September is the southwest monsoon season. The post monsoon season period is from October to December. The normal annual rainfall of the district is 582mm recorded in 32 rainy days in a year. About 82.39% of the annual rainfall is recorded during the southwest monsoon from July to September. August is the wettest month of the year with an average of 9.0 rainy days and 221.5 mm rainfall. Maximum rainfall of 1404mm and minimum rainfall of 255mm were observed in the years 1998 and 1987 respectively.

2.3 Geomorphology & Soil types

The area represents almost an alluvial plain without any conspicuous topographical features and forms a part of the vast Indo-Gangetic plain. The elevation of the area above mean sea level ranges from 256 m amsl in the north to 245 m amsl in the south with an average elevation of 240m.amsl.The general slope of the area is southwards. In the north western part of the district the land slopes south west wards. There are many topographical depressions in the area of which the most pronounced is at Daha, south of Karnal.

The river Yamuna which marks the eastern boundary of the Haryana State as well as Karnal district provides the major drainage in the area. The river Yamuna emerges from Yamnotri off the Bansur-Punch glacier in Tehri Garhwal district of Uttarakhand at an elevation of 6330 meters. It emerges into the plains from the foothills at Kalesar just north of Tajewala. The Chantang Nala is the other drainage line and flows from north to southwest in the western part of the district and disappears near Assandh. The soils in Gharaunda and SE half of Karnal blocks are young, stratified with no profile development. They are sandy to fine sandy loams. The soils in SE half of Nilokheri, SW extremity of Karnal block touching Nilokheri, eastern portion of Nissang, Western half of Gharaunda block are heavily textured varying from sandy loam at the surface to clayey loam at about one meter depth.

2.4 Physiography and Drainage

The district is a part of alluvial plain of Yamuna river. It slope from west to east and water of the area flows towards Yamuna. There are two major physiograpic units in the area.

The khadar, existing within one mile of Yamuna river. It has light soil and the water table very near to surface. It is a flood plain of the river Yamuna and is suitable for rice and sugarcane cultivation.

The other unit is the upland plain spreading in the western part of the district and is inclined towards the south and south-west and covers the karnal Banger area. This area is eastward extension of the upland plain of kaithal district. It is irrigated by tubewells and canals and is a prosperous agricultural area.

The district enjoys perennial river the Yamuna, which forms the eastern boundary of the district. The khadar, the flood plain of the river is very fertile. A seasonal stream, the chautang runs in the Northwest part of the district.

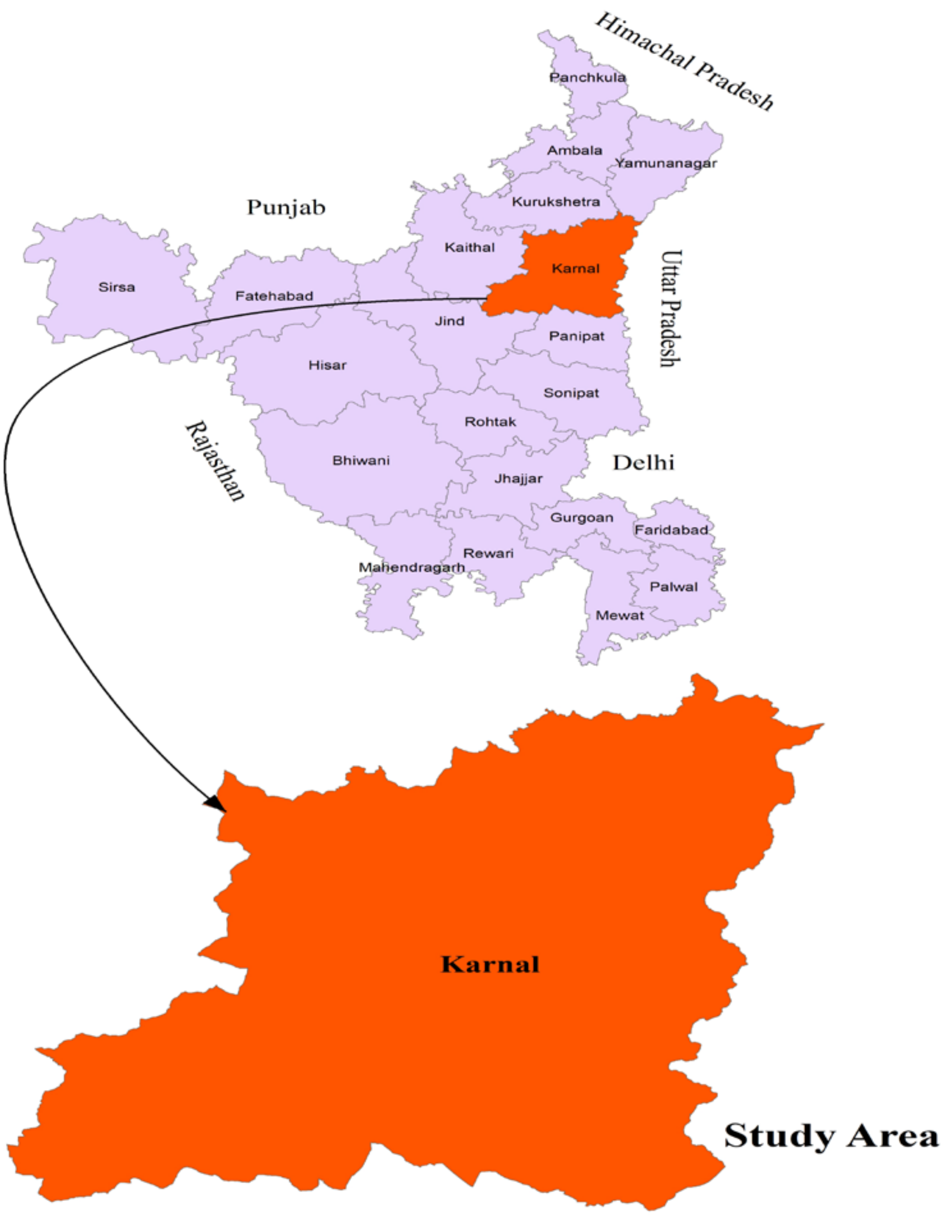

Fig.1. Location map of study area

3. Methodology

3.1 Development of mobile application

The dry well mapping application has been developed using database, designing, coding, and API (application programming interface). A flow chart showing the working of Android based Mobile App used for maaping of dry wells is shown in Fig.2. Fig 3.provides graphical interface of Android based Mobile App.

3.1.1 Database used: The application is developed by using Postgre SQL relational database management system which provides the effective and modern features like views, transactions, concurrency control and complex queries of SQL.

3.1.2 Application programming Interface: It has been designed by using the Eclipse environment. API acts as a means of communication between frontend (user interface) and backend (database). These APIs are mainly used for the positioning with the help of GPS.

3.1.3 Hypertext markup language: It is a markup language mainly used for the designing purpose. This language is mainly based on the tags which performs different functions. The main reason to use this language is its features like easy to learn and handling.

3.1.4 Java script: It is used for making the services of the application which respond according to the given input.

The application consists of various fields which found to be mandatory in order to collect the proper data of the dry wells which are following:

- GPS Location
- Phone Number
- Dry Well Diameter
- Water depth
- Dry well condition
- Height of well from ground
- Landmark
- Remark
- Take photo

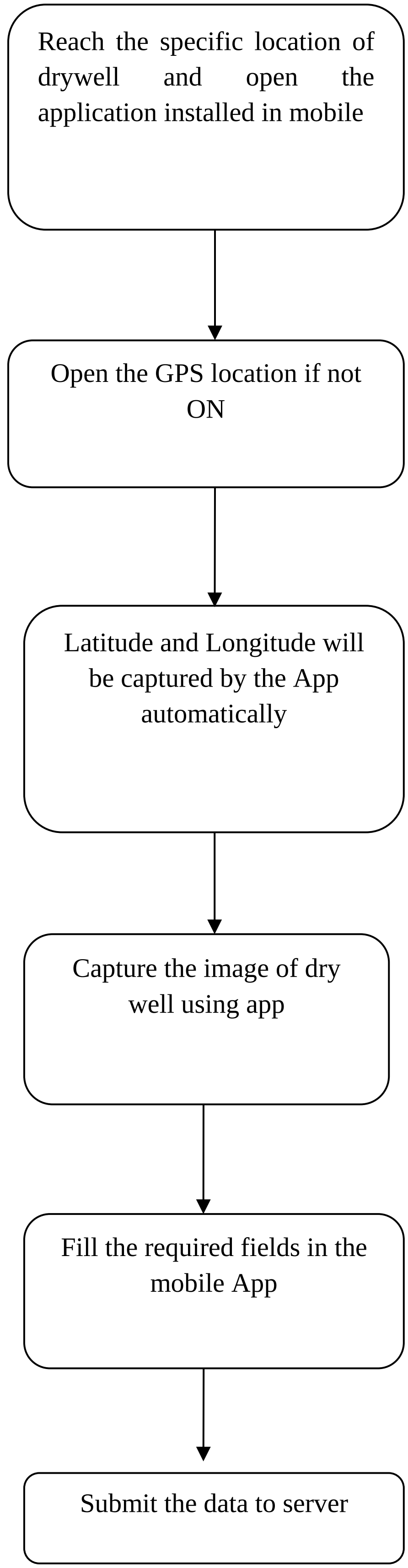

Fig.2. Flow chart showing the working of Android based Mobile App

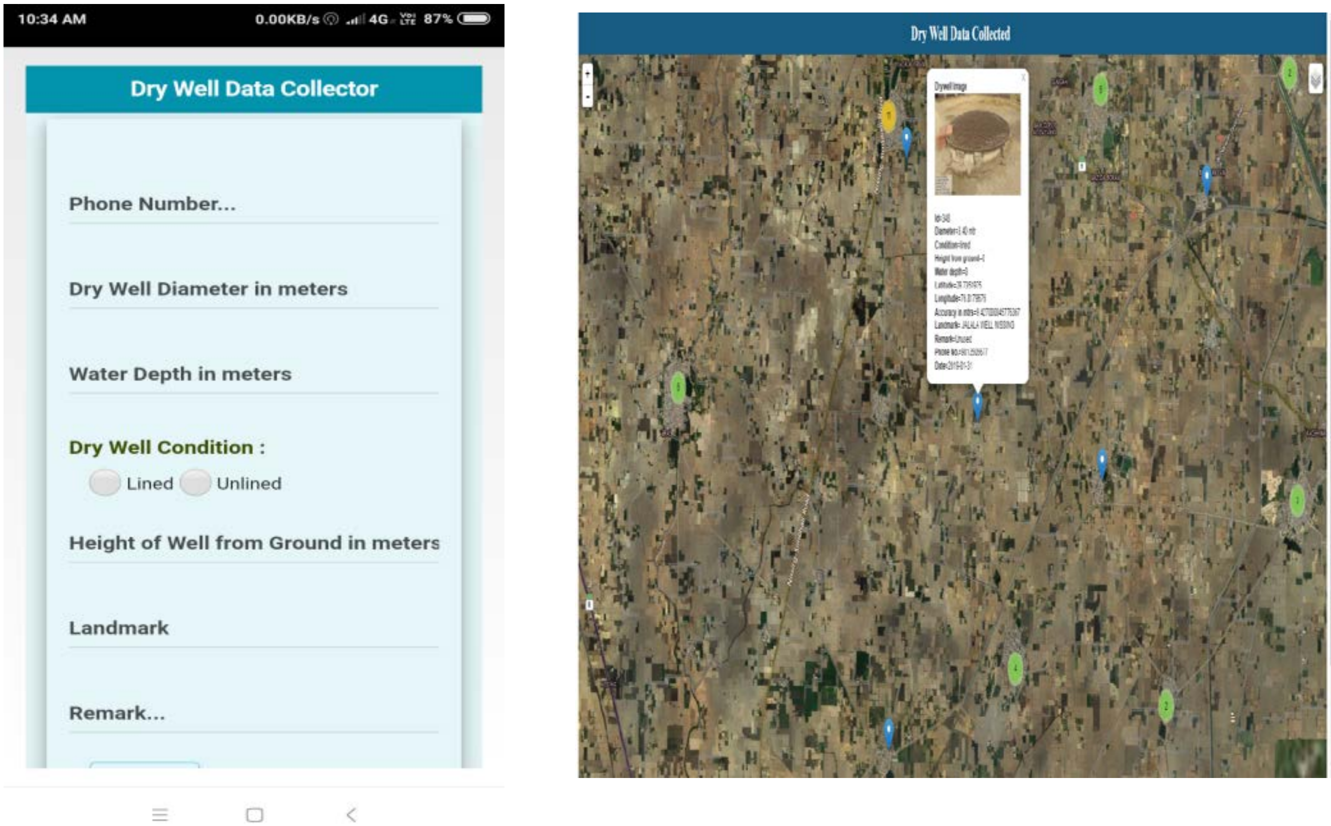

Fig.3. A view of Android based Mobile App used for mapping of dry wells

4. Results and discussion

The study has been carried with the help of Android based Mobile App. A team was deployed block wise to map all the dry wells in a village. Android based Mobile app/GPS was used for Mapping of Dry wells in Karnal. Attributes such as Diameter, Depth to water table and type of well (lined or unlined) etc. were also be collected during field survey. All this data collected were individually processed and analysed in GIS environment. Dry wells and its attributes collected block wise during field survey are shown in Table 1. During the field survey, the maximum of of dry wells was spotted in Nilokheri block and minimum no of wells in karnal block of district.It was also observed that the all of wells were lined and dried.

Table.1. Spatial distribution of dry wells in Karnal

District	Block name	No. of dry wells	Diameter (meters)	Lined/unlined	Height from ground (meters)
Karnal	Nilokheri	132	2-3	lined	0.5-1
	Chirao	124			
	Assandh	114			
	Indri	52			
	Gharaunda	51			
	Karnal	41			

Dry wells were spotted during field survey in blocks of Karnal district. Water wells have been dried due of over pumping of water. It can be seen from Table.1 that most of water wells have been converted into dry wells. Ground water is under stress and the ground water level is declining. There is no scope for further ground water development. Locations of dry wells block wise are shown in Fig.4.The depth to water level is deeper in the north-western parts and east central parts and shallow in north eastern parts and central and southwestern parts (CGWB). Therefore, maximum no. of dry wells were spotted in northwestern parts and minimum no. in northeastern parts and southwestern parts of Karnal district. Locations of wells along with depth to water level are shown in Fig. 5. It is observed from Fig.5, all the blocks have been over exploited. The higher stage of ground water development in the district and it falls in over exploited category resulting of decline in water levels. These blocks need macro analysis and there is an urgent need for conservation of ground water in the district. There is no scope for further ground water development. Only measures should be taken to reduce dependency on ground water and to enhance the ground water recharging resources. Excess rain water in agricultural field, surplus canal water and rooftop rain water can be injected to ground water system. Recharging shafts and injection wells are recharging structures suitable for the district.

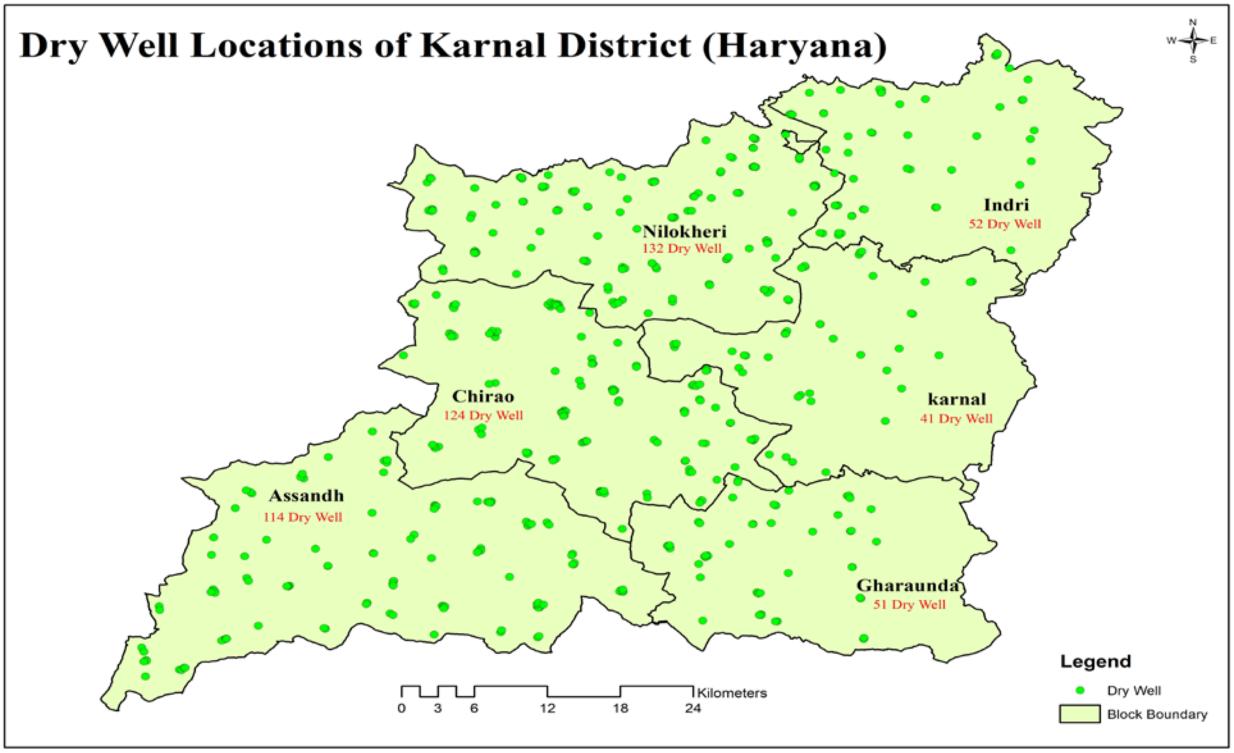

Fig.4. Locations of dry wells in karnal

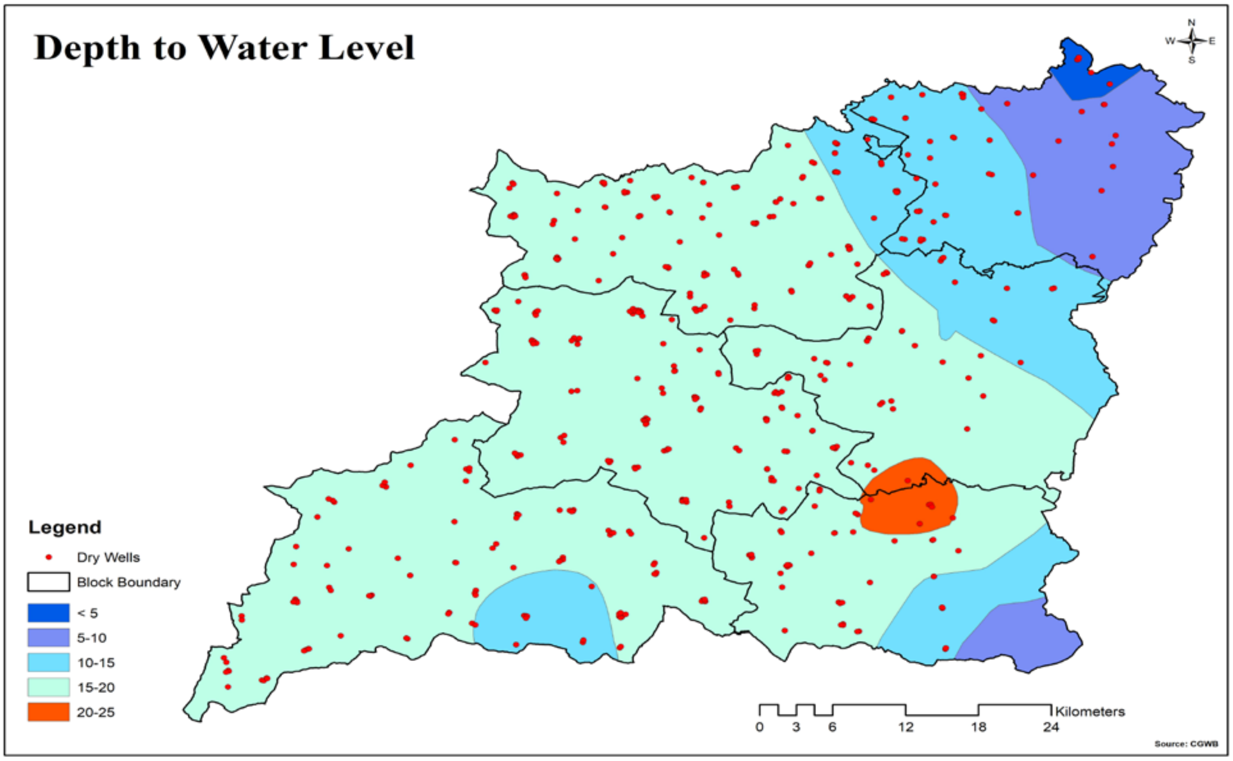

Fig.5. Locations of dry wells and depth to water level in karnal

5. Conclusions

Based upon study it is concluded that

- All the blocks fall under over-exploited category which leads to constant decline of water level over past years in whole district except some of the area.
- Maximum no. of dry wells in Nilokheri block and minimum no of wells in karnal block of district were spotted.
- It was observed that the all of wells were lined and dried.

Recommendations

Based upon study, we come out with the following recommendations.

- Dry wells can be used for storm water runoff reduction and increase groundwater recharge, but they can also minimize the risk of flooding.
- Dry wells can help minimize these effects by allowing storm water to by pass soils with poor infiltration rates to reach more permeable layers.
- The construction of roof top rainwater harvesting and diverts the water to nearest dry wells to recharge the ground water.
- The contribution of surface water to irrigation in the district is very less. Measures should be made to increase the canal water supply for irrigation.
- Change in cropping pattern is recommended to reduce the heavy pumping of ground water.
- Ground water pumping from deep aquifers is recommended to reduce stress on the shallow aquifers.
- Ground water pumping for supplies should be shifted to the active flood plains all along the river Yamuna.

Reference

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