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Determination and Demarcation of Suitable Watershed Area for Artificial Recharge and Rainwater Harvesting

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Abstract

The scope for installation of large and medium irrigation projects is limited due to lack of availability of proper sites, paucity of funds, equity issues and other social factors in many regions of the country. Therefore, the installation of 'determination and demarcation of suitable through watershed area for artificial recharge and rainwater harvesting' for ground water recharge and water harvesting has a great potential in the times to come and the objectives like harvesting every drop of rainwater for purposes of irrigation to create sustainable sources of income for the village community as well as for drinking water supplies. The study of project area i.e., Patan Block, Gundrdehi and Durg block their rainfall, temperature, humidity and also the recommended for artificial recharge and rainwater harvesting with harvesting structures. With the results of the project i.e., the changes in crop production, ground water level and human community improvement is positively. The essential and overall view of the project to development of ground water level, production of crop and also reduced in soil erosion and also the concluded. The best way to manage rain water is to conserve, store and use it right in the field where it is received. Excess water can be stored in small farm reservoirs. Field experience in this regard has clearly demonstrated that it is possible to almost double the cropping intensity and crop production by storing excess rain water in a small reservoir which can save paddy crop from intermittent droughts, allow fish culture during rainy season and help in establishing and or giving lifesaving irrigation to the second crop in post rainy season on deep soils. Harvesting every drop of rain water for purposes of irrigation, plantations including horticulture and floriculture, pasture development, fisheries etc. to create sustainable sources of income for the village community as well as for drinking water supplies. Identify rainfall pattern and distribution with the subsequent drainage system in the prevalent area. To prevent run-off of rain water. To develop methods to increase water retention, conservation and prevent soil loss. Improvise methods to augment water recharging of the land and soil. To encourage restoration of eco-biological balance in the region. To minimize the drought effect by means of soil and water conservation and augmentation of water recharging. To promote economic development of the village communities in the region. Special emphasis to improve the economic and social condition of the poor and disadvantaged sections in the area. To increase the level of ground water table in the area. To reduce run-off velocity in the area in order to check the erosion of fertile upper crust of earth. To improve the water infiltration rate. To control the problem of soil erosion. To control flooding in the agricultural fields.

Keywords: Watershed area; Artificial recharge; Rainwater harvesting; Ground water level; Rainfall; Runoff; Erosion

Introduction

Groundwater is a precious resource with limited availability. Groundwater plays an important role in sustaining economy, environment, and standard of living. It is not only the main source for water supply in urban areas for domestic uses, but also is the largest and most productive source of irrigation water. The relentless increases in population and the resulting spurt in the demand for water requirement, carefully planning and management of this limited water resources is urgently needed. There have been continued efforts for development of groundwater resource to meet the increasing demands of water supply, especially in the last few decades. In uncertain high demand areas, groundwater development has already reached a critical stage, resulting in acute scarcity of the resource. Over development of groundwater resources results in declining groundwater levels, shortage in water supply and increased pumping lifts necessitating deepening of groundwater structures in ensuring added cost. A large volume of rain water is lost as run-off and drainage water every year from farm fields flow to the seas through the network of natural streams and rivers [1].

Rain water availability is quite high in the region ranging from 659 mm to 2006 mm with annual average of 1196 mm. But due to the high variability of rains in terms of onset distribution, amount and withdrawal over space and time it leads to great amount of uncertainty about water availability for rain fed rice cultivation and rice based cropping, in spite of high rainfall received in the region during the entire period [2].

The best way to manage rain water is to conserve, store and use it right in the field where it is received. Excess water can be stored in small farm reservoirs. Field experience in this regard has clearly demonstrated that it is possible to almost double the cropping intensity and crop production by storing excess rain water in a small reservoir which can save paddy crop from intermittent droughts, allow fish culture during rainy season and help in establishing and or giving lifesaving irrigation to the second crop in post rainy season on deep soils [3-5].

Taking in to consideration the above facts water shed based system

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in which watershed is the primary unit to develop the water resources by conservation and storage of rain water is very useful.

Materials and Methods

The study area

After scrutiny of rain water harvesting and artificial ground water recharge structures in Chhattisgarh, Durg block in Durg districts and Gunderdehi block in Balod District was chosen for the study because most of the data including meteorological, hydrological data are available for this district is given below (Figure 1).

Salient features of the project

1. Name of Project: Ground Water Recharging in Pulgaon Nala Watershed Durg Block of Durg District.

2. Name of Milli Watershed: Pulgaon Nala Milli Watershed.

3. Toposheet No: 64 G/8 (Pt) & 64 H/5 (Pt).

4. Block: Durg & Gunderdehi.

5. District: Durg, Balod.

6. Longitude: 81°15'16" to 81°25'35".

7. Latitude: 20°57'03" to 21°11'09".

8. Total no of villages: 69.

9. No. of villages to be covered: 69.

10. Area under watershed which is: 259.7 Sqkm Covered.

Location, extent and accessibility

The Pulgaon Nala Milli Watershed is about 5 km distance in west direction from Durg town of the Durg district, Chhattisgarh State. The area of Pulgaon Nala Milli Watershed is about 256 Sqkm which lies between 20°57'03" to 21°11'09" latitude and 81°15'16" to 81°25'35" longitude and falls under the Survey of India Toposheet No. 64 G/8 (Pt) & 64 H/5 (Pt) (1:50000 scale).

Topographic data

Topographic maps of the study area were collected for use from the Department of Survey of India (SOI), Raipur. Toposheet No. 64 G/8 (Pt) & 64 H/5 (Pt) (1:50000 scale). The Balod district is covered in topographic map No. 64H/5.

Data acquisition

Satellite image for the watershed were collected from Raipur. Department of Soil and Water Engineering (SWE), Faculty of Agricultural Engineering (FAE), Indira Gandhi Krishi Vishwavidyalya (IGKV), Raipur. These satellite data were used in this study. Meteorological and hydrological parameters are being monitored under AICRP on GWU sponsored by Indian Council of Agricultural Research (ICAR), New Delhi and the same were used in the present study. Some hydro-geological data were collected from the Central Ground Water Board (CGWB), Raipur. Thematic maps including depth to water level (per monsoon), depth to water level (post monsoon) and lineament maps were prepared under the assistance of Central Ground Water Board, Senior Scientist. Drainage and water bodies map was prepared with the help of topographic map and MapInfo Professional 8.5 GIS. Watershed map was collected from State Water Resource Department, Government of Chhattisgarh which were rectified with the help of GIS [6,7].

Climate and rainfall

The Pulgaon Nala Milli Watershed experiences sub-tropical climate and is characterized by extreme summer and winter season. The summer months are from March to May and the months of April and May are the hottest. The rainy season extends from the month of June to September with well distributed rainfall through southwest monsoon. Monsoon generally breaks in the third week of June and is Maximum in the months of July and August. Winter season in marked by dry and cold weather with intermittent showers during the months of December and January [8].

Depth to water level

Based on observed water levels in different seasons, the depth to water level maps are prepared. The review of these maps and table indicated that, the depth to water levels in pre-monsoon season (May 2013) ranges between 5.9 to 11.0 mbgl. It is observed that water levels more than 5 mbgl covering the major part especially in southern portion. Water levels less than 5 mbgl is observed in small area in north-west part along river courses. It may be seen that in pre-monsoon period, the lowest water level was recorded as 5.9 mbgl at Hanoda station and the deepest water level was recorded as 11.00 mbgl at Sakrod station. From the Figure 2, it may be seen that the pre-monsoon depth to the water level in the range of 0 to 5 m covers an area of about 6.6%. The depth to water level in the range of 5 to 10 m covers an area of about 58.6%. The depth to water level in the range of 10 to 15 m covers an area of about 34.7% [9].

The depth to water levels in post-monsoon season (Nov 2013) ranges between 2.5 to 7.2 mbgl. It is observed that water levels more

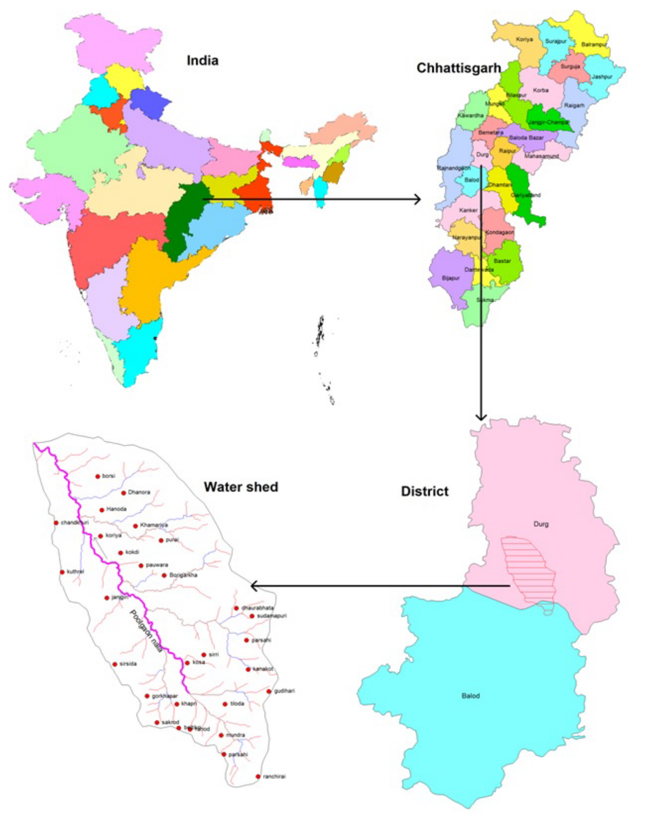

Figure 1: Location map of the Watershed.

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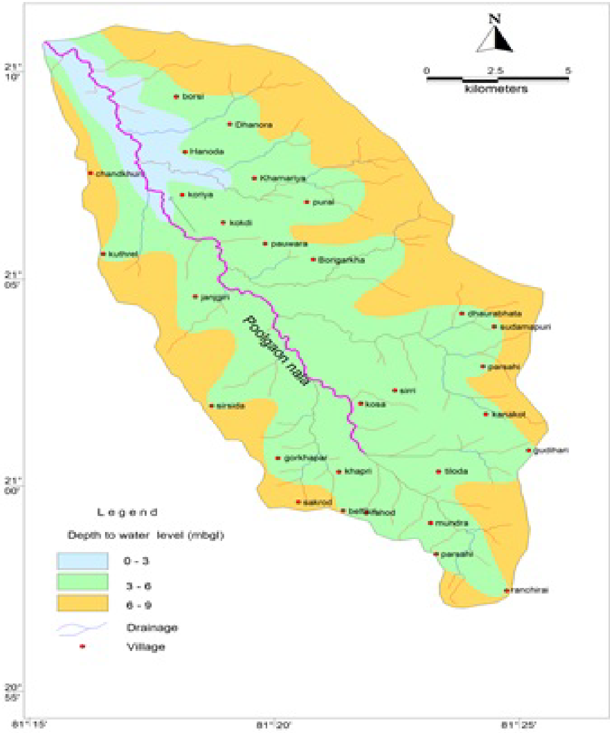

Figure 2: Pre-monsoon depth to water level I map of the study area.

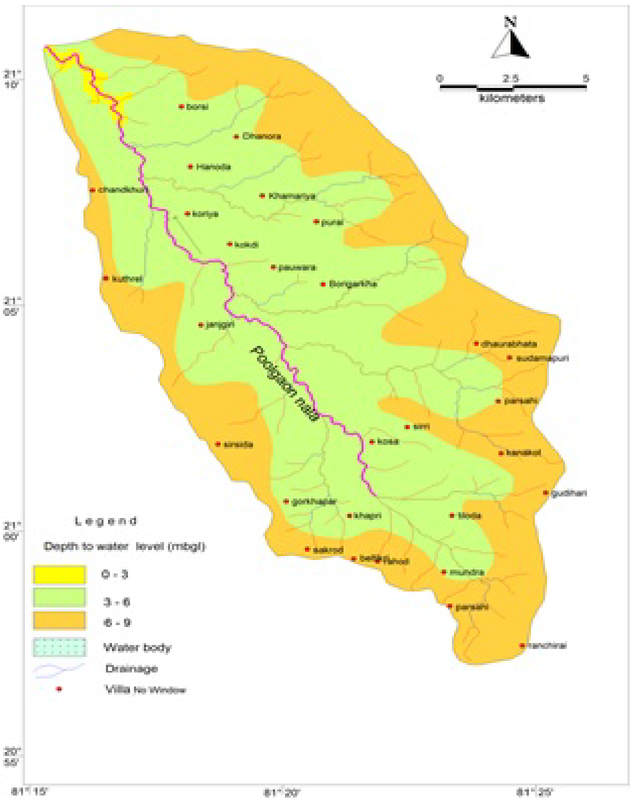

Figure 3: Post monsoon depth to water level I map of the study area.

than 5mbgl also covering southern portion (small area). Water levels 3 to 5 mbgl is observed in central part in major area, however in remaining part it ranges about 0 to 3 mbgl. Based on the pre-monsoon & post-monsoon data water level fluctuation in the study area is calculated & respective map has also been prepared. It is observed that in the study area water level fluctuation varies from 0.2 to 5.0 m. It is observed that water level fluctuation from 2 to 4 mbgl covering part especially in southern and central portion. Fluctuation more than 4 m is observed in patches in central part (Table 1).

It may be seen that in post-monsoon period, the depth to water level less than 3 m (minimum value) and was recorded at Koriya observation station. The maximum depth to water level recorded at Chandkhuri. In other wards it shows that in the area the depth to the water level during post-monsoon period is less than 6 m in almost 55% of the total area. The methodology adopted for artificial recharge is given below:

Based on post-monsoon depth to water level area feasible for artificial recharge has been demarcated and put into 3 categories (Figure 3).

1. Area showing water level 0 to 3 mbgl.
2. Area showing water level 3-6 mbgl.
3. Area showing water level 6-9 mbgl.

The maximum intensity of rainfall in mm/hr for a short duration (normally 20 min) will decide the peak flow to be harvested by the Check dams, Stop dams. The size of the structure and also which type of structure is suitable have to be estimated on the basis of the peak flow. Availability of source water to recharge the subsurface reservoir in the watershed has been assessed in the form of non-committed surplus run-off. The run-off is estimated by using Stranger's Table for the normal monsoon rainfall of the area. The watershed area falls in the category of average catchment. The normal monsoon rainfall of the area being 1196.33 mm. The percentage of run-off to rainfall as per Stranger's and the depth of run-off due to rainfall is 42.5 cm. The total yield of run-off generated from watershed having 259.7 Sqkm area works out to 110.37 mcm and 30% of the total run-off i.e., 33.11 mcm is considered as surplus monsoon run-off available for artificial recharge [10] (Table 2).

Results and Discussion

It is known that the objectives of the present study are to construct artificial recharge structures and do the rain water harvesting in the Pulgaon Nala Milli Watershed in which, most of the rain water goes as surface runoff and to have benefits to the users or population residing in downstream areas.

In experiment we found that the depth to water level in study area during pre-monsoon (May 2013) ranges between 14.80 to 22.80 mbgl and the post monsoon (Nov 2013) water level has been reported to be ranging between 7.90 to 12.50 mbgl. The water level fluctuation in the area varies about 5.80 to 12.10 m. We select area for water harvesting structures that area where seasonal fluctuation is higher than other area. In Figure 4 show that this color of area is gave first priority for artificial recharge which is 70% of total watershed area and 20% area gave second priority for artificial recharge for this watershed area. If we use runoff water for artificial recharge is most useful for citizen of that area [11].

Roof top rain water harvesting

There are 1 Urban Areas Pulgaon Nala Milli Watershed., which

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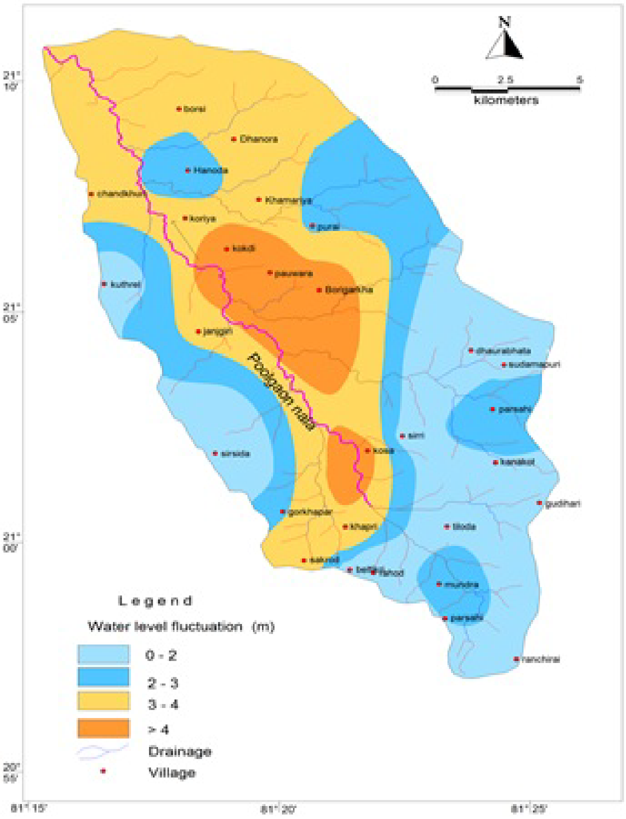

Figure 4: Seasonal water level fluctuation map of the study area.

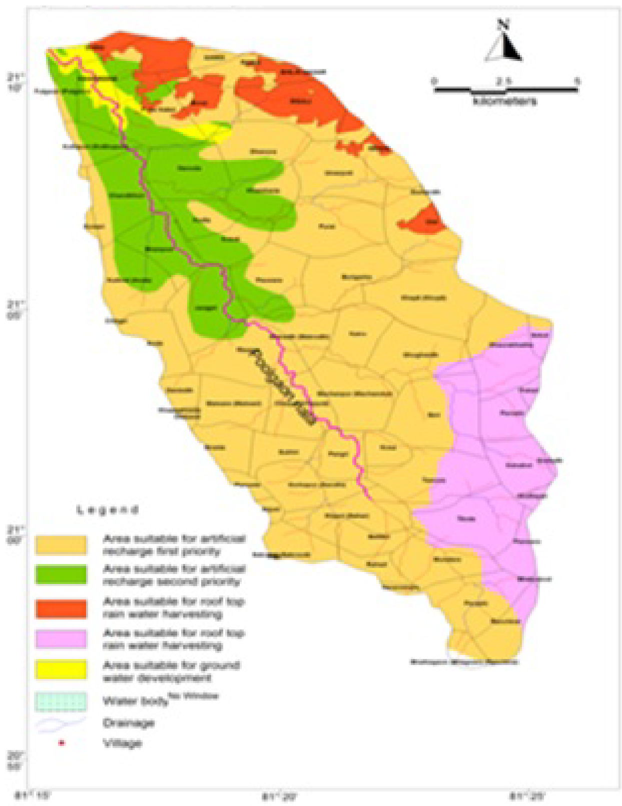

Figure 5: Management plan map for the study area.

S. No.	Name of village	Premonsoon (May 2013) depth to Water level (m bmp)	DTW Aug 13	Postmonsoon (Nov 13) depth to Water level (m bmp)	Water level fluctuation (m)	Decadal trend of ground water level	Geology
1	Hanoda	5.9	1.7	3.8	2.1	No change	Limestone
2	Dhanora	7.8	1.1	4	3.8	Rise	Limestone
3	Khamariya	8	1.3	4.5	3.5	No change	Limestone
4	Borigarkha	9	1.15	4.3	4.7	No change	Limestone
5	Purai	8.1	1.2	5.2	2.9	No change	Limestone
6	Borsi	8.7	0.6	5.4	3.3	Fall	Limestone
7	Kokdi	8.4	1.2	3.8	4.6	No change	Limestone
8	Pauwara	9.1	1.3	4.1	5	No change	Limestone
9	Janjgiri	8.7	1.3	5.4	3.3	Fall	Limestone
10	gorkhapar	8.5	0.8	5.6	2.9	Fall	Limestone
11	sirsida	7	0.78	6.2	0.8	Fall	Limestone
12	chandkhuri	10.6	2.3	7.2	3.4	Fall	Limestone
13	Kuthrel	7.9	1.3	6.4	1.5	Fall	Limestone
14	Sakrod	11	2.8	7.2	3.8	Fall	Limestone
15	Khapri	9.1	1.3	5.2	3.9	Fall	Limestone
16	sudamapuri	7.5	1	6.1	1.4	No change	Shale
17	kosa	9	1.3	4.8	4.2	Fall	Limestone
18	Sirri	7.5	1.3	5.7	1.8	Fall	Limestone
19	kanakot	8.2	1.2	6.3	1.9	Fall	Shale
20	Parsahi	9.2	1.4	6.2	3	Fall	Shale
21	dhaurabhata	6.7	1.2	6.1	0.6	No change	Limestone
22	Beltikri	8.3	1	6.6	1.7	Fall	Limestone
23	Rahod	6.3	1.8	6.1	0.2	Fall	Limestone
24	Parsahi	8.4	1.1	6.4	2	Fall	Limestone

25	ranchirai	8.2	1.6	6.5	1.7	Fall	Limestone
26	tiloda	7.2	1.15	5.7	1.5	Fall	Shale
27	mundra	8.9	1.21	5.9	3	Fall	Limestone
28	Gudihari	8.1	1.5	7.05	1.05	Fall	Shale
29	koriya	7	1	3.5	3.5	No change	Limestone

Table 1: Water level Data of Observation wells.

S. No.	Month	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Average
1	June	57.3	422	269.3	57.2	227.3	175.9	166.4	195.2
2	July	278.1	216.8	197	516.5	600.8	389.6	413.4	386.03
3	Aug.	444.2	304.4	241	253.3	302.7	285.9	376.8	328.12
4	Sep.	146.9	250.4	292.1	33.2	339.4	297.8	186.2	213.68
5	Oct.	2.6	12.6	8.9	36	6.6	13.3	11.3	35.87
6	Nov.	0	0	0	49.8	26.6	0	26.6	12.06
7	Dec.	0	0	0	0	3.6	0	1.6	0.52
8	Jan.	0	0	0	0	0	0	0	18.38
9	Feb.	11.6	3.3	0	0	0	0	0	3.65
10	Mar.	0	0	0	0	0	0	3	2.55
11	April	0	0	0	0	6.6	0	6.3	1.29
12	May	0	0	0	0	0	0	0	0
	Avg.	**940.7**	**1209.5**	**1009**	**946**	**1413.6**	**1162.5**	**1191.6**	**1196.33**

Table 2: Monthly data of Rainfall of Durg block.

covers an area of 25 ham with total number of houses around 5000, due to scarcity of water individual houses in most of the urban areas have gone for construction of bore-wells/ dug-wells for sustainable water supply. The total available water from roof top rainwater harvesting worked out to 26.75 ham (Figure 5).

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