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Ground Water Resources of Darrang District (Old), Assam: Utilization and Management Issues

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Abstract

Ground water or sub-surface water which occurs below the ground surface has now become an important resource though man has long been familiar with its development and uses. In the context of present day crisis of surface water, proper development, utilization and management of ground water resources constitute one of the principal components of development. Hydrogeologically, the entire Darrang district is occupied by alluvial sediments of Quaternary Age and thus, with sufficient ground water recharge from normally occurring rainfall the area has good ground water resource prospect. This paper is an attempt to analyze the spatio-temporal variations of ground water availability, quality, utilization and its management. In order to assess ground water availability, a sample survey was carried out covering the entire district during March and November, 2012 representing the pre-monsoon and post-monsoon seasons respectively. Water samples collected were analysed for quality assessment for the entire district and the results show marked variations in the regional occurrences of ground water with increasing potentials from north to central and southern parts of the district. Chemical analysis of collected water samples reveals that the ground water is fresh and suitable for both the domestic and irrigation purposes though sporadically higher concentration of iron has been noticed. In spite of good ground water resource prospect in the district, its development and utilization level is still not satisfactory. It is mainly used for drinking purpose and to a limited extent for irrigation purposes also. In a situation of meagre amount of rainfall during winter and uncertain monsoon rainfall during summer resulting crop failure, the potential ground water resources may be effectively used as the best alternative for which an assessment of its status, availability, utilization and management is urgently required.

Keywords: Ground water, hydrogeology, alluvium, recharge, quality assessment

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Introduction

Though seventy one percent (71%) of the earth's surface is covered with water but only about three percent (3%) of the total earth's water is fresh water, which is suitable for different purposes, such as domestic, agricultural, urban, recreational, industrial uses etc. With the rapid population growth, the demand for fresh water has increased tremendously worldwide.

Ground water constitutes the largest available source of fresh water, far greater than the surface water supplies in the form of all the lakes, reservoirs and streams. Broadly, the term 'ground water' is applied to all sub-surface water which is found in the soil pore spaces and in the fractures of sand, gravels and rock formations. All these rocks and unconsolidated deposits (silt, sand and gravels), which retain water is called aquifer. Though vast volume of water is found to be stored under ground, but its store is also not unlimited like the other natural resources. The ground water thus is an important resource and its role in respect of different needful uses has of late been an established fact. Hence, large scale development and management of ground water resources for economic as well as socio-cultural upliftment are now under serious consideration in all parts of the world. Keeping all these aspects in view, this study has been taken up to examine the availability, management and utilization pattern of groundwater of Darrang district (old), Assam.

Study Area

The study area, the Darrang district (old) is a part of the central Brahmaputra valley and also an administrative unit and is located on the north bank of Brahmaputra. It occupies an area of about 3481 km^2 with latitudinal and longitudinal extension from $26^0 14^/$ N to $26^0 48^/ 30^{//}$ N and $91^0 44^/$ E to $92^0 27^/$ E respectively. The district is bordered by Bhutan in the north, river Brahmaputra in the south and the Sonitpur and Kamrup districts to the east and west respectively (figure 1).

With characteristic floodplain features, younger and older alluvial plains dotted with small inselbergs, the study area, broadly represents a physiography of an alluvial plain with monotonous flat surface of elevation around 50 m from the sea-level. The area is gradually slopping towards south from foothills of the Himalayas in the north.

Thus, the rivers like Nanoi, Kulshi, Saktola, Noa-Nadi, Mangaldoi and Dhansiri are flowing towards south from the Himalayan foothills and join the Brahmaputra at different points of confluence. They bring with them huge amount of water and sediment discharge during rainy summer season and cause flood and sedimentation in low lying areas.

Geologically the entire district is occupied by Quaternary sediments of older and younger alluvium, where, the northern foothill part is covered mostly by old alluvium consisting of clay, sand, gravel, pebble and boulder, on the other hand, the southern new alluvium contains clay, silt and fine sand in maximum proportions.

With favourable physiographical, geological, lithological and climatic factors, the district happens to be an area of large reserve of under-ground water in regionally extensive aquifers up to a depth ranging from 50 to 300 m.

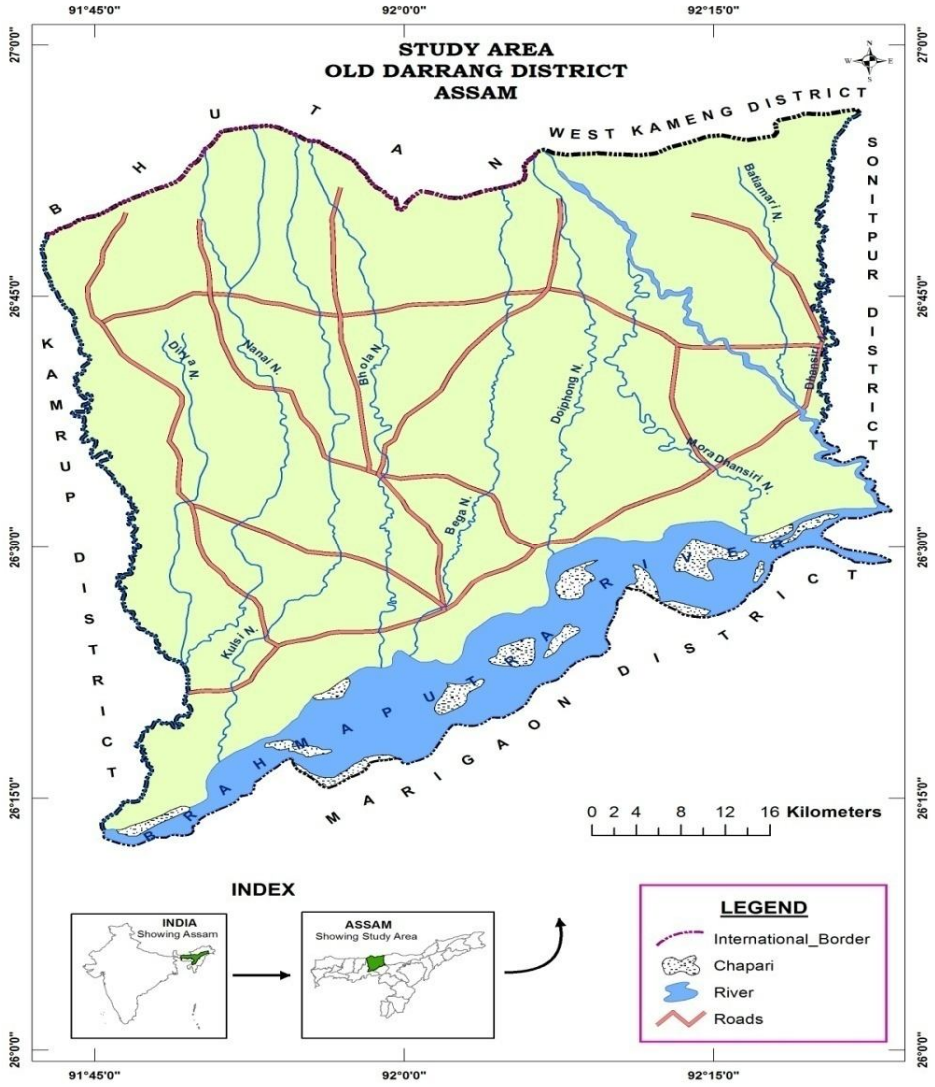

Figure 1: The Study Area

Objectives

The main aim of this paper is to study the ground water availability and its management and utilization aspects.

To achieve this primary aim, the following objectives are taken into consideration:

(i) To examine the ground water availability and its utilization pattern at different locations.
(ii) To relate the regional lithology with ground water occurrence.
(iii) To suggest measures for proper management and utilization of ground water.

Materials and Methods

The entire study has been carried out considering both primary and secondary data. The base map of the study area has been prepared from toposheets bearing numbers78N/13, 78N/14, 78N/15, 83B/1, and 83B/2 with R.F 1:50,000 of Survey of India. By dividing the entire district into three distinct physiographic parts viz. northern, central and southern, a household sample survey was carried out on open wells to understand water level fluctuation during March and November, 2012 representing pre-monsoon and post- monsoon periods respectively. Data on hydrological parameters including ground water availability and geological parameters including lithology were collected from the Central Ground Water Board (CGWB), N.E. Region, Govt. of India and Geological Survey of India.

Discussion

Locational Occurrence and Development of Ground Water

Groundwater occurs at various locations below the earth's surface according to the physical properties of various formations that exist. In Assam, the Brahmaputra valley covers its major portion and as per geological records it is underlain by unconsolidated formations of Quaternary age consisting of sand of various grades, gravels, pebbles and boulders with thin bands of clays and silt. Being located in the central part of the Brahmaputra valley, the entire old Darrang district has been occupied by one group of formation, i.e Quaternary alluvium of unconsolidated sediments. As per survey conducted by CGWB, over regionally extensive aquifers, the ground water is found to occur down to explored depth of 300 m and the aquifers have a very good prospect. The whole aquifers can be grouped into two broad aquifer systems from ground water development point of view.

These are (i) Shallow aquifer system- aquifer occurring within 50 m depth, and (ii) Deeper aquifer system- aquifer occurring within 50 m to 200 m depth. Both shallow and deeper aquifers consist of sand, gravel, pebble and boulder in the northern part. Ground water occurs under unconfined to semi-confined condition in shallow aquifers and an area of about 10 km^2 on north of Dumunichowki is under outflow condition. Ground water in deeper aquifers occurs under semi-confined to confined condition and has a very good yield prospect for ground water development.

As per survey conducted by CGWB and Directorate of Geology and Mining, it is seen that average aquifer transmissivity and permeability of tube wells constructed within 200 m depth in newer alluvium formation ranges from 1875 to 11894 m^2/day and 34 to 296 m/day respectively. The tube wells of southern and central parts of the district are capable of giving discharge of 50-100 m^3/hr. However, in the northern part where the tube wells constructed in the older alluvium upto depth around 70 m the computed transmissivity value ranges from 270 to 616 m^2/day and permeability value ranges from 12 to 27 m/day which are comparatively lower than the aquifers of central and southern part.

The underground water level fluctuation is a natural phenomenon that determines the ground water availability. The water level fluctuates due to seasonal changes especially in the amount of precipitation and evapotranspiration. It should be mentioned that there is no any influence of ground water level fluctuation in the study area on account of ground water exploitation as the study area is not under pressure of intensive exploitation of ground water. The seasonal and regional monitoring of water level fluctuations especially for post and pre-monsoon periods also show mark regional variations. As per calculation the water level fluctuation ranges from 0.4 m to 2.70. In the northern part of the entire district, the value of fluctuation is more than that of southern and central parts. The high value of groundwater level fluctuation is an indication of recharge zone, while the low value indicates discharge zone.

A sample survey which was carried out during March and November, 2012 of 100 wells located in different locations of northern, central and southern parts of the district (table 1) also shows the similar trend of water level fluctuation as recorded by CGWB. The wells located in the northern part have shown higher value of water level fluctuation than that of the central and southern parts. During the survey it has been observed that the range of water level fluctuation between the two periods (pre-monsoon and post-monsoon) varies from 1 m to 2.95 m.

Higher value of water level fluctuation in the northern part may be partly because of its lithological behaviour of old alluvium sediments characterized by low values of transmissivity and permeability.

The gradient of water level contours may be another very important cause for such variation of fluctuation. As per survey during March and November, 2012 made on about 100 wells located in different parts from north to south, a gradual tendency of lowering water table gradient is observed, which has been found to be 1.1 m/km towards north and 0.4 m/km towards south. In the figure 2 a distributional pattern of hydrogeological parameters have been shown.

Besides, long dry season and uncertain rainfall, lack of wetlands and water bodies especially in the northern part and lack of artificial recharge mechanism may cause lowering of water table during post monsoon period.

Table 1: Fluctuations of Groundwater Level During Pre-Monsoon and Post-Monsoon Period in Darrang District (Old)

Parts of the district	Sl. No.	Localities	No. of wells surveyed	Average Water level Below Ground level(m)		Fluctuations of water level in m	Average fluctuations of water level
				March, 2012	November, 2012		
Northern	1	Khairabari	12	5.82	3.78	2.04	2.03
	2	Paneri	11	7.93	4.98	2.95	
	3	Rowta	10	4.78	2.89	1.89	
	4	Udalguri	9	4.95	3.68	1.27	
Central	5	Kalaigaon	12	5.43	3.76	1.67	1.47
	6	Orang	10	4.53	3.53	1	
	7	Chamuapara	7	5.36	3.63	1.73	
Southern	8	Mangaldoi East	10	5.59	4.12	1.72	1.52
	9	Mangaldoi West	10	5.83	4.43	1.4	
	10	Dalgaon	9	4.85	3.39	1.46	

Source: Sample survey carried on wells during March and November, 2012

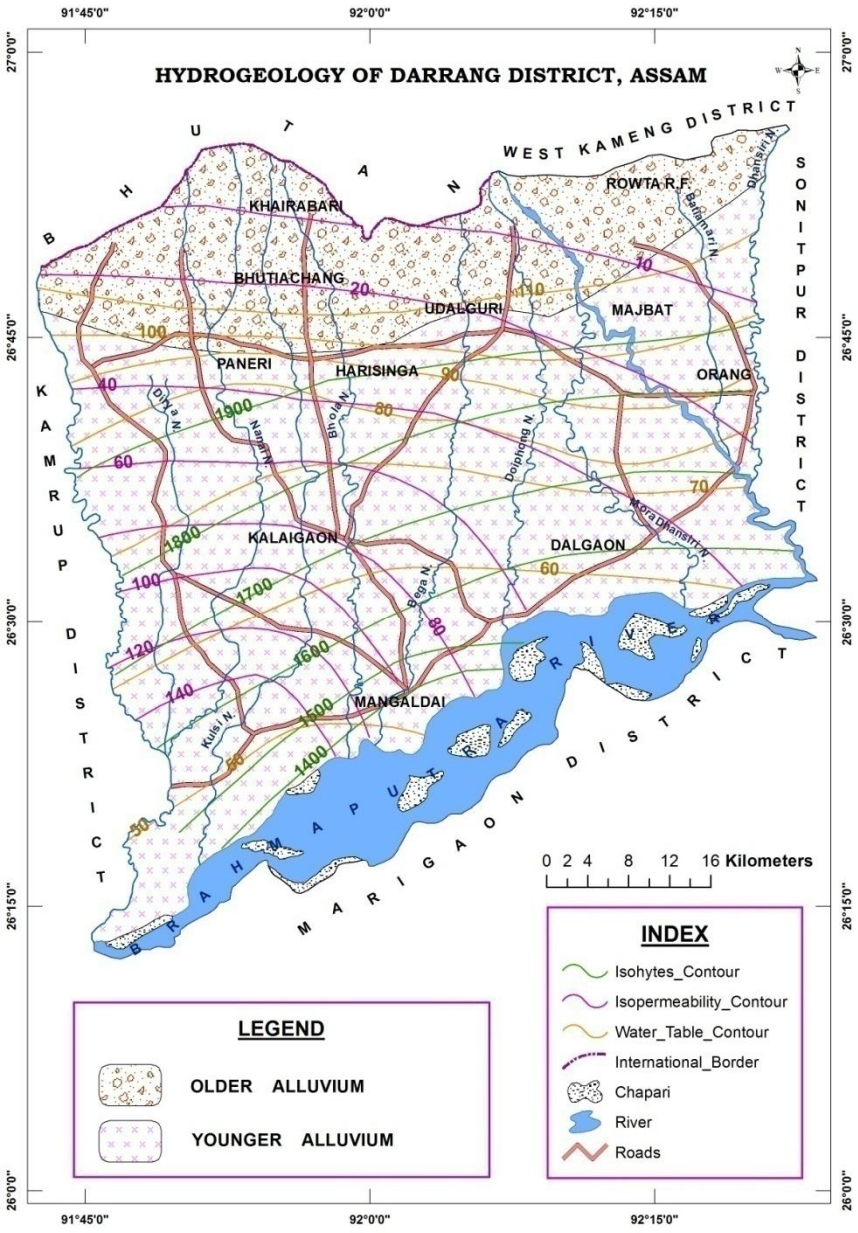

Figure 2. Hydrogeology Map of Darrang District (old)

The entire district is very much suitable for ground water development through provisions like open wells, shallow and deep tube wells. Open wells and filter point wells are feasible all over district for drinking and other purposes.

For agricultural purpose, shallow tube wells are feasible mainly in the central and southern parts. But in spite of having such tremendous scope, the present status of ground water development in the district is at low stage. As per calculations made by Central Ground Water Board, the annual ground water resources are estimated to be 1150 million cubic meter, while the net annual ground water draft is 460 million cubic meter. The present stage of ground water development is about 40% which indicates that the sufficient water resources are still available for development (Table 2).

Table 2: Dynamic Ground Water Resources (as on March, 2004) in Million Cubic Meter

Annual Replenishable Ground Water resources	1150
Net Annual Ground Water Draft	460
Projected demand for domestic and industrial uses upto 2025	52
Stage of Ground Water development	40%

Source: CGWB, N.E.Region, Guwahati, Govt. of India

The quality of ground water has always been influenced by the presence of some heavy metals. Of course, some of the heavy metals such as zinc, cobalt, copper, iron etc are essential for normal growth of life, but their higher concentration causes physiological disorders. Some heavy metals like cadmium, lead, chromium etc. are highly toxic to human beings. Ground water which is considered as the main source of drinking water should always be free from such toxic elements. Heavy metals can reach the ground water through natural process like weathering of rocks and soils, leaching of ore deposits etc. Now a day, anthropogenic activities like dumping of solid-waste, industrial effluents, use of chemicals, domestic garbage etc. are contributing heavy metals to ground water mainly in the urban areas. A chemical analysis carried out at the District laboratory, Dept. of PHE, Mangaldoi, Darrang on 100 water samples collected from different locations (dug wells) of the entire study area suggest that the ground water is almost fresh and suitable for both domestic and irrigational purposes. The analysis clearly reveals that the presence of Mg, Ca, Fe, and Cl is at desirable level. The pH value also shows the comfortable limit in all the locations. Of course, sporadic concentration of iron has been observed.

Except few locations like Mangaldoi and Dalgaon, most of them clearly fall within the desirable as well as permissible limits of iron concentration during pre-monsoon and post-monsoon period (Table 3).

Table 3: Chemical Analysis of Some Parameters of Water Samples Collected from Wells of Different Locations of the Study Area

Parameter	Indian Standard (1983)		Observed value at different sample points									
			Northern part				Central part			Southern part		
	DL	PL	Khoirabari	Paneri	Rowta	Udalguri	Kalaigaon	Orang	Chamuapara	Mangaldoi East	Mangaldoi West	Dalgaon
pH	6.5	9.2	7.32	7.45	7.64	7.53	7.18	8.02	8.03	7.23	7.82	7.31
Ca (mg/l)	75	200	41	38	58	52	57	21	38	43	25	22
Mg (mg/l)	30	100	17	15	6	5	7	5	11	24	14	9
Cl (mg/l)	250	1000	34	23	58	31	65	23	25	87	23	25
F (mg/l)	1	1.5	0.79	0.71	0.54	0.72	0.65	0.15	0.72	0.41	0.72	0.16
Fe (mg/l)	0.3	1	0.69	0.81	0.62	0.75	0.81	0.93	0.63	2.13	0.72	3.9

DL: Desirable Level **PL:** Permissible Level

Note: Laboratory Analysis done in the District Laboratory, Dept. of Public Health Engineering (PHE), Mangaldoi, Darrang, Govt. of Assam.

Lithology and Ground Water Availability

Moist soils and rocks contain ground water. Saturated strata from which it is feasible to obtain groundwater are called the aquifers. The main source of groundwater is infiltration. The infiltration of water after meeting the soil moisture deficiency percolates down deeply and becomes groundwater (Reddy,J. P., 1986). Occurrence of water below the ground depends on the physical properties of the formations, i.e lithology. In order to qualify as an aquifer a soil stratum should not only have pore spaces, but it should be large enough so as to permit the removal of water at reasonably useful rates. Sedimentary materials make up the largest percentage of the world's aquifer, including coarse unconsolidated materials.

As the area is mainly occupied by unconsolidated sediments of new and old alluviums and it receives an annual average rainfall of 2550.3 mm (as per data collected from different raingauge stations located in the study area), it has good groundwater resource prospect. The northern part receives an annual average of 2855.7 mm, central and southern parts receive an annual average rainfall of 2563.4 mm and 1908.1 mm respectively. Thus, it is the most important aquifer system from the groundwater development point of view.

The old alluvial deposits occur in the north-western part of the district with 4 to 13 km width along the foothills of Eastern Himalayas. This can be further sub divided into two groups- high piedmont alluvial and low piedmont alluvial zones. The high level piedmont zone comprises coarse sediments of boulders, pebbles and sands. The sizes of these sediments gradually decrease towards south. This lithological structure is highly porous and highly permeable and many small streams recharge the zone continuously. Groundwater occurs in this zone with shallow aquifer under un-confined and semi-confined conditions having low yield prospect.

The remaining part of the district, i.e the central and the southern part comprising new alluvial or younger alluvial of Recent or Sub-Recent age stretches from the southern edge of the low level piedmont zone to the northern bank of Brahmaputra. The sediments mainly composed of gray coloured sands of varying sizes and little gravel with clay intercalation are highly suitable for storing of groundwater and, thus the southern part of the entire district is highly rich in groundwater potentials. In this lithology, the ground water in deeper aquifer occurs under semi-confined to confined condition and there is a good yield prospect for development through deep tube wells. During field survey it was observed that the tube wells constructed in the newer alluvium had their efficient discharge capacity.

Utilization and Management of Groundwater: Some Suggestions

Underground water is one of the most important natural resources. Hydrogeologically, except a few pockets in the northern part of the district, the entire area is rich in underground water as it is occupied by alluvial sediments of Quaternary age. Underground water occurs under un-confined condition in shallow aquifers and under semi-confined to confined condition in deeper aquifers.

With growing dimension of human activities the demand of underground water has also been increasing in the district like in the other parts of the country. Therefore, proper understanding of the status, development, management and conservation of this precious resource is very essential for the developmental plans and programmes of the district. In this regard, the following are some suggestions which may help the planners and development agencies for proper utilization of the resource.

(i) Agriculture is the main economy of the people living in the district which is mainly dependent on uncertain natural rainfall. Agricultural development is thus highly essential for which special stress is to be given on irrigation, especially through utilization of underground water resources.
(ii) The irrigation water is highly essential in many areas during cultivation of winter crops (rabi crops) when the surface water irrigation becomes insufficient. Hence, ground water irrigation is a must.
(iii) To decrease the base flow of the area in the monsoon period and also to increase agricultural productivity, a massive groundwater development programme is very important which may help recharge the area during post monsoon period.
(iv) The rich aquifer system covering the entire district formed by alluvial deposits is very suitable for groundwater development and thus for drinking and other purposes the construction of individual open wells, filter points wells and even deep wells are feasible all over the district.
(v) For sufficient groundwater development the existing defective and defunct ground water extracting structures should be removed by some new structures.
(vi) The farmers living in the auto flow areas having shallow tube wells have the great advantage for free discharge. For economic use of the ground water they should arrange the cap system in discharge pipes.
(vii) In the extreme northern foothill areas where shallow tube wells are not feasible, deep tube wells and storage tank to collect water during monsoon may be constructed.

Conclusion

Ground water has been an important water resource throughout the ages and it is often considered as the only reliable source of fresh water. The study area occupied by unconsolidated Quaternary sediments with rich aquifers, has the high prospects of underground water development.

The present status of development of this resource is, of course, at low stage. The seasonal water table fluctuation is more in the northern part than the central and southern parts. The causes behind the seasonal water table fluctuations are natural and not due to any over exploitation of ground water resource. Except occasional concentration of iron, the entire area has fresh water reserve suitable for both drinking and irrigational purposes. The entire area except a narrow belt along the northern foothill is feasible for groundwater development through different groundwater extraction structures. Considering agriculture as the mainstay of the people living in the area due stress should be given on groundwater utilization so as to raise rabi crops during rain-deficit winter season and kharif crops during summer season of uncertain monsoon rains.

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