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GROUNDWATER LEVELS AND WELL WATER QUALITY IN AND AROUND CWRDM CAMPUS, KOZHIKODE

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ABSTRACT

In spite of the fact that Kerala receives a very good amount of annual rainfall, its uneven distribution and undulating topography results in low retention of the precipitation and high surface runoff. So the most effective ways to increase the water availability in this situation is insitu water conservation and artificial groundwater recharge. CWRDM has got about 70 acre campus in Kunnamangalam block which falls under semi-critical category. The topography is undulating and the area falls in two watersheds, receives an average annual rainfall of 3200 mm with the surface runoff draining to Kallai River. The soil type in the area is lateritic with hard laterite exposed at certain patches. Cropping pattern is coconut, cashew and mixed tree crops. The area is drained by streamlets spread over two watersheds and having a ridge in between. Monthly water levels and well water quality in CWRDM campus and adjacent areas were monitored for providing artificial recharge to augment groundwater resources. There are many dug wells in the campus (depth varies from 7 m-10 m). It is observed that the overburden thickness varies from 1m to 10m. The charnockite gneiss underlying the weathered zone is fractured at various depths and most of the bore wells are low yielding. The depth to water level observed between 4 to 9 m during peak summer (March/April), depending on the topography. The observed specific yield of the aquifer in the area is 0.03. The observed dynamic yield according to the studies conducted by CWRDM is of the order of 6500 cubic metres. The concentration of all the dissolved species, in shallow wells falls within limits prescribed by drinking water standards (BIS) except pH. The TDS concentration of the hard rock aquifer of the region is higher compared to the laterite aquifer. Iron records higher concentrations in bore wells according to the standards.

Keywords:. *Artificial Groundwater Recharge, CWRDM campus, Kozhikode, Kerala*

INTRODUCTION

In spite of the fact that Kerala State receives a very good amount of annual rainfall, its uneven distribution and undulating topography results in low retention of the precipitation and high surface runoff. Drought and acute water scarcity have become a recurring and regular phenomenon every year immediately after the cessation of monsoon. Studies indicate that landuse / landcover changes have a negative impact on groundwater recharge in many areas. Due to the nature of rainfall distribution, the valley areas get flooded during rainy season and sloppy uplands dry up during summer [1]. One of the most effective ways to increase the water availability in this situation is *insitu* water conservation and artificial groundwater recharge.

The Centre for Water Resources Development and Management has got about 70 acre campus at Kottamparamba in Kozhikode District. The area is under Kunnamangalam block which falls under semi-critical category as per the groundwater resource assessment estimates of the year 2017 [2, 3]. The stage of groundwater development in the block is 86.06%. The topography is quite undulating and the area falls in two watersheds (Peringalom and Mundikkalthazham) which receives an average annual rainfall of 3200 mm with the surface runoff draining to Kallai River. Presently the water requirement of the Centre is partially met from the wells within the campus and partially through pumping water from nearby Poonurpuzha. During the summer season the flow in this river is negligibly low.

Some amount of Kozhikode city water supply is met from this river. To tide over the water scarce situation in CWRDM campus and to make the Centre water self sufficient, this project has been proposed. Widespread groundwater recharge and rain-water harvesting measures in the campus has been proposed under this project, which will not only contribute to the groundwater augmentation, but also serve as a demonstration of scientific water conservation and management for others to follow.

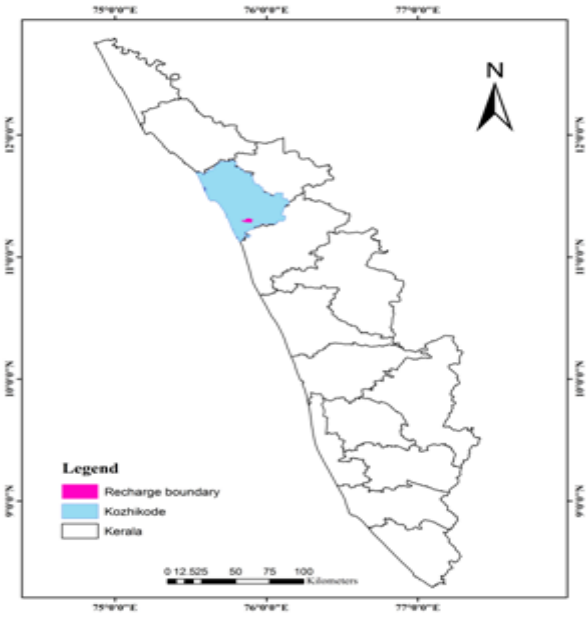

Fig.1:Location of CWRDM Campus within Kerala

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CWRDM being a premier research organization established by the Government of Kerala in the water sector, the groundwater recharge measures proposed to be implemented within the campus under this project will act as demonstration model. These can also be shown as working models to the trainees who undergo various training programmes being conducted in the Centre on a regular basis under the Water Resources Management and Training Project. CWRDM has a Water Resources Museum which is open to the public. Throughout the year, students from many schools visit the Water Museum. The proposed structures will be added educational information for the students.

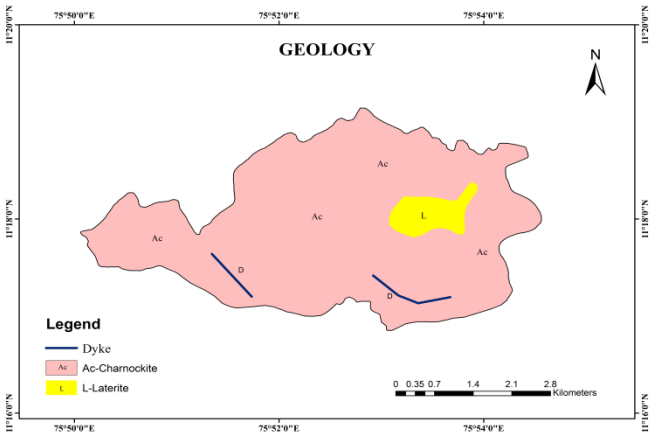


Fig.2:Geology of CWRDM Campus

Centre for Water Resources Development and Management (CWRDM) is having its Headquarters at Kozhikode district. (11° 17' 07" N, 75° 52' 15" E). It comes in Kunnamangalam Block, Kallai river basin under Peringalom and Mundikkalthazham watersheds. Around 200 Employees & project staff work in the office and 250 family members live in the quarters. Besides this, a floating daily population of trainees/visitors/guests/ labourers (about 100) present**.** The **c**ultivable area is 23 ha, non-cultivable area is 5 ha. The soil type is Lateritic with hard laterite exposed at certain patches. It comes under the soil class Ultisol and soil series Kunnamangalam. The soil is sandy loam to clayey loam in texture.

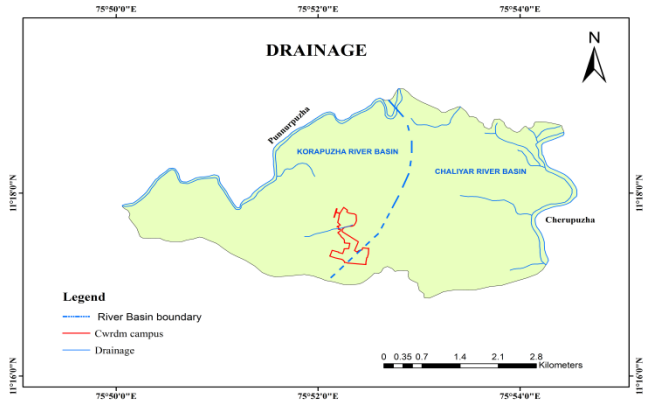


Fig.3:Drainage map of CWRDM Campus

The infiltration rate of the soil ranges from 0.414 cm/hr to 8.28 cm/hr and water retention capacity of the soil is low (110-130 mm). Kaolinitic type of clay is present in the soil, therefore cation Exchange Capacity (CEC) of the soil is low. Bulk density of the soil ranges from 1.2-1.4 gm/cc. The saturated hydraulic conductivity of the soil ranges from 1.2×10^{-2} cm/sec to 3.5×10^{-2} cm/sec within the soil profile. A peculiar characteristic of laterite soil is increase in clay content with increase in depth of soil. The illuviation under lateritisation may be main reason for increasing clay content and in turn lower hydraulic conductivity of the lower layer. The depth of soil ranges from 1.50 m - 2.00 m. Below 1.50 m -2.00 m, a layer of laterite stone is found. Because of the impervious layer underlying the laterite, ground water recharge is low. Cropping pattern is coconut, cashew and mixed tree crops. Area under irrigation is nil except ornamental and garden plants of about 700 pots and 0.3 ha lawns.

Humid tropical climate experiences in the area with annual rainfall of 3233 mm, with average annual (for 10 years) 3233 mm measured by the CWRDM rain gauge in the campus. The no. of rainy days is 130 with peak intensity : 100-120 mm/day. Drought period is Jan- May with Temperature range of 24-34^0 C. The Humidity is 80-90%, Potential annual evaporation is about 1174 mm and Wind speed is 3-4 Km/hr. Generally undulating midland topography is seen. The elevation ranges between 74m to 130 m above MSL. The slope direction is south east and south west with slope ranging from 5 to 50% and certain pockets exhibits even higher values.

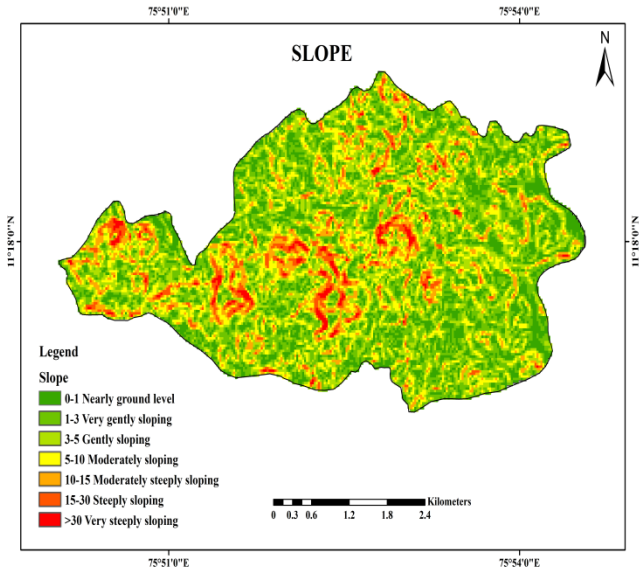


Fig.4:Slope map of CWRDM Campus

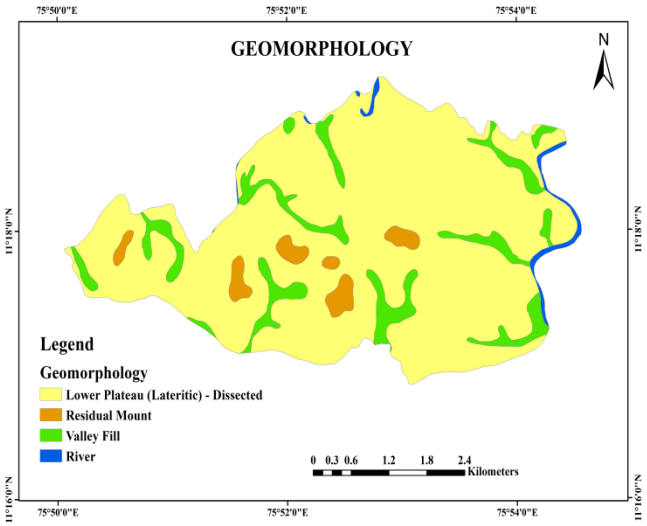


Fig.5:Geomorphology of CWRDM Campus

Geomorphologically the area is drained by streamlets spread over two watersheds and having a ridge in between. Major portion of the surface runoff is draining out of the campus. Part of the surface runoff is harvested and stored in two tanks. Three ferro-cement tanks are also constructed to store roof top water. Geologically CWRDM campus is covered by primary laterite overlying archaean metamorphic rocks. There are two laterite mounds with outcrops of charnockite gneiss at some places which is separated by a broad valley. The valleys and other low lying areas are occupied by unsorted fill materials and laterite, below which Charnockite is expected. The thickness of laterite and valley fills varies from a fraction of a metre to few tens of meters. In the area varying trends of outcrops have been observed. Also numerous quartzo-feldspathic intrusions have been seen in the area. The laterite at many places retains most of the parent structures [4].

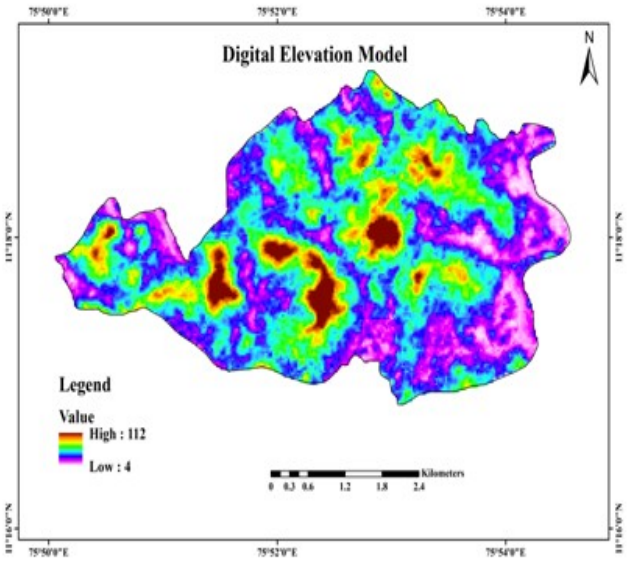


Fig.6:DEM of CWRDM Campus

MATERIALS AND METHODS

Observation well network was fixed taking into account the watershed boundaries around the campus. 26 open wells were selected for monthly water level measurements in and around the CWRDM campus. Well details like total depth, depth of top soil, laterite and lithomerge clay thickness, depth of overburden etc were collected in addition to the well details. Monthly water levels were measured for one year period (July 2017 to July 2018) and spatial contour maps were prepared in ArcGIS software for every month. Water samples were collected from 20 wells selected to assess the drinking water quality [5]. The parameters analysed are pH,Turbidity, TDS, TH, TA, Chloride, sulphate, calcium, magnesium, iron, Total coliforms and E.Coli. The spatial variation maps of the parameters were prepared. Geology, Geomorphology, drainage, contour maps, DEM, slope maps were also prepared.

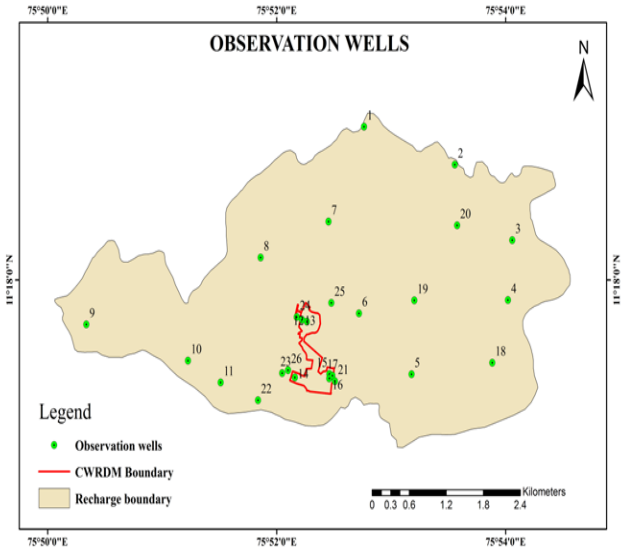


Fig.7: Locations of observation wells

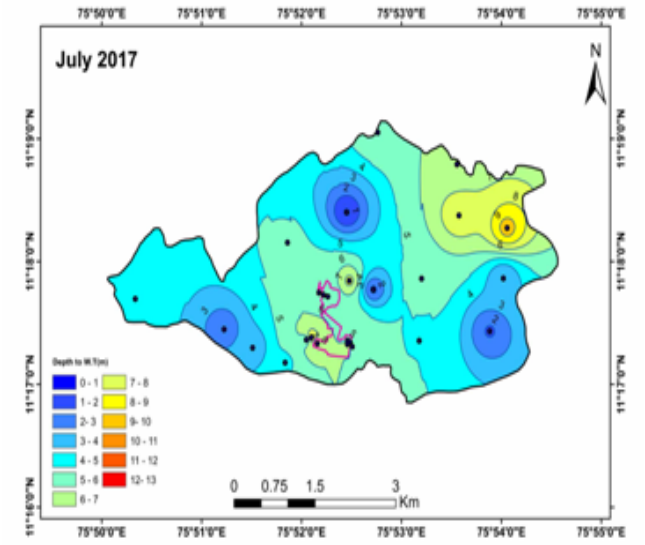
RESULTS AND DISCUSSION

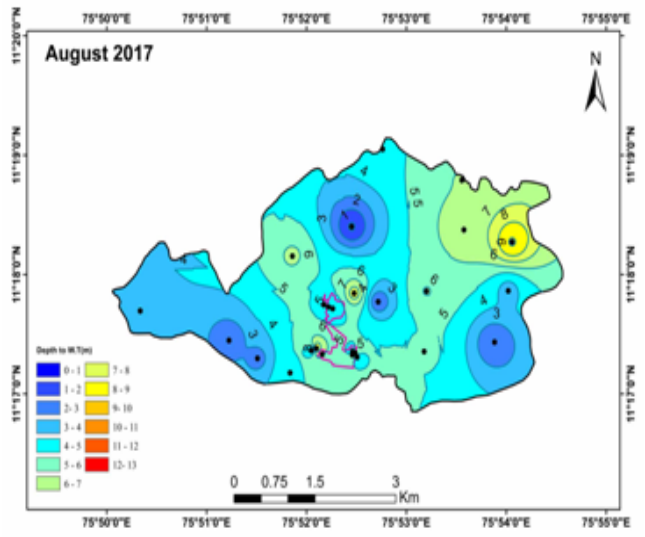
There are fourteen dug wells in the CWRDM campus. Depth of these wells varied from 7 m to 10 m. From the exploratory borehole lithologs and road cuttings, it is observed that the overburden thickness varied from 1m to 10 m. The clay layer overlying the weathered rock varies in thickness from 30 cm to 1m. The Charnockite gneiss underlying the weathered zone is fractured at various depths and most of the bore wells are low yielding. Two aquifers exist in the campus area- shallow aquifer in lateritic formation and deeper one is fractured hard rock aquifer. All the dug wells in the campus are in the lateritic aquifer and none of them have reached the hard rock aquifer. The depth to water level varies between 4 to 9 m during peak summer months (March/April), depending on the topography. The observed specific yield of the aquifer in the area is 0.03,

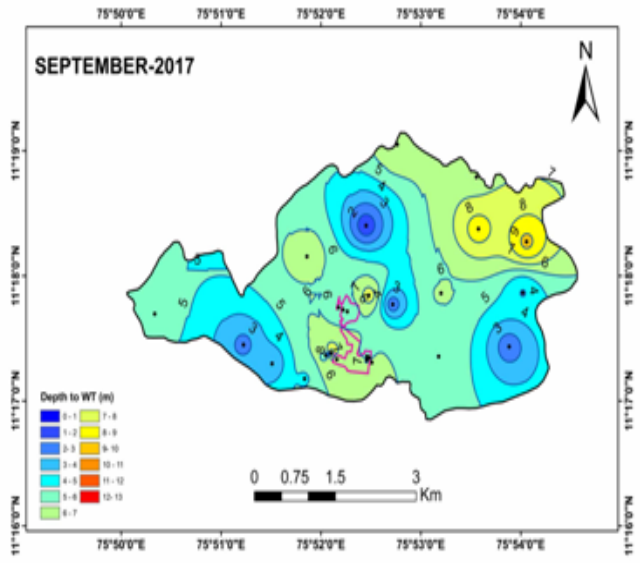
which is typical to laterite. The observed dynamic yield according to the studies conducted is of the order of 9.4 cubic meters. The concentration of all the dissolved species, in shallow wells falls within limits prescribed by drinking water standards (BIS) except pH. The TDS concentration of the hard rock aquifer of the region is higher compared to the laterite aquifer water samples. Iron record higher concentrations in bore well water samples.

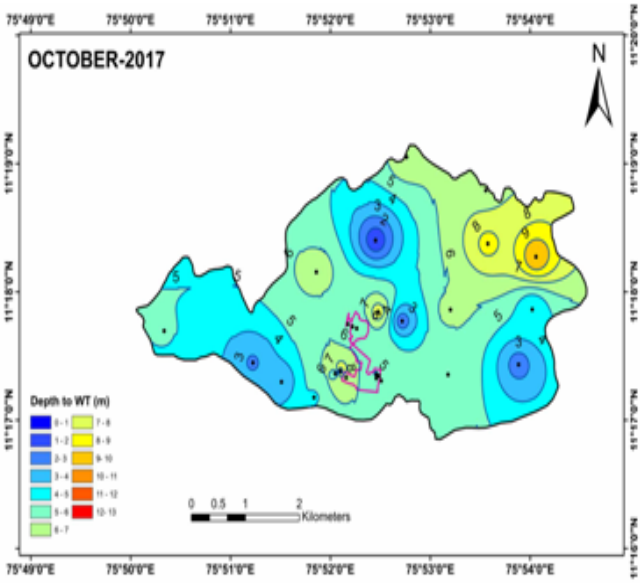
Monthly water level fluctuations

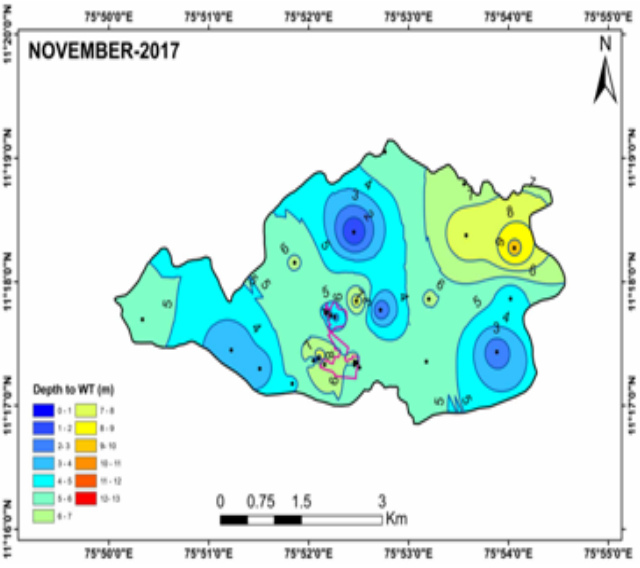
In July 2017 the water level of the wells ranges from 0.94-9.38 m bgl and subsequent months the water level ranges as follows: 0.91-9.08 (Aug), 1.44-9.2 (Sept), 1.37-9.81 (Oct), 1.98-9.25 (Nov), 1.74-9.39 (Dec), 2.16-9.64 (Jan), 3.26-10.65 (Feb), 4.09-12.2 (Mar), 4.3-12.43 (Apr), 3.58-11.33 (May), 1.46-10.1 (Jun) and 0.91-8.11 for July 2018. The spatial variation of water levels are given in the Figure 8 below.

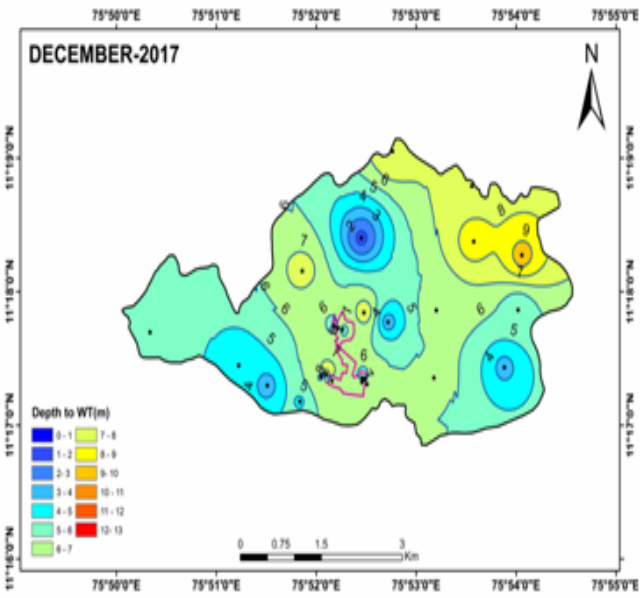


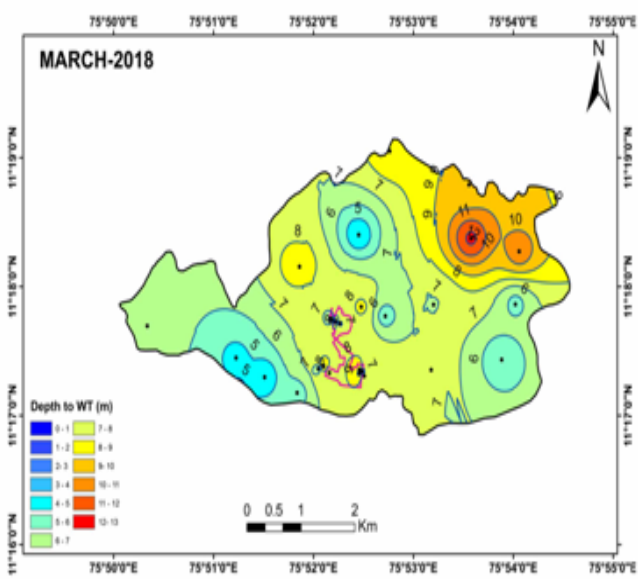


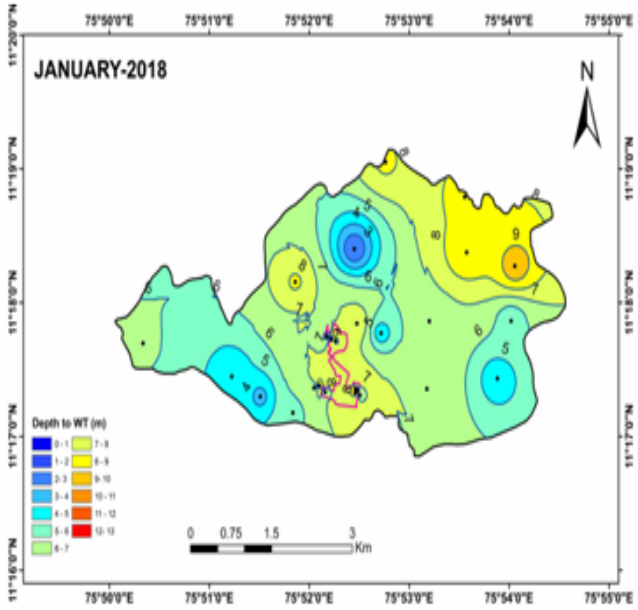







DECEMBER-2017
N
Depth to WT(m)
0 0.75 1.5 3
Km


MARCH-2018
N
Depth to WT (m)
0 0.5 1 2
Km


JANUARY-2018
N
Depth to WT (m)
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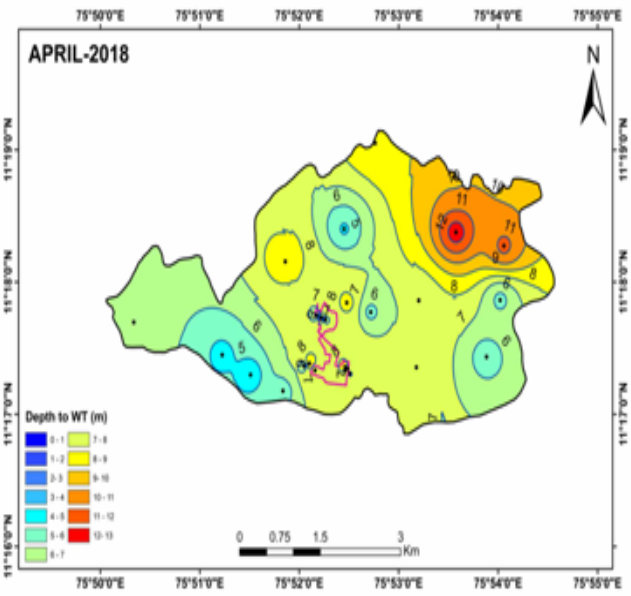
Km


APRIL-2018
N
Depth to WT (m)
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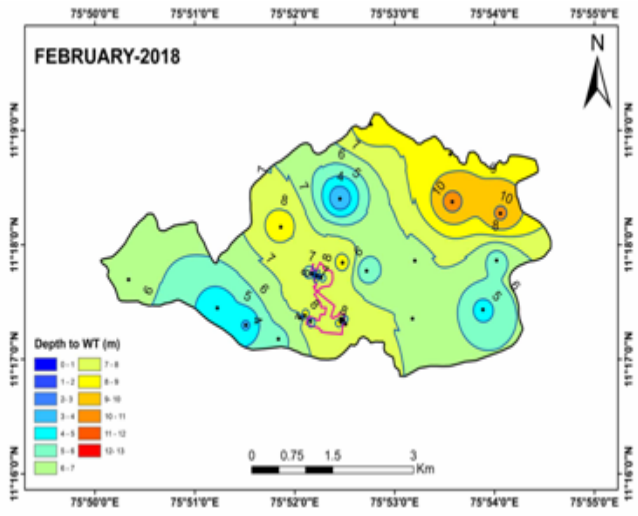
Km


FEBRUARY-2018
N
Depth to WT (m)
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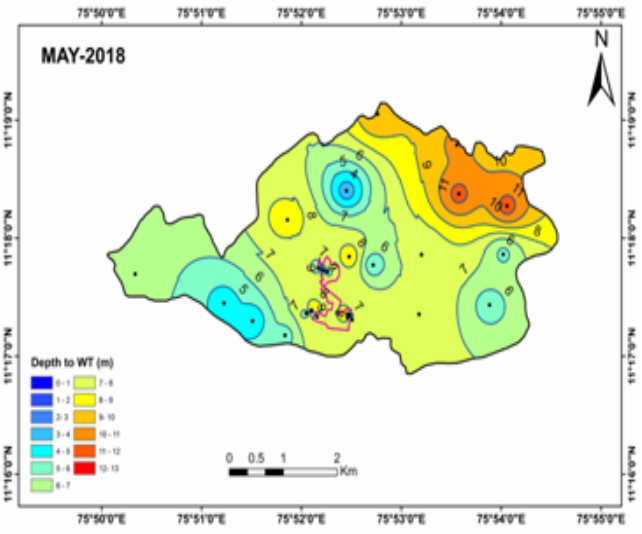
Km


MAY-2018
N
Depth to WT (m)
0 0.5 1 2
Km

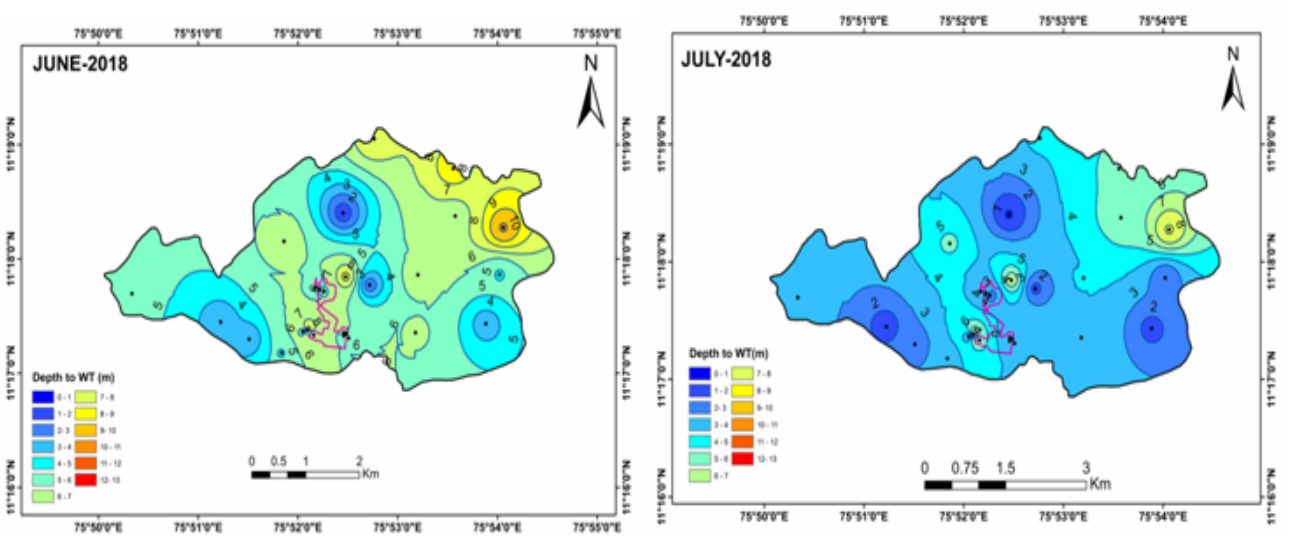
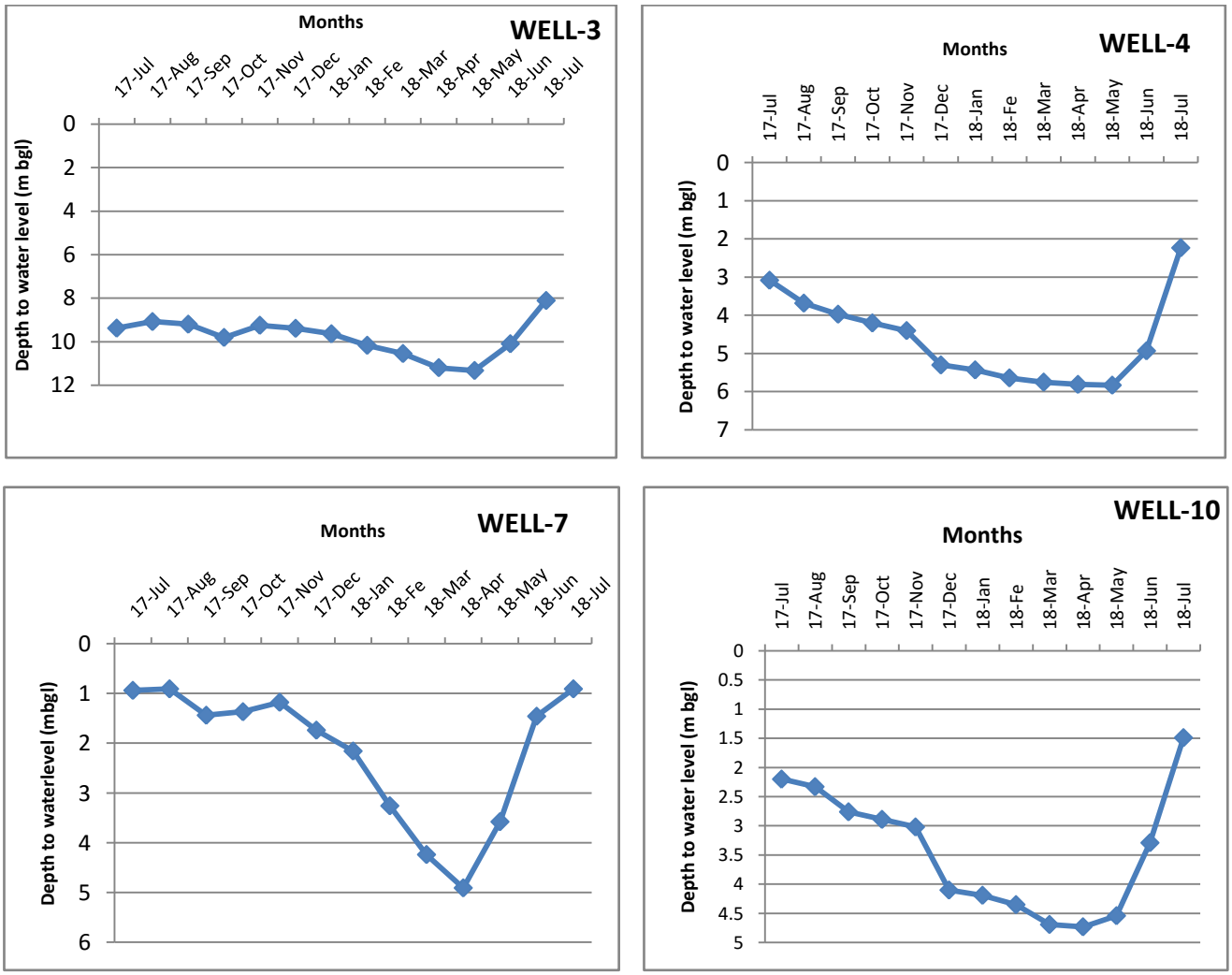


Fig. 8 Depth to water level during different months

Well hydrographs

Monthly water levels were plotted in graphs to construct the well hydrographs which connect water levels of everymonth. From the graphs obtained, it is seen that some typical well hydrographs are obtained and it is given below (Fig.9).



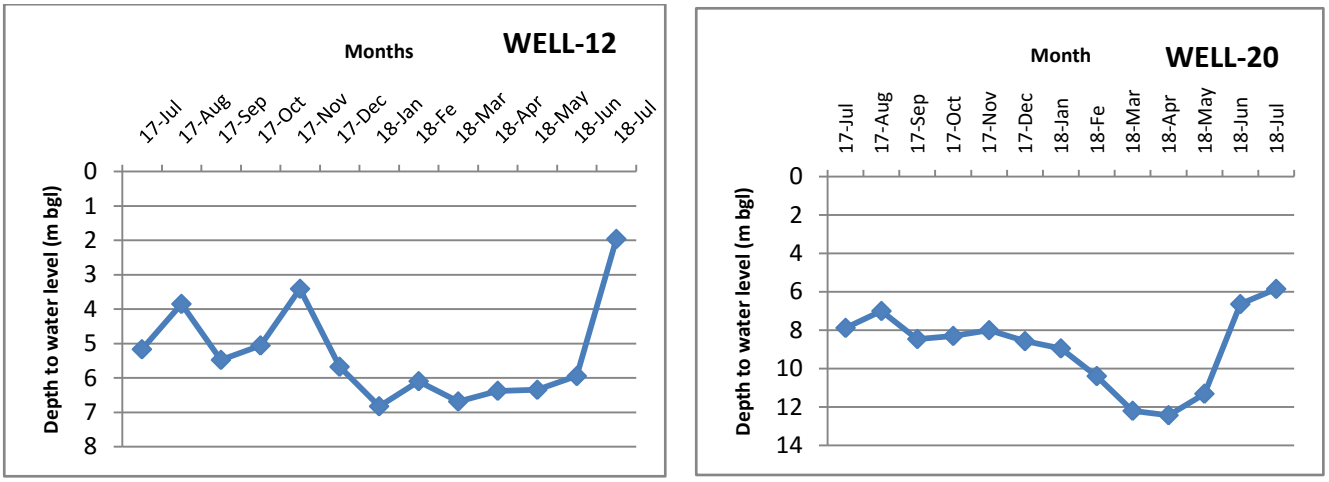


Fig.9 Well hydrographs

The well hydrograph represents the pattern of groundwater utilization, rainfall and recharge. The hydrograph of the well-3 is normal type with maximum utilization in April and May. August and November received maximum recharge orminimum utilization. Four types of well hydrographs observed in the study area. Two types are showing smooth trendswith normal fluctuations and others are showing sharp trends. This trend indicates the soil properties, depth ofoverburden and depth to bedrock and also the abstraction pattern. Nearly flat hydrographs are also seen in two placesindicating very less fluctuation in water levels.

Well water Quality

About 20 dug well samples were analyzed to assess the groundwater quality in the campus and its vicinity. The pH of the samples found varying from 5.02-6.28 and turbidity from 0.2-16.3 NTU. TDS varies from 24-88 mg/l. TH and TA varies from7.92-47.52 mg/l and 4-44 mg/l respectively. The chloride concentration in the water samples varied from 3.96-23.74 mg/l and sulphate from <1-12.6 mg/l. The calcium concentration varies from 1.58-11.09 mg/l and magnesium from <1-4.81. Iron is below detectable limit in

Table 1: Water quality parameters of the well water samples in the study area

Well No	pH	Turbidity (NTU)	TDS (mg/l)	TH as $CaCO_3$ (mg/l)	TA as $CaCO_3$ (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Total coliforms (MPN/ 100 ml)
6	5.55	0.4	50	11.88	12	11.87	2.12	3.17	<1.0	BDL	100
12	5.42	1.7	41	15.84	24	11.87	<1.0	3.17	1.92	0.56	Absent
13	5.45	0.4	58	31.68	32	15.82	1.32	7.92	2.89	BDL	9300
14	5.63	0.5	25	11.88	16	7.91	<1.0	3.17	<1.0	0.21	100
15	5.65	0.8	61	15.84	16	11.87	1	3.17	1.92	BDL	700
16	5.51	0.9	38	19.8	24	7.91	<1.0	4.75	1.92	BDL	400
17	5.61	BDL	80	15.84	8	23.74	1.72	3.12	1.92	BDL	700
21	6.05	0.2	40	11.88	12	7.91	3.44	3.17	<1.0	BDL	100
22	5.02	0.4	39	11.88	12	15.82	1.16	3.17	<1.0	BDL	400
23	5.67	0.4	33	11.88	12	11.87	1	3.17	<1.0	BDL	400
24	5.74	0.3	44	19.8	12	11.87	<1.0	3.17	2.89	BDL	100
25	5.98	BDL	40	19.8	16	7.91	<1.0	4.75	1.92	BDL	7500
26	5.53	BDL	24	7.92	4	7.91	<1.0	1.58	<1.0	BDL	6400
27	5.27	1.5	26	11.88	8	3.96	1.28	3.17	<1.0	0.55	Absent
28	6.08	16.3	24	15.84	12	7.91	3.6	3.17	1.92	2.16	Absent
29	5.66	BDL	54	15.84	4	11.87	<1.0	3.17	1.92	BDL	100
30	6.28	1.3	88	47.52	44	7.91	12.6	11.09	4.81	0.67	7500
31	5.66	BDL	28	11.88	8	7.91	<1.0	3.17	<1.0	BDL	Absent
32	5.53	BDL	31	11.88	12	7.91	<1.0	3.17	<1.0	BDL	6400
33	5.82	BDL	51	19.8	8	11.87	2	4.75	1.92	BDL	Absent

most of the samples and higher concentration in few samples (2.16 mg/l). Total coliforms present in most of the samples (100-9300 MPN/100 ml) and E.coli is absent in the samples (Table 1).

CONCLUSIONS

Monthly water levels and well water quality in CWRDM campus and adjacent areas were monitored for providing artificial recharge to augment groundwater resources. There are many dug wells in CWRDM campus (depth of these varies from 7 m-10 m). It is observed that the overburden thickness varies from 1m to 10m. The charnockite gneiss underlying the weathered zone is fractured at various depths and most of the bore wells are low yielding. The depth to water level below ground level observed between 4 to 9 m during peak summer months (March/April), depending on the topography. The observed specific yield of the aquifer in the area is 0.03. The observed dynamic yield according to the studies conducted is of the order of 6500 cubic metres. The concentration of all the dissolved species, in shallow wells falls within limits prescribed by drinking water standards except pH. The TDS concentration of the hard rock aquifer of the region is higher compared to the laterite aquifer water [6,7]. Iron records higher concentrations in bore wells according to the standards (BIS).

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