Can we treat dug well water level as ground water level

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Abstract: *Water lies beneath the surface of the earth into two zones broadly, saturated and unsaturated zone. The upper most level of saturated zone is called as ground water level. This level is controlled by hydro-geological set up and human interference. Ground water system is much complicated in alluvium than hard rock hydro-geological set up. In an alluvium set up where thick clay belongs to the upper most layer, dug well water level is never synonymous with ground water level. The present paper is an argument to establish that water level of dug well cannot be treated as ground water level in an area where thick clay lies on the earth surface.The water comes into dug well either from soil seepage or from direct rainfall. This water level is directly influenced by the surrounding pond water. The present work is an attempt to look into how ground water level and dug water level exists in the study area distinctively. The investigation has been done on Chandernagore Municipal Corporation (CMC) and Hooghly-Chinsurah Municipality (HCM), two class-I cities of West Bengal. The supporting database is mainly primary; however, secondary database has also been used for the better reflection of the work. The samples have been selected purposively from CMC and HCM.*

Keywords: *Dug well water level, Ground water level, Clay layer, Seepage, Aquifer*

1. Introduction:

Water is a natural resource which occurs into different modes in our earth system. Water lies beneath the surface of the earth into two zones broadly, saturated and unsaturated zone. The upper most level of saturated zone is called as ground water level.Water in the saturated zone is the only underground water that is to supply wells and springs and is the only water to which the name ground water is correctly applied (1). Ground water level of a particular place is defined by the total input and output of water in that system with respect to time. Ground water level is also called as static water level if the water level does not get affected by any pumping operation. Static water level refers to the elevation or level of the water table in a well when the pump is not operating (2).Water level in dug well may be analogous to ground water level and also may not be. This is mainly controlled by the hydro-geological set up of the concerned area. The contour map of water level measured in the dug wells at Patna for both for pre-monsoon and post-monsoon period (3). Water levels encountered in deep aquifer that indicate piezometric surface of the deep confined aquifer are different from the phreatic surface in the dugwells(4).The water level depth of Meerut district, Uttar Pradesh is recorded from open shallow masonary wells (5). However, dug well water level and ground water level exists separately in Chandernagore Municipal Corporation (CMC) and in Hooghly-Chinsurah Municipality (HCM).

CMC and HCM are two class-I cities of West Bengal which are situated in the eastern most part of Hooghly district. The geographical location of the study area is 22°50′08″ N to 22°56′42″ N and 88°18′16″ E to 88° 24′ 40″ E(Figure - 1). The area is situated on the newer alluvium of Holocene age of Gangetic delta. The main composition of the alluvium is clay and sand with different gradations. Clay is the dominant geological material on the surface of the area. The main source of water of both the cities is ground water. Being located on a newer alluvium zone the area is also facing a declining trend of static water table. The thick clay layer gifts a great opportunity to the area to have numerous numbers of ponds and also dug wells. Here, dug well water level is not affected by the declining trend of static water level significantly.

The present research work is an attempt to look into how ground water level and dug water level exists in the study area distinctively. The paper is an argument to establish that water level of dug well cannot be treated as ground water level in an area where thick clay lies on the earth surface.

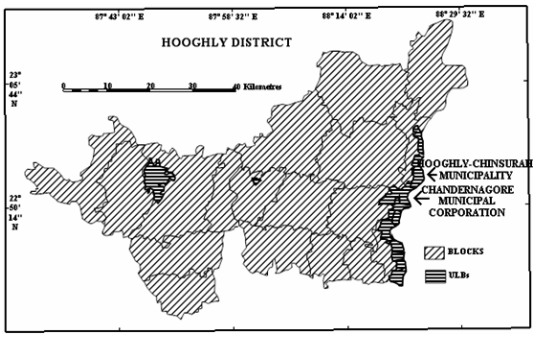


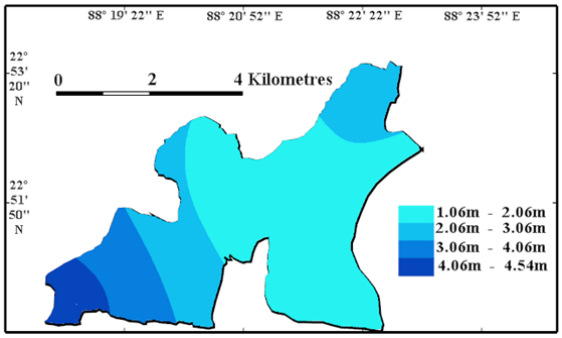
Figure – 1: Location map

1. Database and Methodology:

The present study is mainly based on primary database which has been shaped by some secondary data sources also. The primary data regarding water level of dug wells has been collected purposively based on their geographical locations from CMC and HCM. The depth of water level is measured from ground surface. There are 33 wards in CMC and 30 wards in HCM. Two samples (i.e dug well) from each ward have been selected purposively. Therefore, the total number of samples chosen from CMC is 64 (except ward no. 27 which is out of the present study). However, few wards are there in HCM where only one dug well has been found from each ward. Therefore, the total number of samples is 51 in HCM. Including both the cities, the number of samples are (64+51) 115 for the study done in pre-monsoon and in post-monsoon season of 2011. The secondary database regarding static water level has been provided by State Water Investigation Directorate (SWID), West Bengal and also by the water departments of the concerned cities. The lithological studies of the area have been done based on the lithologs of different bore wells of the area.

2. Water Level of dug well:

Water level of dug well is not same over the area. The depth of water level is measured in pre-monsoon (April) and post-monsoon (November) season of 2011. Each and every sample was studied during pre-monsoon and post-monsoon to measure the depth minutely which helps to get net available water resource from dug wells. The water is available round the year. The water level of dug well of the area is directly influenced by the amount of precipitated rainfall over the area, surrounding pond water, domestic withdrawal of water and also evapo-transpiration, as the water table lies in the root zone of local vegetation mainly in post-monsoon season.The minimum and maximum depth of pre-monsoon water level of CMC is 0.8 metre below ground level (mbgl) and 4.8 mbgl respectively. The minimum and maximum post-monsoon water level of CMC is 0.3 mbgl and 2.7 mbgl. The average depth of pre-monsoon and post-monsoon water levelis 1.8 mbgl and 0.9 mbgl in CMC. The average fluctuation of water table is 0.9 m in CMC in 2011. The pre-monsoon water level (CV= 45%) is less consistent than post-monsoon water level (CV= 38%) over CMC. Water table fluctuation varies over the area with remarkable range. The range of water level fluctuation belongs to 0.2 mbgl to 3.7 mbgl. The depth of bottom of well differs from place to place. The highest depth is recorded as 9.4 mbgl and the lowest depth is recorded as 3.3 mbgl in CMC. Depth of wells helps to estimate the volume of water within the well. The average depth of bottom of wells in CMC is 6.09 mbgl. Therefore, a well can hold 2777.27 litres (2.777 cumec) of water maximum on an average. The minimum depth of water level during pre-monsoon has been recorded in the central part of CMC which belongs to 1.06 mbgl to 2.06 mbgl. The maximum depth of water level has been recorded in the south-western part of CMC which belongs to 4.06 mbgl to 4.54 mbgl(Figure - 2).



Figure– 2: Pre-monsoon water level of dug well of CMC, 2011

It is observed that most of the area of CMC is occupied by the range of minimum depth zone. The maximum depth zone is least in terms of surface coverage area of CMC. The depth of water level increases from central to north and south-western part of CMC. During post-monsoon, most of the area of CMC belongs to shallow water level zone having a depth of 0.75 mbgl to 1.25 mbgl. The maximum depth has been found in the north-eastern part of the area having a depth of 2.25 mbgl to 2.72 mbgl. The maximum depth zone covers very small part of the area. The depth of water table increases toward north-eastern part of CMC (Figure- 3).

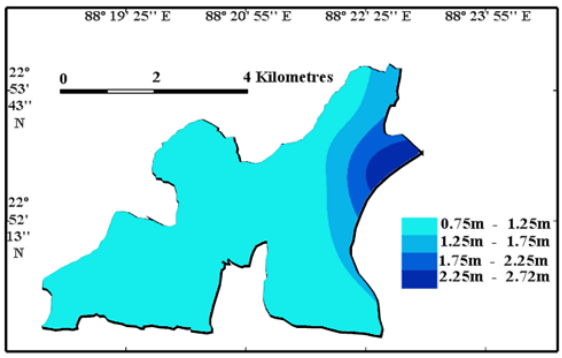
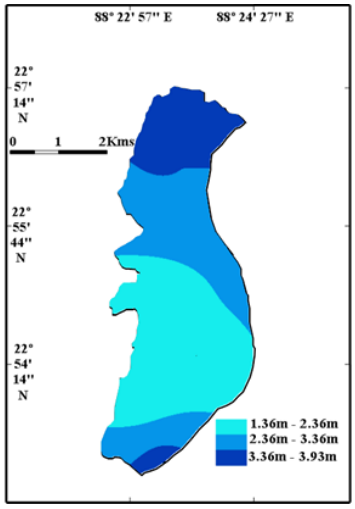


Figure – 3: Post-monsoon water level of dug well of CMC, 2011

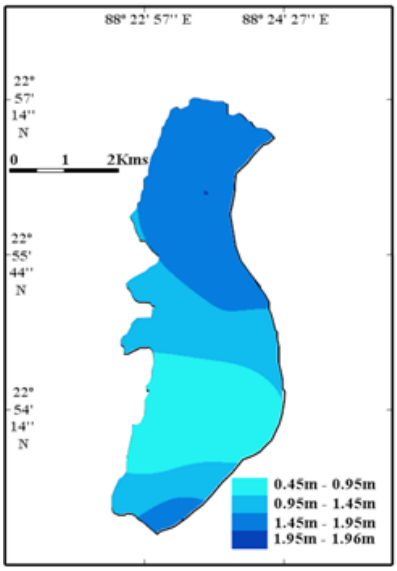
From the above discussion it is clear that the pattern of depth of water level is almost reverse in between pre-monsoon and post-monsoon period which increases the water level between fluctuation zones. The depth range is lower in post-monsoon water level than pre-monsoon water level in CMC. Therefore, we get four zones of water level in pre-monsoon and in post-monsoon periods, however, the interval is 0.5 m in post-monsoon whereas 1 m in pre-monsoon season over the area. Therefore, the gradient is maximum in pre-monsoon season than in post-monsoon season.

The minimum and maximum depth of pre-monsoon water level in HCM is 1.1 mbgl and 4.0 mbgl respectively. The average depth of pre-monsoon water level is 2.26 mbgl which is more than that of CMC. The minimum and maximum depth of post-monsoon water level is 0.5 mbgl and 2.3 mbgl respectively. The average depth of post-monsoon water level is 1.18 mbgl which is also more than that of CMC. The average fluctuation of pre-monsoon and post-monsoon water level is 1.08 m. The average depth of surface soil and clay is 27.5 m from the surface. Therefore, the pre-monsoon and post-monsoon water level belongs to surface soil and clay.The maximum depth zone covers northern and southern most part of HCM having a depth of 3.36 mbgl to 3.93 mbgl during pre-monsoon period. The shallow depth zone covers south-central part of the area having a depth of 1.36 mbgl to 2.36 mbgl. The depth of water level also increases from south-central to north and south inHCM during pre-monsoon(Figure - 4).



Figure– 4: Pre-monsoon water level of dug well of HCM, 2011

The maximum depth zone having a depth of 1.95 mbgl to 1.96 mbgl covers northern part and southern most area of HCM during post-monsoon period. The south-central part is covered with shallow depth zone having a depth of 0.45 mbgl to 0.95 mbgl. Therefore, the depth of water level increases from south-central to north and south inHCM during post-monsoon (Figure - 5).



Figure– 5: Post-monsoon water level of dug well of HCM, 2011

The range of gradient of water level during pre-monsoon and post-monsoon is lower in HCM than CMC. The average depth of bottom of a well is 5.65 mbgl which is less than CMC. Therefore, water holding capacity of a well is 2576.61 litres (2.5766 cumec) maximum on an average in HCM.

3. Ground water level

Ground water level indicates the upper most water level of the saturated zone. Ground water level is treated as static water level when the level is not influenced by any pumping operation. Generally, it is stated that the ground water level in an unconfined aquifer is synonymous to piezometric surface. However, in confined aquifer piezometric surface may be or may not be analogous to ground water level. The ground water level or static water level belongs to the study area much below than water level of dug well. Here, ground water level represents the piezometric surface. The trend of ground water level is declining over the years (Figure - 6). The static water level of CMC and HCM show that the pre-monsoon level was 11.50 mbgl and 8.57 mbgl in 1995 which increased to 16.53 mbgl and 15.09 mbgl respectively in 2011 (Table - 1).It is found that the ground water of CMC and HCM get recharged not by the amount of rainfall the area itself gains, rather it comes mainly from the surrounding rural areas.

Table-1: Pre-monsoon static water level of the study area

Year	Water level of CMC (mbgl)	Water level of HCM (mbgl)
1995	11.50	8.57
2000	12.08	9.70
2004	12.95	10.48
2011	16.53	15.09

Source: SWID, West Bengal and Water supply dept. of the cities

Figure – 6: Temporal pre-monsoon static water level

4. Discussion and Result

It is clear from the above discussion that there is prominent difference between water level of dug well and static water level in CMC and in HCM(Figure - 7). Generally, it is found that the water level of dug well is mainly influenced by rain water of the area and also by surrounding ponds. Water is available round the year. Many dug wells are there which are used round the year with sufficient water withdrawal. Despite, these dug wells never get dry that means they get constant water supply from the surrounding ponds which comes in the well through soil seepage. There are huge numbers of ponds with different sizes in the study area. The average depth of surface soil and clay from the surface is 27.5 metres which has been derived from the lithological logs of the area. With the increase of depth the nature of clay also changes. Higher the depth means higher the pressure which compact the material. In the clay layer, within the dug well water level zones permit water to come into the well from the surrounding ponds. However, this clay behaves like an aquitard below a certain depth in the area. Clay is more compressible than other geological materials in an alluvium environment. Clayey materials are highly compressible (6). Thick clay layer on the top does not allow pond water, dug well water to get into the static water level. Otherwise there was a little chance

of declining static water level. It is estimated from field survey that the amount of annual renewable surface water (water in different sized ponds) amounts to 896.40 hectare metres in CMC and 497.88 hectare metres in HCM (2011). This huge amount of renewable water do not make dug wells dry round the year keeping a constant supply. It is observed from field survey (2011) that many building constructions are done by using water from dug wells in the study area because of constant availability of water in the dug wells round the year.

Therefore, water in dug well comes through soil seepage and directly from rain water. It is not the ground water of aquifer. However, in other hydro-geological set up water level in dug well is an indicator of static water level. Generally, water level of dug well and of ground water is same where high permeable material exists on the surface to the depth of aquifer. In that cases both water level responses equally.

Figure – 7: Pre-monsoon water level of dug well and ground water

5. Conclusion:

The depth of water level of dug well is much above the static water level of the area. Static water level indicates the piezometric surface which is directly connected to the aquifer system of the area. This difference in the depth of dug well water level and static water level is observed mainly because of thick clay layer on the top. The average depth of surface soil and clay is around 27.5 metres from surface. Clay helps to create huge number of ponds and to separate the water level of dug wells from the ground water level of the area. Therefore, it is established that we cannot treat dug well water level as ground water level where thick clay layer exists on the surface.

6. Acknowledgements:

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