Impact of urbanization in the groundwater levels around the underground metro rail corridors in Chennai.

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Abstract

This paper made an attempt to predict the changes in the water level pattern on either side of the underground metro rail corridor.Twenty observation wells are located in the study area .Five wells on each side of the corridor I(Cenral to Thirumangalam) and Corridor 2(Washermenpet to Saidapet).The Water levels were taken for the post monsoon and pre monsoon periods of the twenty wells. The water levels which were observed were tabulated and the minimum and maximum water level values are identified for each corridor for their respective directions. The differences in between the minimum and maximum values are calculated to find the changes that occurred in the water level pattern. From the results the sides of the corridors affected with lower water levels are identified.It is found that the topography and the properties of the subsurface aquifer becomes the major factors for the fluctuations in the water level.

Keywords: Water Level, Underground, GIS, Metro rail Corridor,Ground water

1. Introduction

The underground tunnel construction creates major destruction to the ground water regime. It affects the flow characteristic and the lithology properties if the aquifers are getting changed and results in the less storage in the aquifers. The permeability properties of the soil are greatly affected and the water bearing strata characteristic also getting changed. These tunnel constructions also involves in major drafting of the water for installation also an added factor for the changes in the water level pattern. The destruction of the natural properties of the soil strata becomes responsible for the changes in the soil pressure distribution,thus alters stability of the soil structure. Ground water is considered as the only dependable source due to its ready availability and it is proven that most of the agricultural, industrial and domestic supplies are only with ground water (Purna *et al*.,2006)Urbanization is considered to be the major threat which alters the topography. It is a geomorphic process and affects the system of ground water. Water quality and stream flow characteristics are all changes due to this urbanization. The temperature and natural vegetation in the soil are gets modified. All of the above elevation of the water table changes is considered as a major one (John M. Sharp, 2010).Recharge in the well naturally depends upon magnitude, duration and intensity of the precipitation in the shallow aquifer (Dourte *et al.*,2013;.Huang and Zhao,2013; Freeze and

Cherry,1979) Impervious covers created because of urbanization reduces the ground water recharge but most commonly the recharge is increased due to urbanization and also the water quality can be predicted using spatial distribution(Sharp *et al*., 2009;Lilly *et al*.,2017).Urbanization also alters the natural surroundings such as natural deposits and water residues (Sridhar, 2018).Fall and rise of water table always occurs (Simpson, 1994;George,1992; Whitesides *et al*.,1983) with urbanization.Lack of rainfall reduces the recharge below the sub surface aquifers thus causes deep well water absorption. Over drafting of water dries up the wells(Prabhu Shankar and Jayavadivel,2020).The design and construction activities also affect the water table. The activities requires dewatering if the water table is very close to the surface during the construction of deep tunnels(Powers *et al.*,2007)Because of urbanization landscape are leveled for the requirements of the construction procedure. This may makes the elevated areas to be lowered and vice (Barton, 1962; Williams, 1977; Brick, 2009).Water table depletion encourages the sea water intrusion and the environment related to ground water ecosystem is declined. And also the changes in the soil pressure causes subsidence(Cook *et al*.,2001;Young ,2008).

2. Study area

Chennai city becomes the need for a new rail based rapid transport system. The system provides a fast, reliable, convenient, efficient, modern and economical mode of public transport. The underground corridor covers from Washermenpet to Saidapet with a length of 14.3 kms and the corridor with a length of 9.7 kms. from Chennai Central to Anna Nagar 2nd Avenue will be considered for analysis and it is shown in the Figure1. Rail level at midsection in tunneling portion shall be kept at least 12.0 m below the ground level so that a cover of 6m is available over the tunnels.

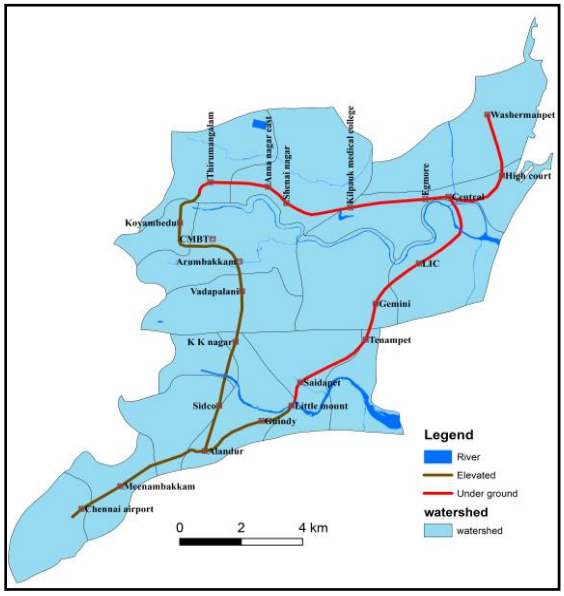

Figure 1 Study area with Station points

3.Water Level Data

In the study area twenty primary wells are located around the underground metro rail corridors. Five wells are located on either side of the corridors I and II using GIS with their latitudes and longitudes. The well locations with the base map are shown in Figure 2.Water Level data was taken at the primary well points on either side of the corridor for both the post monsoon and pre monsoon periods after the tunnel construction and it is given in the Table 1.From the collected data the minimum and maximum values of the water levels of the wells are derived and it is furnished in the Table 2.

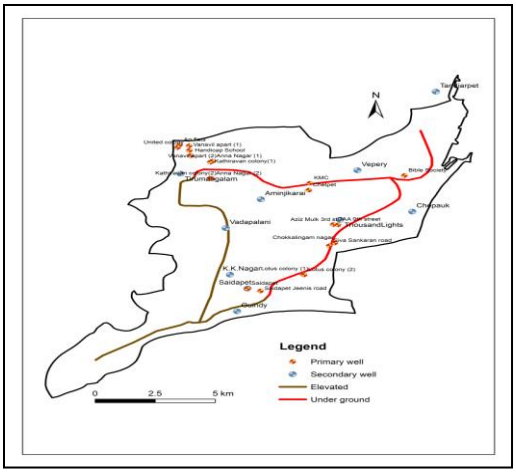

Figure 2 Study area with well locations

Table 1 Water Levels above Mean sea Level in (m) on either side of the Corridor I and Corridor II

Season		Post Monsoon	Pre Monsoon
Directions	**Corridor 1 Central to Thirumangalam**	**W.L(m.s.l)**	**W.L(m.s.l)**
North	KMC	5.26	1.31
	School Road	8.50	6.30
	Thirumangalam(1)	7.96	5.26
	Thirumangalam(2)	8.86	5.58
	Vanavil(1)	5.81	3.54
	Vanavil(2)	5.31	2.74
	AP Flates	8.76	7.50
South	Chetpet	3.01	-1.25
	Anna Nagar(1)	8.06	6.32
	Anna Nagar(2)	8.86	6.43
	UPC	10.04	8.50
	Bible Society	4.48	1.50
Directions	**Corridor 2 Washermenpet to Saidapet**	**W.L(m.s.l)**	**W.L(m.s.l)**
West	Aziz mulk	2.51	-0.29
	Teynampet	7.91	2.31
	S-Market	5.44	2.35
	Saidapet	8.86	6.66
East	Nandanam(2)	7.86	5.14
	GAA	4.31	0.27
	DMS	10.56	5.86
	Nandanam(1)	4.86	4.16

Table 2 Minimum and Maximum values of Water Levels above Mean sea Level in (m).

Season		Post Monsoon		Pre Monsoon	
Directions		**North**	**South**	**North**	**South**
Corridor I	**Min**	5.26	3.01	1.31	-1.25
	Max	8.86	10.04	7.5	8.5

		West	East	West	East
Corridor II	**Min**	2.51	4.31	-0.29	0.27
	Max	8.86	10.56	6.66	5.86

4. Analysis and Discussion

To observe the changes in the ground water level above mean sea level due to the tunneling effect , 20 observation wells five wells each located on either side of both corridors. The pre-monsoon and post-monsoon water levels after the tunnel construction are analyzed and it was shown in Figure 3 and Figure 4 .In the corridor I that is from the underground stretch, Central to Thirumangalam. In the North side of the corridor, during the post monsoon season the minimum to maximum value of water level above mean sea level seems to be 5.26m to 8.86m.Similarly in the South side the value shows as 3.01m to 10.04m.

During the pre monsoon period 1.31m and 7.5 m is the minimum and maximum water levels in the North side of the corridor. Similarly in the South side -1.25m and 8.5m seems to be the minimum and a maximum water level exists in the corridor. The water level ranges clearly shows that, in both the pre monsoon and post monsoon period the South side of the corridor got affected with low water levels when compared to the North side of the corridor.

In the corridor II that is from Washermenpet to Saidapet, West side of the corridor shows a decreased water levels and the East side of the corridor shows a increased water level pattern. The minimum to maximum value of water level exists in the West side of the corridor during the post monsoon period is 2.51m to 8.86m and in the East side it seems to be in the range of 4.31m to 10.56m.During the pre monsoon season, West side of the corridor carries -0.29m and 6.66m as minimum and maximum water levels. Similarly in the East side, 0.27m and 5.86m seems to be the minimum and maximum water levels. In the corridor I water level of nearly 1.8m is seems to be headed up in the North side of the corridor when compared to the south side of the corridor. Similarly a water level of about 1.5m seems to be increased on the East side of the corridor in both the season.

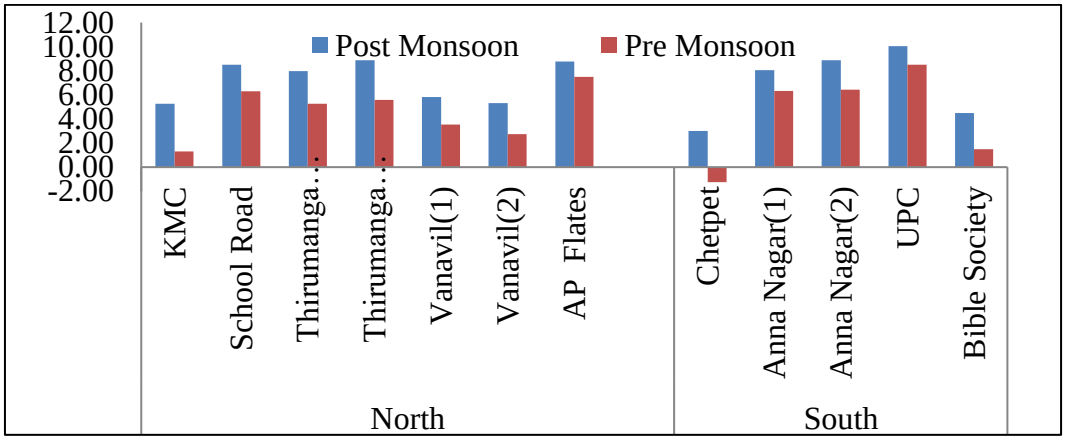

Figure 3 Comparison of North and South side, Pre-monsoon and

Post-monsoon water levels (m) above mean sea level of Corridor, Central to Thirumangalam after tunnel construction

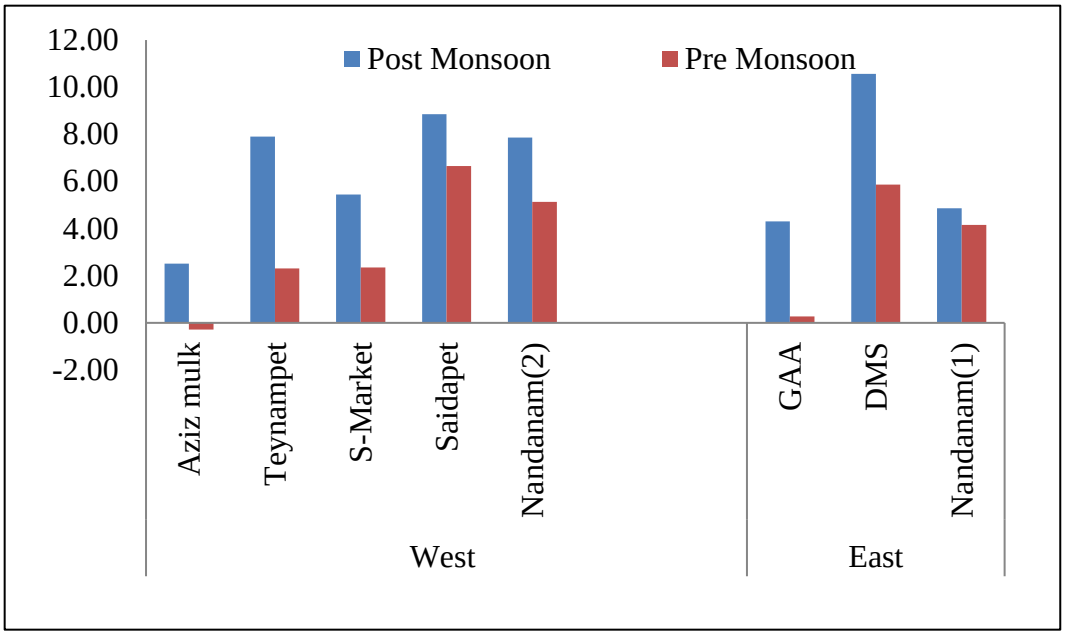

Figure 4 Comparison of West and East side, Pre-monsoon and Post-monsoon water levels(m) above mean sea level of Corridor, Washermenpet to Saidapet after tunnel construction

5. Conclusion

The predicted water level pattern clearly shows that the water levels have got decreased in the South side of the corridor when compared to the North side of the corridor in the Corridor I(Central to Thirumangalam).Similarly in Corridor II (Washermenpet to Saidapet) show the decreased levels in the west side of the Corridor when compared to the East side of the Corridor. This may due to the obstruction created in the flow of water and also the slope of the terrain drains the water from South to North side of the Corridor. The East sides of the Corridor are nearer to the coastal plain of Chennai thus shows the increased water levels when compared to the west side wells which is far away from the coastal plain. However in hydro geology parameters are site specific and the properties which have got altered due to this tunnel becomes the reason for the rise and fall water levels.

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