FREQUENCY ANALYSIS OF RAINFALL DEVIATION IN SALEM DT, TAMILNADU

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ABSTRACT

The aim of this project is to give a complete study of 15 years (2004-2018) daily rainfall data for Salem district was collected from the TWAD (Tamil Nadu Water Supply and Drainage Board) to analyse the nature of distribution and frequency of rainfall. The report includes the objectives of the work.

Average annual rainfall for 15 years data was collected as 1438.1 mm and average annual rainy days were 65.9 maximum monthly rainfall (297.58 mm) was received during the month of September which was mostly by southwest monsoon. Maximum rainy days were in October (7.6 days).

The rainfall received during the winter, summer, southwest and northeast monsoon seasons were 11.5, 191.0, 553.5, 343.0 mm, respectively. Rainfall frequency analysis done by Weibull's method revealed that the annual average rainfall of 14938.1 mm can be expected to occur once in 3.5 years at a probability of 35%. Monthly dependable rainfall (p>75%) is expected to occur in every year during the months from September to October.

INTRODUCTION

Water is the most precious resource required for the very existence of living being. It is a chemical compound and it may either occur in liquid or solid or gaseous form. All these three forms are extremely useful to man in providing him the luxuries and comforts in addition to the basic necessities. Water is the renewable natural resource by the annual replenishment of meteoric precipitation. As it is the medium for most of the chemical, biochemical and biological reactions, it happens to be the elixir of life.

The human activities such as rapid urbanization, ever increasing population and deforestation have interrupted the natural hydrological cycle. This ecological imbalance results in non-uniform distribution of rainfall. The present world has to meet both the challenges of increasing water demand and the depleting water resources. The contamination of water resources is also increasing in the course of development and modernization. Hence, a threat to the quantity and quality of this valuable resource is emerging at an alarming rate.

The present study provides the evaluation of groundwater quality during premonsoon and postmonsoon seasons of the study area. It provides the information about the concentration of total dissolved solids in groundwater of any location before digging a well for use. The present study provides a design methodology for groundwater quality improvement using artificial recharge. It also provides the information about the recharge potential of the study area. The authorities can estimate the concentration of major cation and anion of the groundwater present in any location before testing the sample.

Salem is known all over the country for its role in poultry and cattle farms. It is also familiar for its automobile industry all over the southern peninsula. The district has been divided into 14 administrative blocks and five municipalities by government of Tamilnadu. The area of the district is 3404 sq.km. The district has a population of 15 million. The average rainfall of the district is 670 mm. The ground water table is available below 250 m in some parts of the district. The total livestock strength of the district is 9.07 lakhs and the strength of the poultry is 12.9 million. 10.3 million eggs are being produced every day in this district and supplied all over the country.

whole district depends on groundwater for drinking, irrigation and industries. 78.12 % of the total irrigation is carried out with the help of groundwater. The district has 81,110 numbers of open wells and 5,144 numbers of bore wells for public use. The rate of

Conceptually, water quality refers to the characteristics of a water supply that will influence its suitability for a specific use i.e., how well the quality meets the needs of the user. Even a personal preference such as taste is a simple evaluation of acceptability. For example, if two drinking waters of equally good quality are available, people may express a preference for one supply rather than the other; the better tasting water becomes the preferred supply.

The quality of water is a vital factor for mankind as it is directly linked with human health. The quality of groundwater is being modified when it is in the course of movement through the hydrological cycle and through the various processes such as evaporation, transpiration, uptake by vegetation, oxidation/reduction, cation exchange, dissociation of minerals, precipitation of secondary minerals, mixing of waters, leaching of fertilizers, manure and pollution (Appelo and Postma 1993).

Presence of certain minerals such as iron, calcium, magnesium etc., in small quantities in groundwater may be good for health, because human bodies need certain amount of these elements as nourishments. But when these materials and others are dissolved in large amounts, the water may become unfit for consumption. Some times the water may contain toxic or poisonous substances such as arsenic, cadmium etc. These substances are harmful to the health even if it is present in very low quantities.

In irrigation water quality evaluation, emphases are placed on the chemical and physical characteristics of the water. Other factors are considered as important in special applications. Specific uses have different quality needs and one water supply is considered more acceptable if it produces better results and causes fewer problems than an alternative water supply. Poor quality of water adversely affects the plant growth also. (Wilcox 1948; Thorne and Peterson 1954; US Salinity Laboratory Staff 1954; Holden 1971; Todd 2001; WHO 1984; Hem 1991; Karanth 1997).

The water quality should satisfy the requirements or standards set for the specific use. The standards specified by Bureau of Indian standard specification (IS:10500 1991) is taken in this work to evaluate the quality of groundwater for drinking purpose and USSL, Wilcox, Doneen classifications are taken to evaluate the quality of the groundwater for irrigation purpose of the study area.

REVIEW OF LITERATURE

2.1 LITERATURE REVIEW

Ramasamyet al(1999) have analysed the monthly and annual rainfall data of Coimbatore district for the period from 1971-72 to 1993-94. This analysis shows that the rainfall is just normal and below from 1980-81 to 1993-94. Hence the rainfall of this nature might not contribute to augment groundwater potential.

In the same way, **Singh et al(2004)** have made an attempt to understand the performance of monthly rainfall for June, July, August and September when the seasonal rainfall is reported to be excess, deficient or normal by using historical data series of 30 years (1970-99) of monthly and seasonal rainfall. All the locations receive excess or normal rainfall in monsoon season when individual month receives excess rainfall in the entire subdivision. From the probability analysis, it is seen that there is a rare possibility of occurrence of seasonal rainfall to be excess/deficient when the monthly rainfall of any month is deficient/excess in the entire subdivision.

Prediction of groundwater levels has significant applications in water resource utilization and management. The purpose of observation of groundwater lies primarily in studying its temporal and spatial changes. Statistical approaches are becoming increasingly useful for the evaluation of groundwater regimes. **Rockaway &Johnson (1977)** have indicated that the application of trend analysis to groundwater studies is based on the assumption that the water table could be approximated by a mathematically computed polynomial of water levels of the wells in the aquifer.

Marechalet al(2002) have observed the short-interval water levels in a deep well in an unconfined crystalline rock aquifer. The observed values show cyclic fluctuation in the water levels and principal trend due to rainfall recharge. Spectral analysis is carried out to evaluate the correlation of the cyclic fluctuation to the synthetic earth tides as well as groundwater withdrawal time series in the surrounding area. It is found that the fluctuations have considerably high correlation with earth tides, whereas groundwater pumping does not show any significant correlation with water table fluctuations. It is concluded that the earth tides cause fluctuations in the water table and unconfined aquifer is characterized by a low porosity.

The conventional method of estimating recharges is used by **Penman (1948) and Grindley(1967)**. Recharge is viewed as a function of effective rainfall, precipitation minus evaporation, which is distributed according to a simple land use model.

Farrington &Bartle (1988) have evaluated water balances of Banskia woodland on coastal deep sands of Southwestern Australia in detail. Estimation of groundwater recharge using the water balance approach shows considerable variation in water levels over the years. Recharge highly correlates with the annual rises in groundwater table and the rainfall received during winter and spring seasons. A long-term estimates of groundwater recharge at the site, using the chloride balance, is similar to the average value obtained using the water balance method.

Dharaet al(1994) have taken a practicable approach for recharge estimation from rainfall and soil parameters in lower deltaic region of Ganges, originating from the Himalayan region of India. Infiltration rate, rainfall and evaporation dataare being collected continuously for a period of 140 days from 1stJune to 18thOctober for the year 1990. Recharge is estimated by three empirical formulae on the basis of rainfall. It is also estimated on a modified concept of prolonged infiltration rate after 36 hours of saturation of soil that seems to be a better method as it is found that the total amount of infiltrated water is 77.29 m, which has potential recharge under continuous water supply.

Similarly, Jayakumar & Ramasamy (1995) have conducted a study on groundwater in the Attur village of Salem district in Tamil Nadu. Fifty wells are identified and their well yield data are derived from pumping tests. Rainfall data of 35 years are collected and extrapolated to 50 well locations by kriging method. The well yield data are taken as the dependent variable and rainfall data are taken as the independent variable and bivariate and third degree polynomial regression analyses are carried out. From such analyses, a model is developed, which is capable of predicting well yield from rainfall data. The predicted and observed yields are compared. The variations are restricted within 20% of the original values; hence the model could be accepted.

The monsoon rain recharges mainly hard rock aquifers in the rain-fed areas of India. The water table is at its lowest level in the beginning of the monsoon (May-June),it rises as the monsoon progresses, attains its highest level at the end of the monsoon (October-November) and recedes thereafter during the non-monsoon period. Since the groundwater levels in hard rock aquifers determine the amount of water available from dug wells, simulation of the response of the groundwater level to rainfall is a necessary part of Dug Well Irrigation Management (DWIM).

The reaction of groundwater depends on many factors including storage coefficient, transmissibility, thickness, shape and areal extent of the aquifer, initial groundwater level, intensity and distribution of rainfall, drainage pattern of the watershed, vegetation and the water withdrawal pattern for human and other uses. Therefore the recharge rate of any unconfined aquifer is both “site specific” **(Rennollset al 1980, Viswanathan1983)** and “time specific” **(Viswanathan 1984).**

2.2 GENERAL

Water is a precious and renewable resource on the earth. Most of the people depend upon the rainfall for agricultural production. The demand for clean water is increasing nowadays due to the decrease in the rainfall and the deterioration of the surface water quality due to the discharge of industrial effluent and domestic sewage. The study of rainfall pattern and the availability of groundwater are important for planning the use of available water for drinking and agriculture purposes. The variability of rainfall and the pattern of precipitationplay a major role in developing the economy of the country (Sharda 2005). The total rainfall received in a given period at a location is highly varying from one year to another. The variation in the rainfall is due to the climate of the place. Geologically, the study area enjoys a tropical climate. The pleasant weather occurs in the month of November to January and cools down progressively from the middle of June.

The mean daily maximum temperature drops to 30.2°C while the mean daily minimum drops to 19.2°C in January. The study areareceives the rainfall under theinfluence of both southwest and northeast monsoons. The northeast monsoon chiefly contributes to the rainfall in the district. Hydro-meteorological study is helpful to assess the causes for the water quality deterioration. The rainfall data collected from the Tamil Nadu Water and Drainage (TWAD) board and Public Works Department (PWD) is used for the hydro meteorological analysis of the study area

2.3 ANALYSIS OF RAINFALL

Rainfall from in and around the study area from fifteen rain gauge stations is taken to assess the total rainfall. The latitude and the longitude of the rain gauge station locations are presented in Table 2.1. The geographic allocations of the rain gauge stations are shown in Fig 2.1

Table 2.1 Locations of the rain gauge stations

Rain gauge stations	Latitude	Longitude
Anaimaduvu reservoir	11°46'27"	78°25'36"
Atthur	11°35'55"	78°36'20"
Edappadi	11°35'07"	77°50'34"
Gangavalli	11°29'51"	78°38'50"
Kolathur	11°50'34"	77°34'05"
Kullampatti	11°34'07"	77°47'33"
Mettur	11°48'27"	77°48'01"
Nangavalli	11°45'28"	77°53'43"
Omalur	11°44'29"	78°02'31"
Pillukurichi	11°38'28"	77°46'50"
Salem	11°40'09"	78°09'31"
Sankari	11°28'25"	78°52'06"
Thammampatti	11°26'24"	78°29'07"
Vazhapadi	11°39'20"	78°23'47"
Yercaud	11°47'24"	78°12'39"

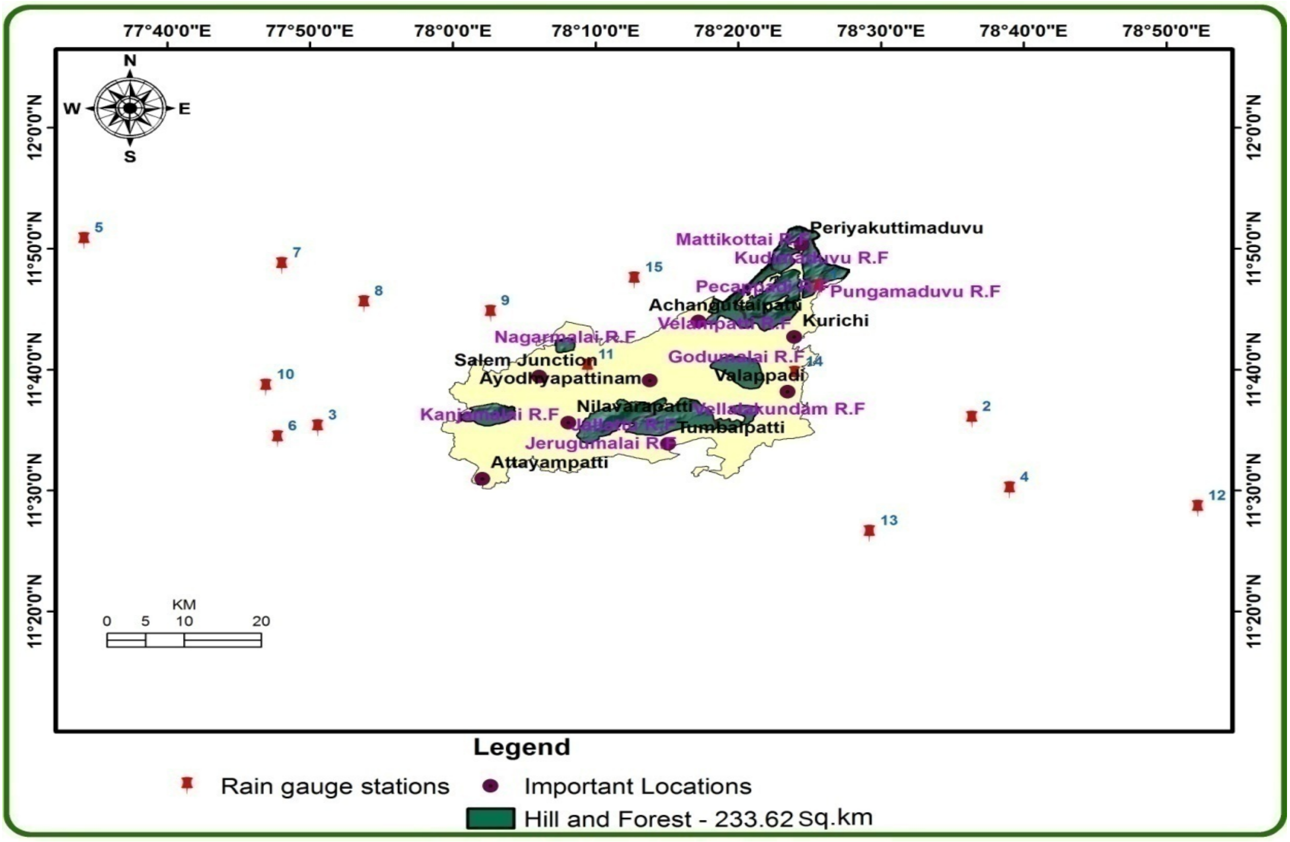


Figure 2.1 Location of rain gauge stations

For the present study, rainfall data from 2004 to 2013 (one decade) are considered. Table 2.2 and Figure 2.2 give the annual and average rainfall for various rain gauge stations. The highest rainfall of 1850.70mm was recorded in Yercaud in the year 2004. There was no rainfall in the year 2012 and 2013 in Gangavalli. Most of the rain gauge stations received highest rainfall in the year 2005. In Salem district, Atthur 912.71mm, Mettur 1042.41mm, Nangavalli 913.09mm, Salem 980.41mm and Yercaud 1542.64mm received higher average rainfall as compared to anormal rainfall of 898.0 mm.

The average rainfall observed in all the rain gauge stations during 2004 to 2018 for post monsoon, pre monsoon, southwest monsoon and northeast monsoon are given in Table 2.3

Table 2.2 Annual and average rainfall from rain gauge stations

Rain gauge stations		Rainfall (mm)								
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Anaimaduvu reservoir	878.2	1026	990	862	728	727	1174	1247	756	300
Atthur	1096.1	942.5	800.8	832.1	957.3	721.4	1630.1	1226.7	520.1	400
Edappadi	673.7	1329	588	921.41	735	360.5	989.6	905.3	628	373.1
Gangavalli	928.9	1106.8	743.5	1024.28	808.58	680.5	298.2	2.4	0	0

Kolathur	1621.6	1065.1	982.4	877.4	765.1	500.54	863.92	335.9	446.45	171.9
Kullampatti	718.4	1584.71	887	774	890.5	516.76	1101.5	787	555.3	426.5
Mettur	1359.2	1521	1252.1	1037.88	976.2	913.92	1345.9	1213.8	570.6	233.5
Nangavalli	866	1401.1	1171.34	1072.5	1228.2	566.19	997	1233.95	503.8	90.8
Omalur	1194.8	987.8	750.6	1018.8	834.82	755.45	803.9	1067.91	961.4	230
Pillukurichi	750.4	1271.6	793	702.4	782.7	463.32	863	771.7	590.7	227.5
Salem	1232.2	1359.9	1028.5	893.22	957.8	842.24	1190.2	955.9	1003.4	340.7
Sankari	938.32	1049.12	611.5	549.62	814.4	541.706	988.5	1113.1	655.7	280.2
Thammampatti	1004.9	1222.5	800.2	964.38	869.92	708.2	1049.2	936.4	657.7	352.2
Vazhapadi	1139.5	1396.2	717.6	728.3	752.2	586.9	1027.5	1064	681.62	331.2
Yercaud	1850.7	1835	1477.7	1637.32	1638.4	1285.6	1752.08	1736.4	1540.3	672.92

Rain gauge stations	**Rainfall (mm)**					AVERAGE
	2014	2015	2016	2017	2018	
Anaimaduvu reservoir	75.91	115.5833	61	94.91666	105.75	609.42
Atthur	76.56	102.575	43.4667	87.35833	79.867	623.31
Edappadi	65.56	92.047	31.45	71.816	41.125	520.37
Gangavalli	47.21	91.10	55.71667	79.07	85.7727	393.65
Kolathur	27.03	45.25	15.67	80.35	41.125	522.68
Kullampatti	93.16	160.7	42.83	80.35	102.41	581.49

Mettur	59.4	91.033	31.275	54.97	78.558	716.00
Nangavalli	59.76	115.45	57.94	51.25	73	633.02
Omalur	62.83	79.91667	55.05	76.31	74.65	596.92
Pillukurichi	55.58	89.51667	28.666	102.55	73.23	504.48
Salem	64.41	94.20833	44.525	84.1833333 3	83.00	678.19
Sankari	67.63	110.7083	32.35	65.99	91.74	566.15
Thammampatti	72.9	93.9	26.766	79.77	78.88	774.26
Vazhapadi	72.21	79.17	44.25	91.84	80.8	986.00
Yercaud	104.49	157.2583	115.31	137.61	146.10	1072.19

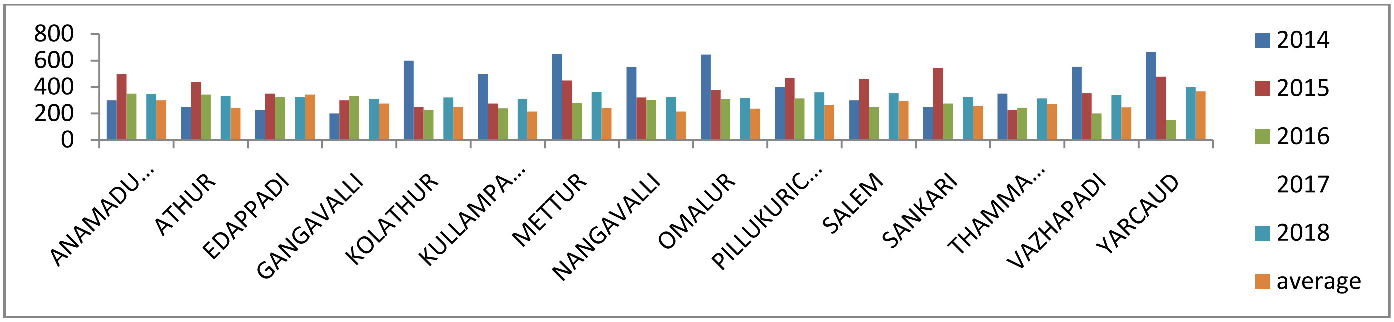


Figure 2.2 Annual rainfall from rain gauge stations

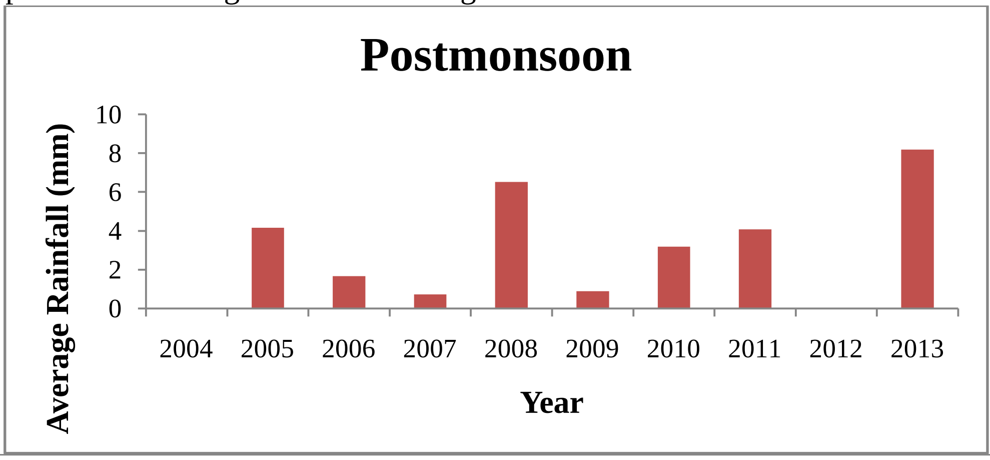
Table 2.3 Average rainfall from all the rain gauge stations different seasons

Seasons	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Postmonsoon	0.00	4.17	1.66	0.72	6.51	0.90	3.19	4.08	0.00	8.18
Premonsoon	122.56	81.88	52.21	45.67	47.38	55.35	52.62	69.78	32.99	24.03
Southwest monsoon	66.39	91.81	86.68	99.78	102.85	76.44	113.78	91.63	83.04	44.43
Northeast monsoon	150.10	217.33	133.21	129.61	116.46	68.14	150.76	129.71	80.10	9.73

Seasons	2014	2015	2016	2017	2018
Postmonsoon	1.66	0.72	6.51	0.90	3.19
Premonsoon	52.21	45.67	47.38	55.35	52.62
Southwest monsoon	86.68	99.78	102.85	76.44	113.78
Northeast monsoon	133.21	129.61	116.46	68.14	150.76

2.3.1 Average Rainfall during Postmonsoon Season

The average rainfall during the postmonsoon season is presented in Figures 2.3. During postmonsoon season, the region received the highest average rainfall of 8.18mm during the year 2018 and it had no rainfall during the year 2004 and 2018.



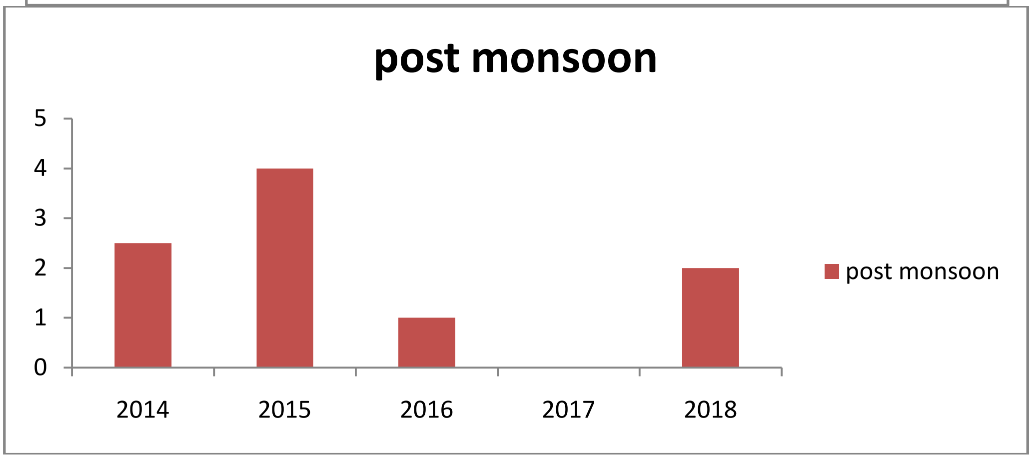
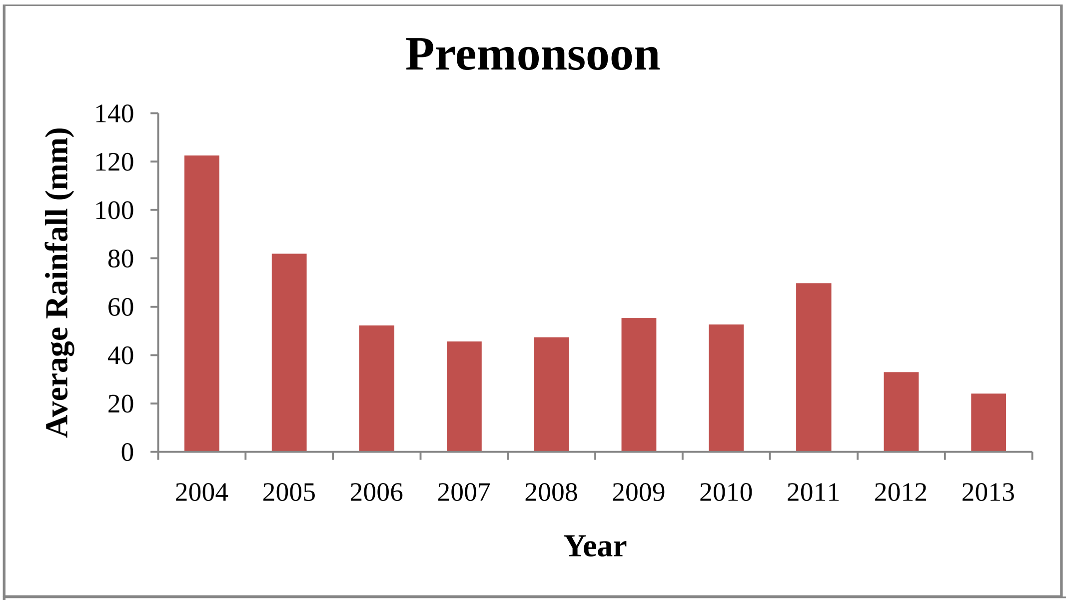


Figure 2.3 Average rainfall during post monsoon season

2.3.2 Average Rainfall during Pre monsoon Season

The average rainfall during the pre monsoon season is presented in Figure 2.4. During pre monsoon season, the region received the highest average rainfall of 122.56mm during the year 2004 and the lowest average rainfall of 24.03mm was recorded during the year 2018.



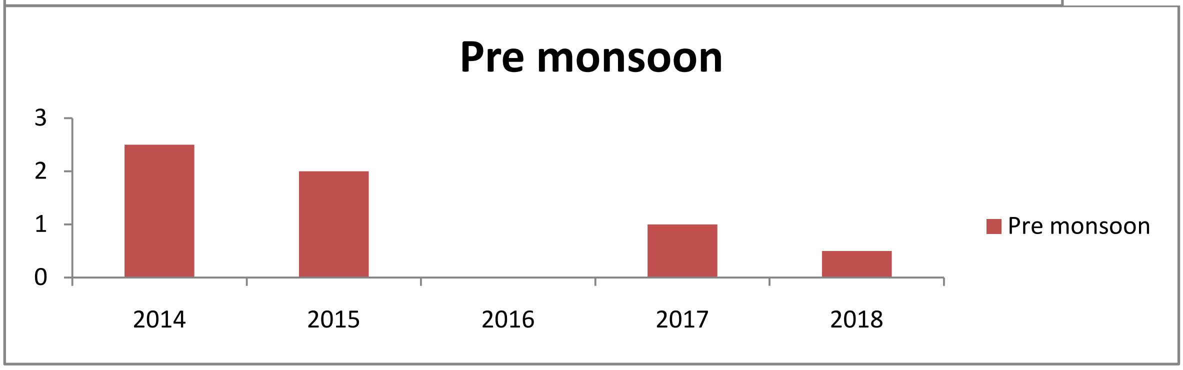
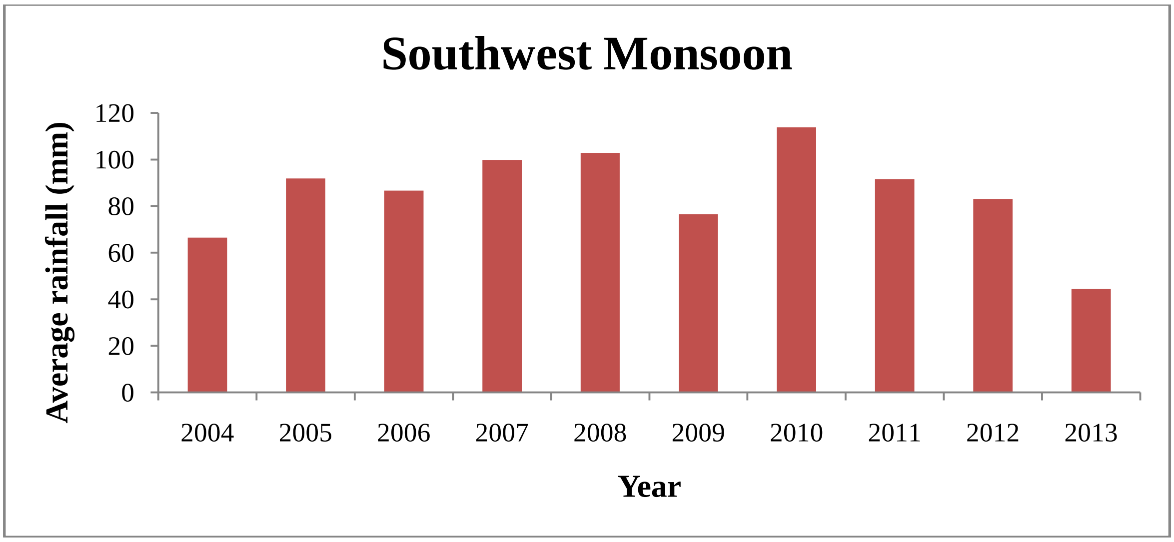


Figure 2.4 Average rainfall during premonsoon season

2.3.3 Average Rainfall during Southwest Monsoon Season

The average rainfall during the southwest monsoon season is presented in Figure 2.5. During southwest monsoon season, the region received the highest average rainfall of 113.78mm during the year 2010 and the lowest average rainfall of 44.43mm was recorded during the year 2018.



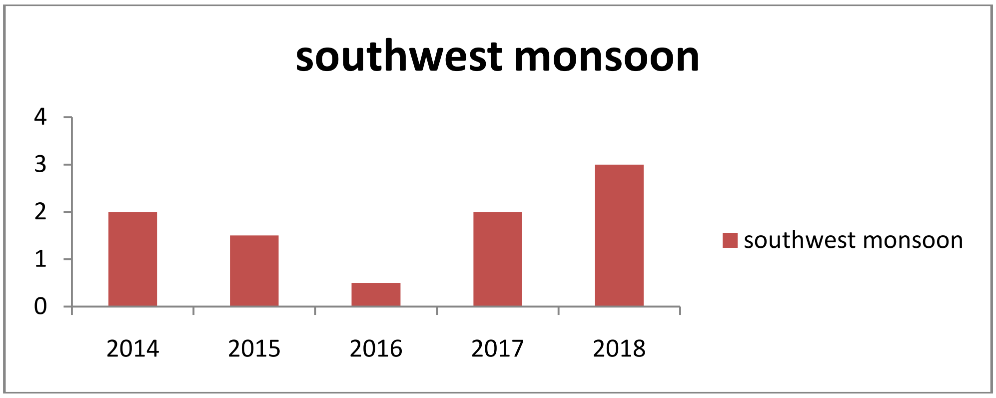
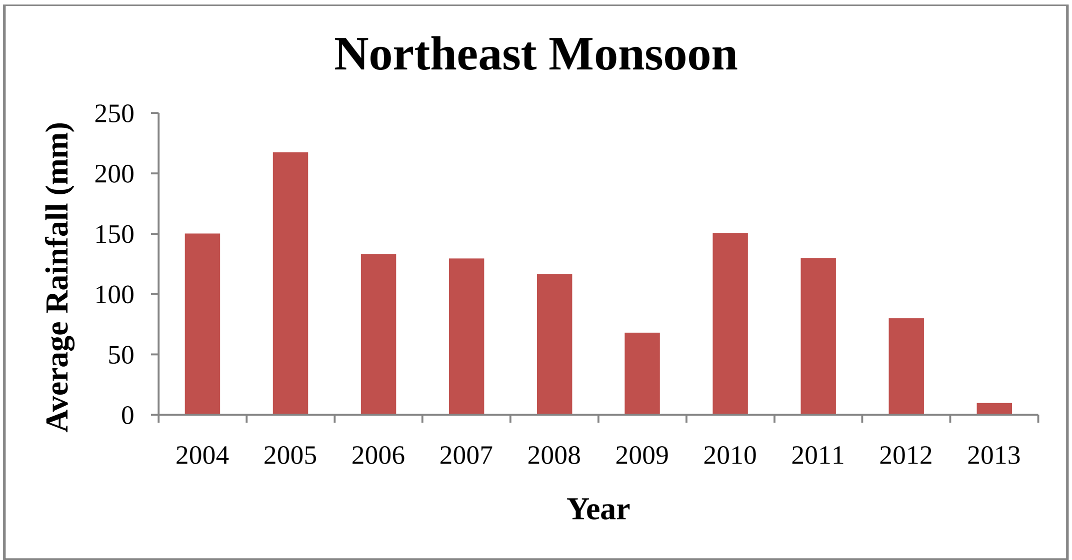


Figure 2.5 Average rainfall during southwestmonsoon season

2.3.4 Average Rainfall during Northeast Monsoon Season

The northeast monsoon season is an important rainy season. The average rainfall during the north east monsoon season is presented in Figure 2.6.

During northeast monsoon season, the region received the highest average rainfall of 217.33mm during the year 2005 and the lowest average rainfall of 9.73mm was noticed during the year 2018.



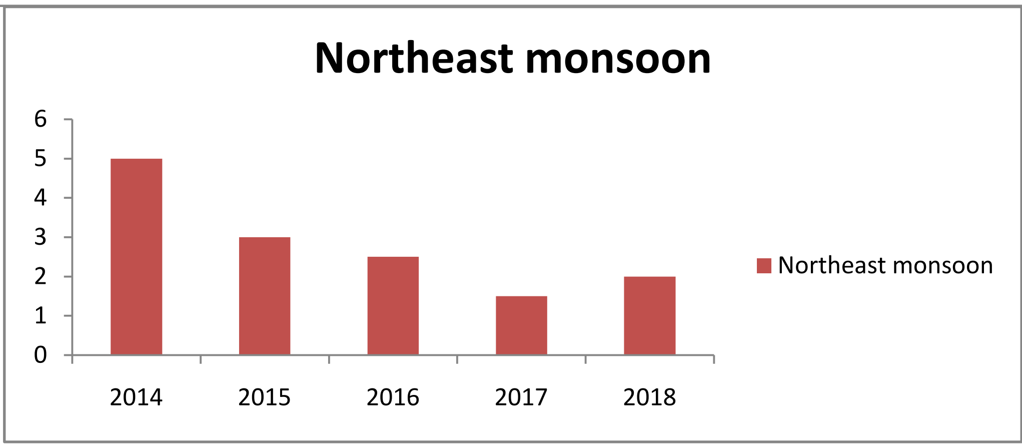


Figure 2.6 Average rainfall during northeast monsoon season

2.4 ANALYSIS OF GROUNDWATER LEVEL

Groundwater systems are dynamic and they adjust continually to short-term and long-term changes inclimate, groundwater withdrawal, and land use (Todd 2007). The natural conditions affecting the groundwater level involve climatic parameters like rainfall,evapotranspiration and so on, whereas anthropogenic influences include pumpage from the aquifer, recharge due to irrigation systems and other practices like waste disposal.

Physical properties of soil such as the porosity, permeability andthickness of the rocks or sediments that compose the aquifer affect the water balance. Groundwater levels are controlled by the balance among recharge, storage and discharge from an aquifer. When the rate of recharge to an aquifer exceeds the rate of discharge, water levels or hydraulic heads would rise. Conversely, when the rate of groundwater withdrawal or discharge is greater than the rate of groundwater recharge, the water stored in the aquifer gets depleted and water levels or hydraulic heads would decline. Determination of the gradient (slope) of the water table in the investigation of groundwater quality would predict the velocity and direction of movement of groundwater contaminants.

Groundwater levels in the study area from fourteen observation wells are considered for the analysis. The latitude and longitude of the observation wells within the study area are presented in Table 2.4. The location of observation wells in the study area is presented in Figure 2.7 and the classification of groundwater level based on depth is presented in Table 2.5.

Table 2.4 Locations of the observation wellsin the study area

S.No.	Well No.	Block	Latitude	Longitude
1	53502	Attayampatty	11°31'50"	78°03'55"
2	53504	Vedukathampatty	11°39'10"	78°04'55"
3	53505	Ariyanur	11°35'35"	78°04'40"
4	53506A	Nalikkalpatty	11°36'05"	78°07'40"
5	53507	Panamarathupatti	11°33'35"	78°10'00"
6	53508	Kamalapatty	11°35'20"	78°17'30"
7	53510	Vellalakundam	11°37'30"	78°19'58"
8	53511	Pudupalayam	11°38'50"	78°24'15"
9	53512	Attanurpatty	11°41'20"	78°24'40"
10	53513	Kurichy	11°43'40"	78°24'40"
11	53515	Karipatti	11°39'55"	78°17'15"
12	53516	Kattur	11°42'00"	78°16'00"
13	53517	Kannankurichy	11°41'55"	78°11'10"
14	53518A	Suramangalam	11°40'30"	78°07'25"

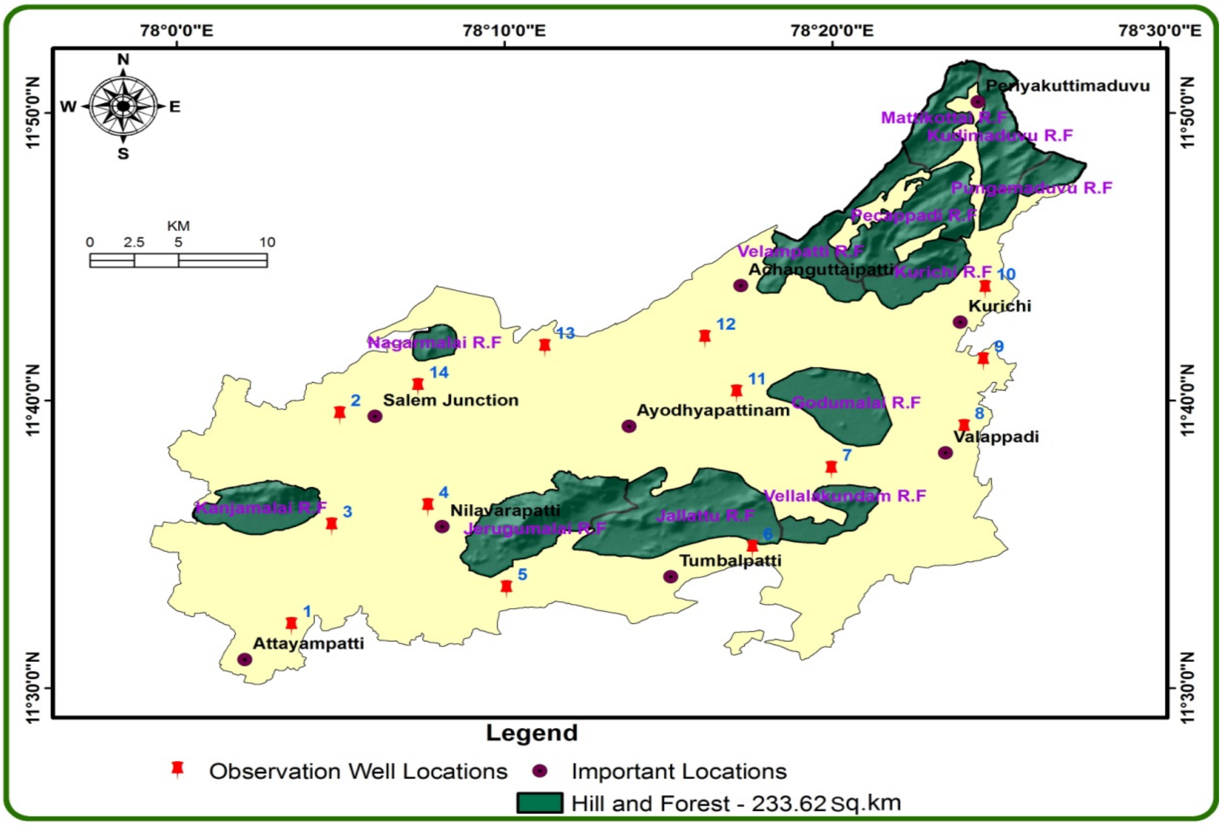


Figure 2.7 Location of observation wells

Table 2.5 Classification of groundwater level based on depth

Depth to groundwater	Classification
< 2m	Very shallow
2 – 7m	Shallow
7 – 30m	Proximal
> 30m	Deep

The average ground water levels observed in all the observation wells in metres below ground level (m bgl) during 2004 to 2018 for post monsoon, pre monsoon, southwest monsoon and northeast monsoon are presented in Table 2.6.

Table 2.6 Average water level from observation wells for different seasons

Seasons	2004 (m bgl)	2005 (m bgl)	2006 (m bgl)	2007 (m bgl)	2008 (m bgl)	2009 (m bgl)	2010 (m bgl)	2011 (m bgl)	2012 (m bgl)	2013 (m bgl)
Postmonsoon	6.92	8.06	3.78	4.81	5.77	6.83	9.67	6.95	5.85	10.32

Premonsoon	7.50	9.03	5.77	7.33	6.34	7.50	9.94	7.68	7.80	12.48
Southwest monsoon	8.11	10.38	7.15	9.43	7.42	8.75	10.44	8.53	8.50	14.70
Northeast monsoon	7.34	5.30	4.98	7.57	6.32	8.77	7.77	7.17	8.63	11.75

2.4.1 Average Groundwater Level during Post monsoon Season

The average groundwater level during the post monsoon season is presented in Figure 2.8. During post monsoon season, the level of the groundwater was found to be shallow during the year 2006 with a depth of 3.78m below ground level (bgl) and decline in water level occured in the year 2018 with a depth of 10.32m bgl.

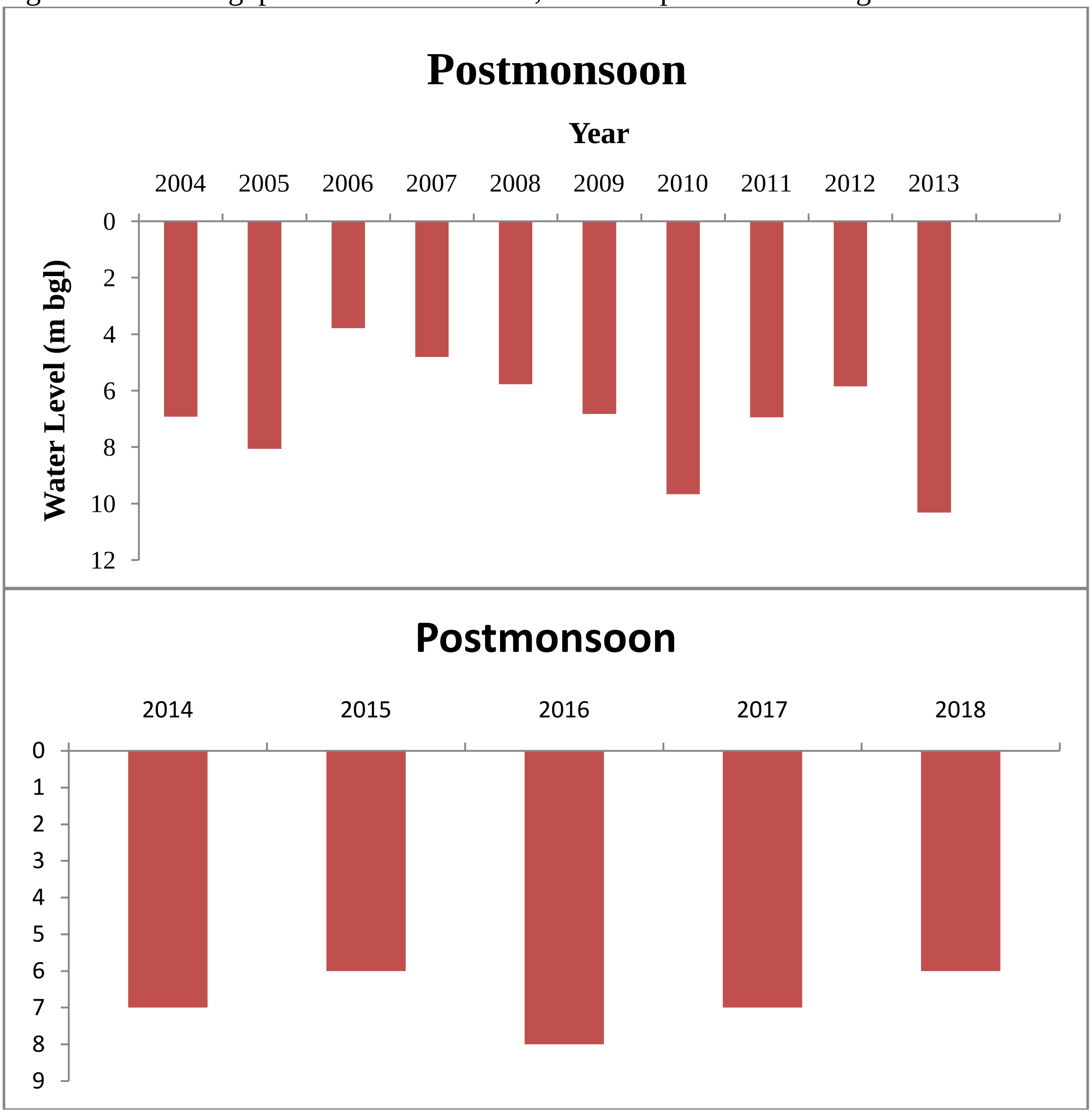


Figure 2.8 Average groundwater level during postmonsoon season

2.4.2 Average Groundwater Level during Pre monsoon Season

The average groundwater level during the premonsoon season is presented in Figure 2.9. During premonsoon season, the level of the groundwater was found to be shallow during the year 2006 with a depth of 5.77m bgl and decline in water level occured in the year 2018 with a depth of 12.48m bgl.

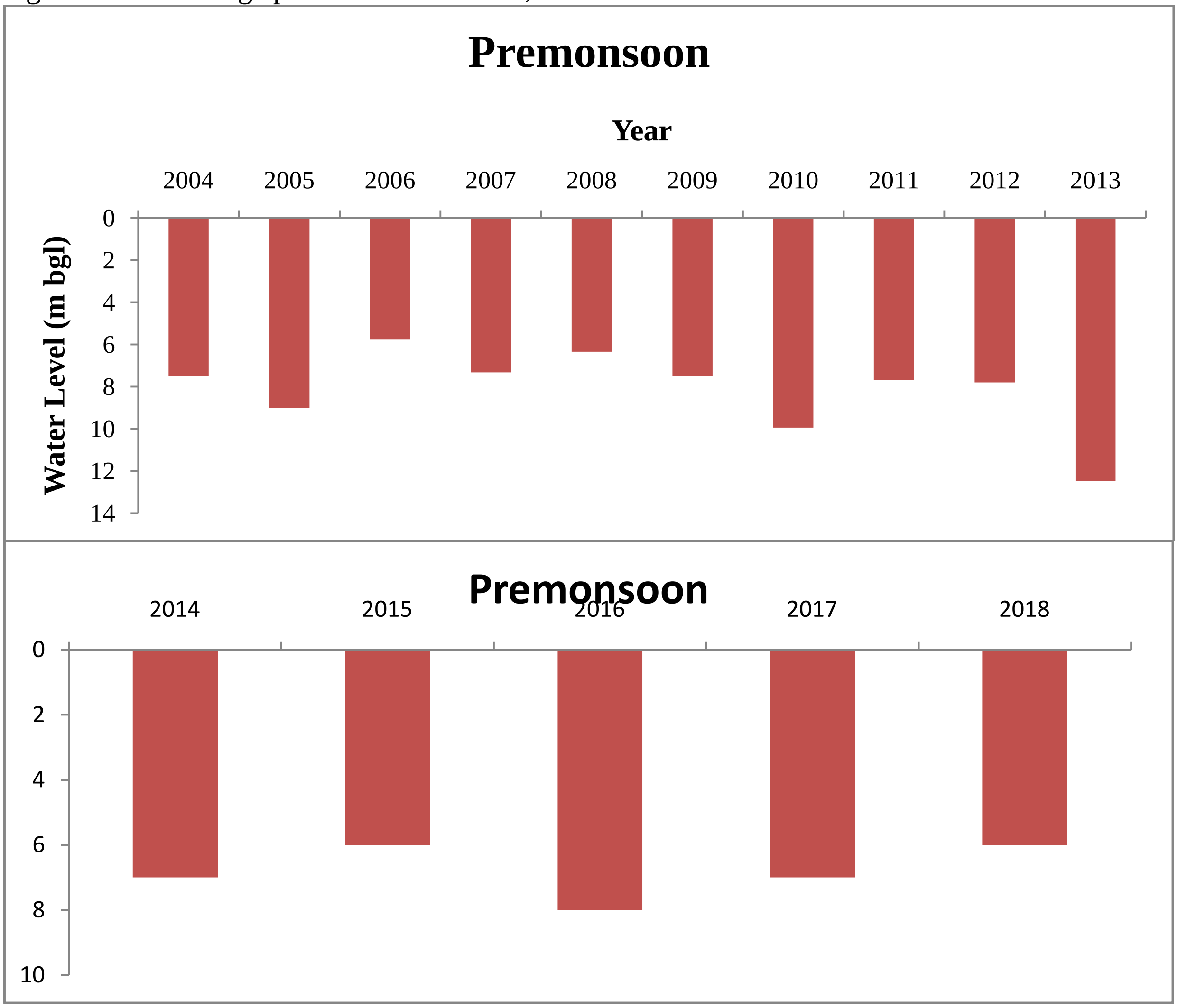
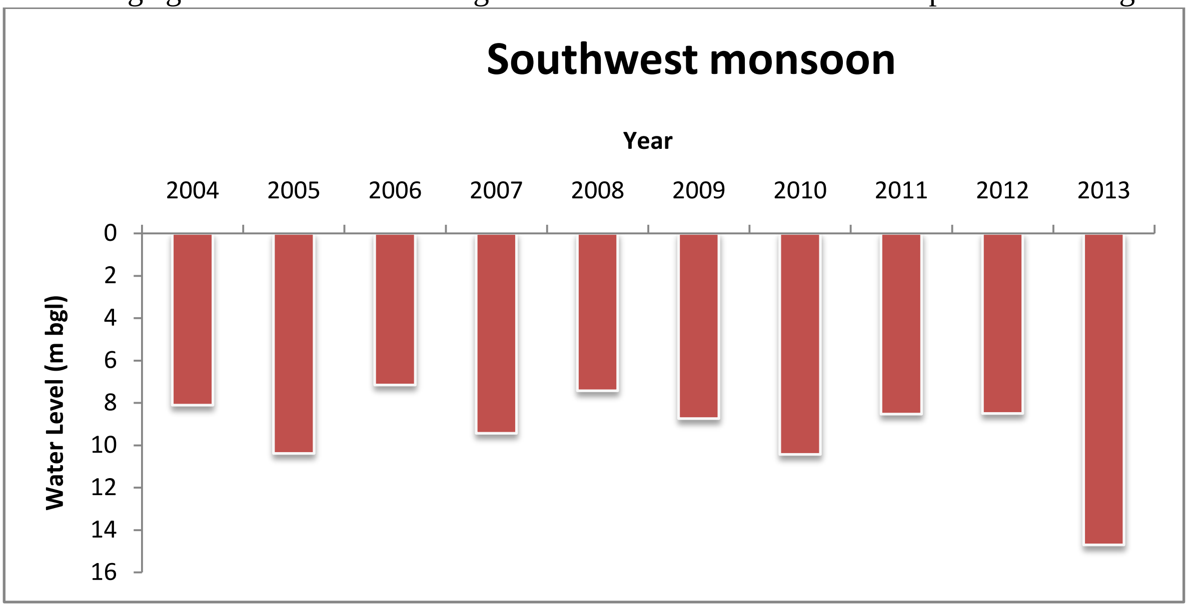


Figure 2.9Average groundwater level during premonsoon season

2.4.3 Average Groundwater Level during Southwest Monsoon Season

The average groundwater level during the southwest monsoon season is presented in Figure 2.10.



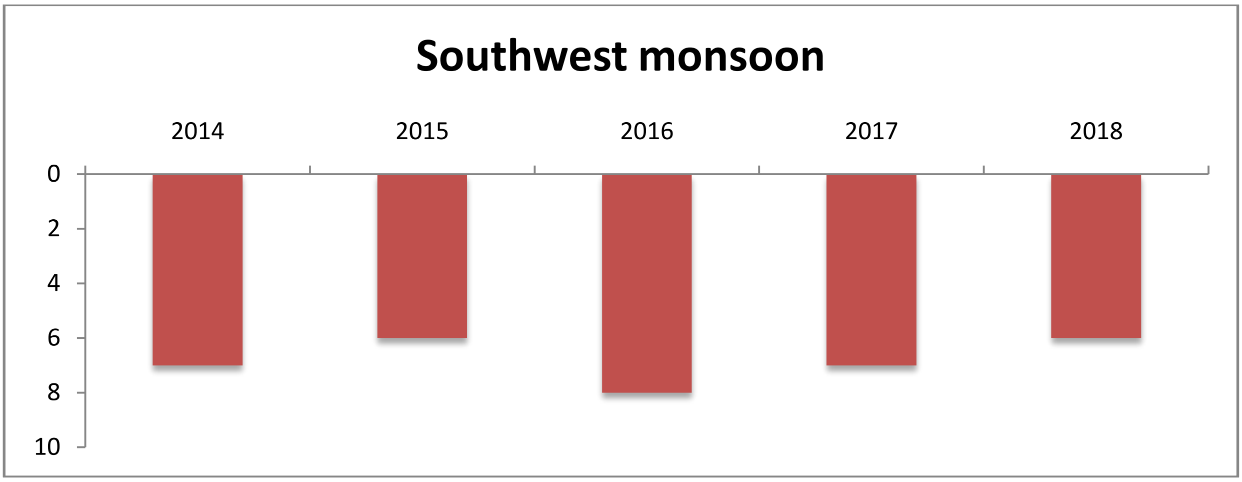


Figure 2.10 Average groundwater level during southwest monsoon season

During southwest monsoon season, the level of the groundwater was found to be proximal during the year 2006 with a depth of 7.15m bgl and decline in water level occured in the year 2013 with a depth of 14.70m bgl.

2.4.4 Average Groundwater Level during Northeast Monsoon Season

The average water level during the northeast monsoon season is presented in Figure 2.11. During northeast monsoon season, the level of the groundwater was shallow during the year 2006 with a depth of 4.98m bgl and decline in water level occurred in the year 2018 with a depth of 11.75m bgl

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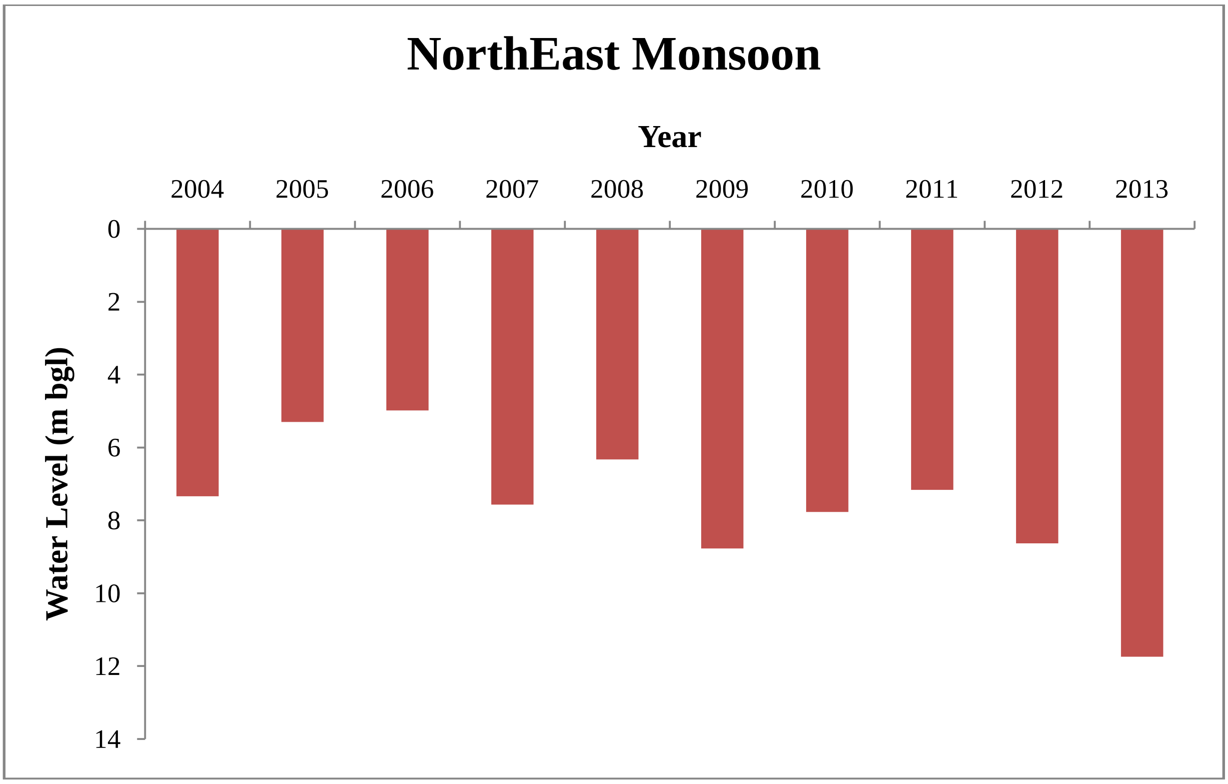

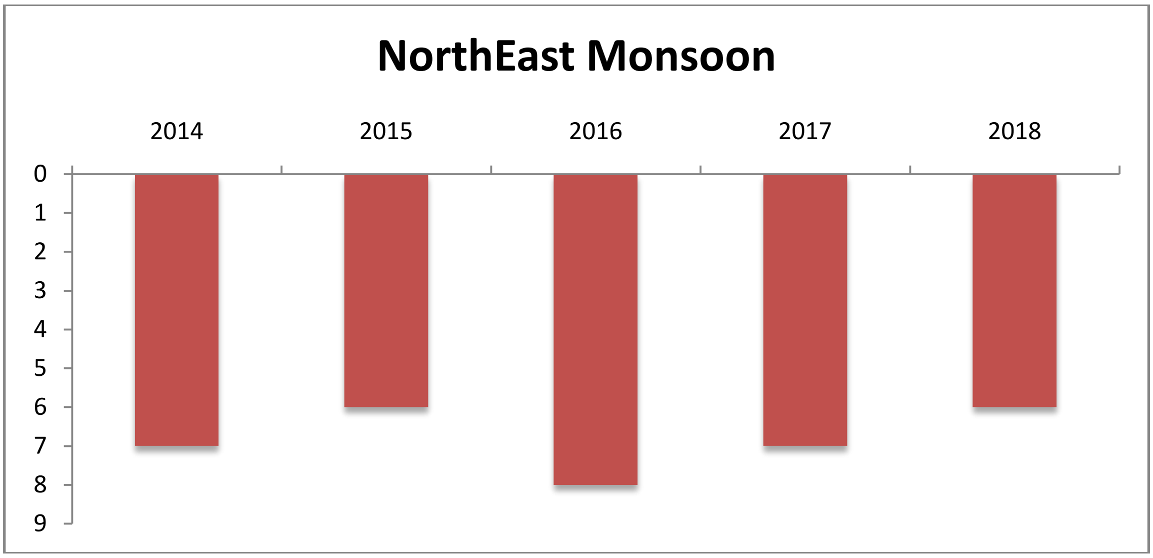

Figure 2.11 Average groundwater level during northeast monsoon season

2.5 RESULTS AND DISCUSSION

2.5.1 Rainfall Analysis

The annual rainfall from 2004 to 2018 for all the rain gauge stations is presented in Table 2.8. Table 2.8 shows that most of the rain gauge stations have recorded high amount of rainfall that is more than the annual mean rainfall of 987mm during the year 2005. The rain gauge station Yercaud received high amount of rainfall from 2004 to 2017, and in the year 2018, it was slightly reduced.

The average rainfall for various rain gauge stations is presented in Figure 2.12. The average rainfall from various rain gauge stations shows that heavy rainfall occurs during the northeast monsoon season and very less or no rainfall occurs during the postmonsoon season. Reduction in the rainfall is noticed in Gangavalli rain gauge station in the year 2014.

Table 2.8 Annual rainfall for different rain gauge stations from 2004 to 2018

Rain gauge stations	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification	Annual rainfall	Classification
Anaimaduvu reservoir	878.2	Low	1026	High	990	Low	862	Low	728	Low	727	Low	1174	High	1247	High	756	Low	300	Low
Atthur	1096.1	High	942.5	Low	800.8	Low	832.1	Low	957.3	Low	721.4	Low	1630.1	High	1226.7	High	520.1	Low	400	Low
Edappadi	673.7	Low	1329	High	588	Low	921.41	Low	735	Low	360.5	Low	989.6	Low	905.3	Low	628	Low	373.1	Low
Gangavalli	928.9	Low	1106.8	High	743.5	Low	1024.28	High	808.58	Low	680.5	Low	298.2	Low	2.4	Low	0	Low	0	Low
Kolathur	1621.6	High	1065.1	High	982.4	Low	877.4	Low	765.1	Low	500.54	Low	863.92	Low	335.9	Low	446.4	Low	171.9	Low
Kullampatti	718.4	Low	1584.7	High	887	Low	774	Low	890.5	Low	516.76	Low	1101.5	High	787	Low	555.3	Low	426.5	Low
Mettur	1359.2	High	1521	High	1252.1	High	1037.88	High	976.2	Low	913.92	Low	1345.9	High	1213.8	High	570.6	Low	233.5	Low

Nangavalli	866	Low	1401.1	High	1171.34	High	1072.5	High	1228.2	High	566.19	Low	997	Low	1233.95	High	503.8	Low	90.8	Low
Omalur	1194.8	High	987.8	Low	750.6	Low	1018.8	High	834.82	Low	755.45	Low	803.9	Low	1067.91	High	961.4	Low	230	Low
Pillukurichi	750.4	Low	1271.6	High	793	Low	702.4	Low	782.7	Low	463.32	Low	863	Low	771.7	Low	590.7	Low	227.5	Low
Salem	1232.2	High	1359.9	High	1028.5	High	893.22	Low	957.8	Low	842.24	Low	1190.2	High	955.9	High	1003.4	Low	340.7	Low
Sankari	938.32	Low	1049.12	High	611.5	Low	549.62	Low	814.4	Low	541.706	Low	988.5	Low	1113.1	High	655.7	Low	280.2	Low
Thammampatti	1004.9	High	1222.5	High	800.2	Low	964.38	Low	869.92	Low	708.2	Low	1049.2	High	936.4	Low	657.7	Low	352.2	Low
Vazhapadi	1139.5	High	1396.2	High	717.6	Low	728.3	Low	752.2	Low	586.9	Low	1027.5	High	1064	High	681.62	Low	331.2	Low
Yercaud	1850.7	High	1835	High	1477.7	High	1637.32	High	1638.4	High	1285.6	High	1752.08	High	1736.4	High	1540.3	High	672.92	Low

Rain gauge stations	**2014**		**2015**		**2016**		**2017**		**2018**	
	Annual rainfall	**Classification**	**Annual rainfall**	**Classification**	**Annual rainfall**	**Classification**	**Annual rainfall**	**Classification**	**Annual rainfall**	**Classification**
Anaimaduvu reservoir	878.2	Low	1026	High	990	Low	862	Low	728	Low
Atthur	1096.1	High	942.5	Low	800.8	Low	832.1	Low	957.3	Low
Edappadi	673.7	Low	1329	High	588	Low	921.41	Low	735	Low
Gangavalli	928.9	Low	1106.8	High	743.5	Low	1024.28	High	808.58	Low
Kolathur	1621.6	High	1065.1	High	982.4	Low	877.4	Low	765.1	Low
Kullampatti	718.4	Low	1584.7	High	887	Low	774	Low	890.5	Low
Mettur	1359.2	High	1521	High	1252.1	High	1037.88	High	976.2	Low
Nangavalli	866	Low	1401.1	High	1171.34	High	1072.5	High	1228.2	High
Omalur	1194.8	High	987.8	Low	750.6	Low	1018.8	High	834.82	Low
Pillukurichi	750.4	Low	1271.6	High	793	Low	702.4	Low	782.7	Low
Salem	1232.2	High	1359.9	High	1028.5	High	893.22	Low	957.8	Low
Sankari	938.32	Low	1049.12	High	611.5	Low	549.62	Low	814.4	Low
Thammampatti	1004.9	High	1222.5	High	800.2	Low	964.38	Low	869.92	Low
Vazhapadi	1139.5	High	1396.2	High	717.6	Low	728.3	Low	752.2	Low
Yercaud	1850.7	High	1835	High	1477.7	High	1637.32	High	1638.4	High

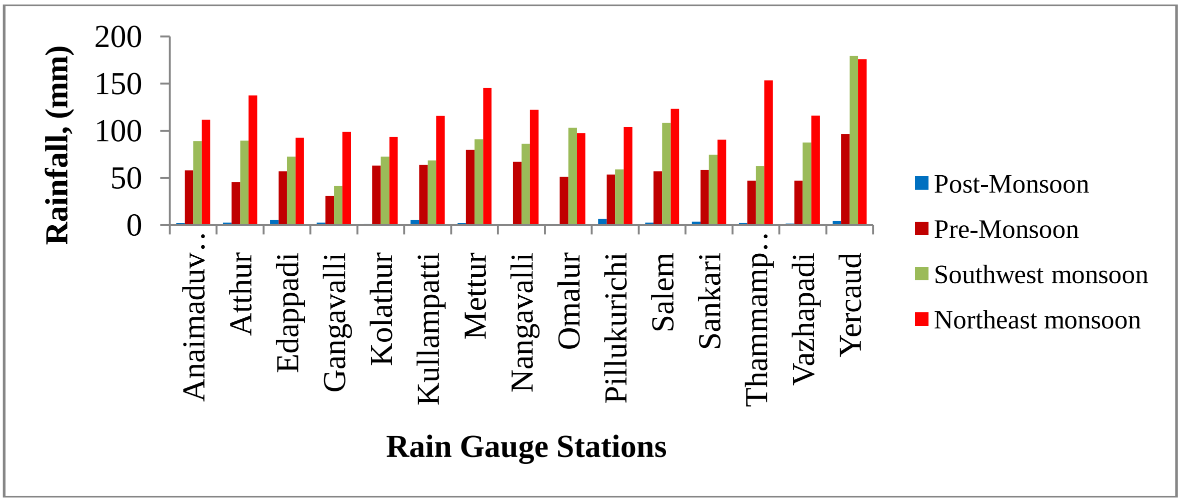

Figure 2.12 Average rainfall for different rain gauge stations

2.5.2 Groundwater Level Analysis

The average groundwater level for various observation wells are presented in Figure 2.13. Ground water level classification from 2004 to 2018 is presented in Table 2.9. Table 2.9 shows that the groundwater level in the observation wells in the study area belong to very shallow to proximal level. The average depth of groundwater level during premonsoon from 2004 to 2018 varies between 5.77m bgl and12.48 m bgl.

The average depth of groundwater level during postmonsoon from 2004 to 2018 varies between 3.78m bgl and 10.32 m bgl. The average depth of groundwater level during southwest monsoon from 2004 to 2018, it varies between 7.15m bgl and 17.70 m bgl. The average depth of groundwater level during northeast monsoon from 2004 to 2018, floats between 4.98m bgl and 11.75 m bgl.

Shallow depth of water table is available at the surface even though the rainfalls in some areas are below the average annual rainfall. From the groundwater level fluctuation over a period of 15 years, it is noticed that the water level goes down during the southwest monsoon season. The analysis shows that the rainfall would affect the water quality in the study area.

2.5.3 Groundwater Recharge Potential Zoneby Overlay Analysis

The spatial distribution of recharge zones of the study area is presented in Figure 2.14. The area covered by high recharge potential zone is found to be 17.59 Sq.km. Moderate recharge potential zone is found to spread over some parts of the study area covering an area of about 83.5 Sq.km

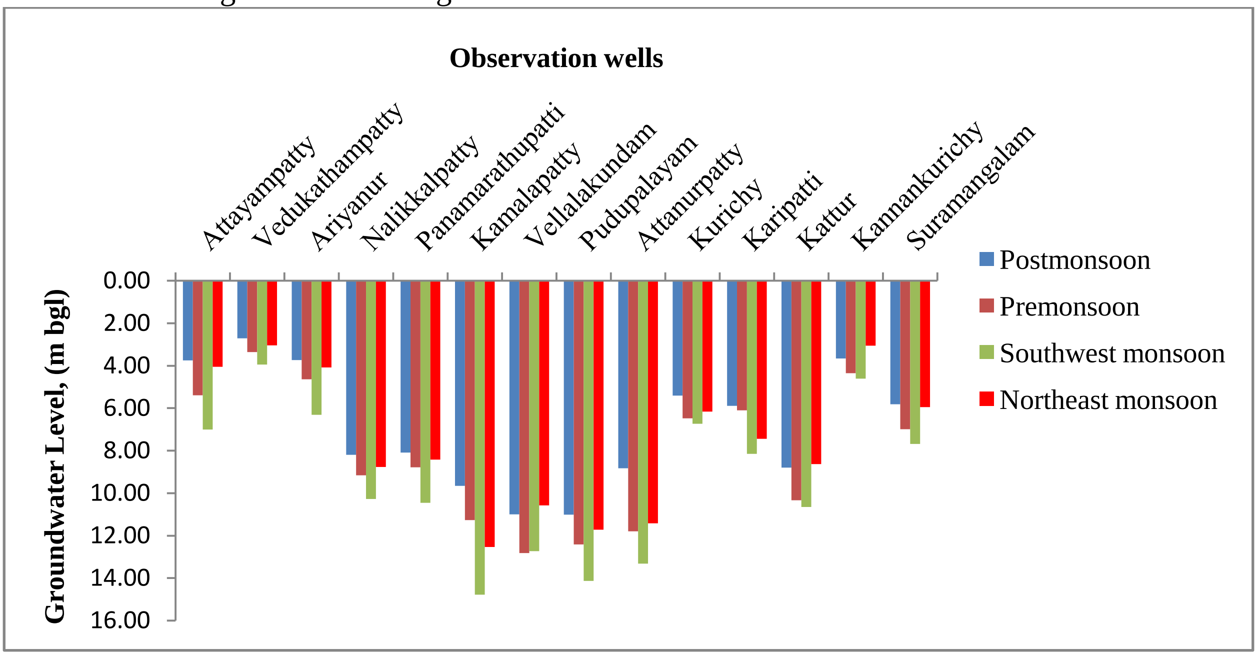

Figure 2.13 Average groundwater levels for observation wells

Table5.9 Water level classification for different observation wells from 2004 to 2018

Observation well	2004		2005		2006		2007		2008		2009		2010		2011		2012		2013	
	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification
Attayampatty	5.1	Shallow	6.4	Shallow	3.8	Shallow	4.7	Shallow	3.0	Shallow	5.0	Shallow	7.3	Proximal	2.8	Shallow	5.2	Shallow	9.9	Proximal
Vedukathampatty	6.2	Shallow	1.6	Very shallow	2.7	Shallow	4.0	Shallow	2.9	Shallow	3.8	Shallow	2.7	Shallow	2.3	Shallow	3.0	Shallow	4.4	Shallow
Ariyanur	0.0	Very shallow	2.3	Shallow	4.3	Shallow	7.5	Proximal	4.4	Shallow	4.1	Shallow	7.8	Proximal	3.8	Shallow	5.2	Shallow	9.7	Proximal
Nalikkalpatty	14.0	Proximal	17.2	Proximal	5.0	Shallow	6.1	Shallow	6.9	Shallow	9.1	Proximal	9.2	Proximal	7.8	Proximal	6.8	Shallow	10.7	Proximal
Panamarathupatti	8.5	Proximal	16.8	Proximal	6.1	Shallow	5.8	Shallow	5.7	Shallow	5.7	Shallow	10.3	Proximal	8.4	Proximal	9.6	Proximal	14.5	Proximal
Kamalapatty	0.0	Very shallow	6.6	Shallow	8.3	Proximal	12.6	Proximal	17.9	Proximal	17.7	Proximal	17.1	Proximal	12.3	Proximal	11.9	Proximal	20.3	Proximal
Vellalakundam	14.5	Proximal	13.6	Proximal	7.2	Proximal	8.3	Proximal	9.7	Proximal	9.7	Proximal	15.3	Proximal	14.1	Proximal	11.3	Proximal	15.6	Proximal
Pudupalayam	18.0	Proximal	13.8	Proximal	5.6	Shallow	11.3	Proximal	8.5	Proximal	11.8	Proximal	17.3	Proximal	14.5	Proximal	11.4	Proximal	13.6	Proximal
Attanurpatty	18.8	Proximal	13.8	Proximal	9.1	Proximal	11.6	Proximal	7.9	Proximal	10.1	Proximal	9.4	Proximal	7.9	Proximal	9.3	Proximal	19.1	Proximal
Kurichy	0.0	Very shallow	0.6	Very shallow	6.7	Shallow	7.0	Proximal	5.0	Shallow	7.4	Proximal	8.8	Proximal	9.0	Proximal	7.4	Proximal	11.9	Proximal
Karipatti	0.0	Very shallow	0.4	Very shallow	8.9	Proximal	10.3	Proximal	6.2	Shallow	9.0	Proximal	3.7	Shallow	3.7	Shallow	8.3	Proximal	21.1	Proximal
Kattur	10.0	Proximal	11.2	Proximal	6.0	Shallow	8.2	Proximal	6.7	Shallow	8.6	Proximal	12.2	Proximal	11.0	Proximal	10.7	Proximal	13.0	Proximal
Kannankurichy	5.3	Shallow	6.5	Shallow	3.2	Shallow	4.1	Shallow	3.1	Shallow	3.6	Shallow	3.5	Shallow	2.8	Shallow	3.7	Shallow	4.1	Shallow
Suramangalam	5.5	Shallow	6.7	Shallow	3.7	Shallow	5.8	Shallow	5.3	Shallow	8.1	Proximal	8.6	Proximal	7.3	Proximal	7.0	Proximal	9.5	Proximal

Observation well	2014		2015		2016		2017		2018	
	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification	Average water level	Classification
Attayampatty	5.1	Shallow	6.4	Shallow	3.8	Shallow	4.7	Shallow	3.0	Shallow

Vedukathampatty	6.2	Shallow	1.6	Very shallow	2.7	Shallow	4.0	Shallow	2.9	Shallow
Ariyanur	0.0	Very shallow	2.3	Shallow	4.3	Shallow	7.5	Proximal	4.4	Shallow
Nalikkalpatty	14.0	Proximal	17.2	Proximal	5.0	Shallow	6.1	Shallow	6.9	Shallow
Panamarathupatti	8.5	Proximal	16.8	Proximal	6.1	Shallow	5.8	Shallow	5.7	Shallow
Kamalapatty	0.0	Very shallow	6.6	Shallow	8.3	Proximal	12.6	Proximal	17.9	Proximal
Vellalakundam	14.5	Proximal	13.6	Proximal	7.2	Proximal	8.3	Proximal	9.7	Proximal
Pudupalayam	18.0	Proximal	13.8	Proximal	5.6	Shallow	11.3	Proximal	8.5	Proximal
Attanurpatty	18.8	Proximal	13.8	Proximal	9.1	Proximal	11.6	Proximal	7.9	Proximal
Kurichy	0.0	Very shallow	0.6	Very shallow	6.7	Shallow	7.0	Proximal	5.0	Shallow
Karipatti	0.0	Very shallow	0.4	Very shallow	8.9	Proximal	10.3	Proximal	6.2	Shallow
Kattur	10.0	Proximal	11.2	Proximal	6.0	Shallow	8.2	Proximal	6.7	Shallow
Kannankurichy	5.3	Shallow	6.5	Shallow	3.2	Shallow	4.1	Shallow	3.1	Shallow
Suramangalam	5.5	Shallow	6.7	Shallow	3.7	Shallow	5.8	Shallow	5.3	Shallow

CONCLUSION

This research work consists of evaluation of rainwater quality during pre monsoon and post monsoon seasons. Based on the research work, the following conclusions are made. The influencing factors of groundwater quality in this study reveals

- There is no remarkable change in the correlation pattern among pre monsoon water quality parameters and among the post monsoon water quality parameters. It can be concluded that the cause for groundwater quality difference between the seasons is the dissolution of chemical concentration of the water solution due to rainfall.
- Some of the parameters have higher values of standard deviation during both seasons. It can be concluded that the factors controlling the concentrations of these parameters are not uniform at all the sample locations of the study area. Some of the parameters have low concentrations during pre monsoon season than during post monsoon season. The higher rate of rainfall and higher dissolution during this season may be concluded as the cause for their lower concentration.
- Based on orders of eigen values of load factors on difference water quality parameters in pre monsoon and post monsoon groundwater samples, their importance in the groundwater chemistry is understood. The eigen values of parameters, which are responsible for total hardness and salinity occupy higher loading in post monsoon samples than in pre monsoon samples. The major source which alters the concentrations of these parameters is the infiltration due to rainfall.

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