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WATER CONSERVATION STRATEGIES FOR OPTIMIZATION OFGROUNDWATER

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ABSTRACT: The quality of surface water in a particular region is determined by natural processes, such as the rate of precipitation, weathering, and the erosion of soil and anthropogenic effects such as industrial, urban and agriculture and the human-induced exploitation in the use of resources like water (Jarvie et al.,1998; Mahvi and.,2005; Nouri and co.,2008). Changes in land use increase the number of impervious surfaces which causes storm runoff events which negatively impact ecosystems of streams and the quality of water (Paul and Meyer, 2001). The management of water resources has a significant impact on society and the living standards. Conservation of water is the process of collecting and conserving water from its various forms, like storm-water, run-off, and rain that otherwise would be wasted to be used later for productive purposes. Conservation of water has attracted a lot of attention from academics institutionalisms, professionals and non-professionals over the past few years due to it being low-cost solution to water shortages.

I. INTRODUCTION

Techniques like Rain Water Harvesting (RWH) and Artificial Recharge (AR) to groundwater are effective tools in the management of water as they directly benefit the community in addressing the water shortage of the present and the future generation to a certain degree. Rainwater is a major source of fresh water in the sense of collecting rainwater to use or pumping it to the ground to improve the amount of groundwater stored in the aquifer is referred to as rainwater harvesting. Harvesting rainwater is practiced since the early civilizations in India and has since been modified techniques using local resources (Agarwal and Narain 2005).

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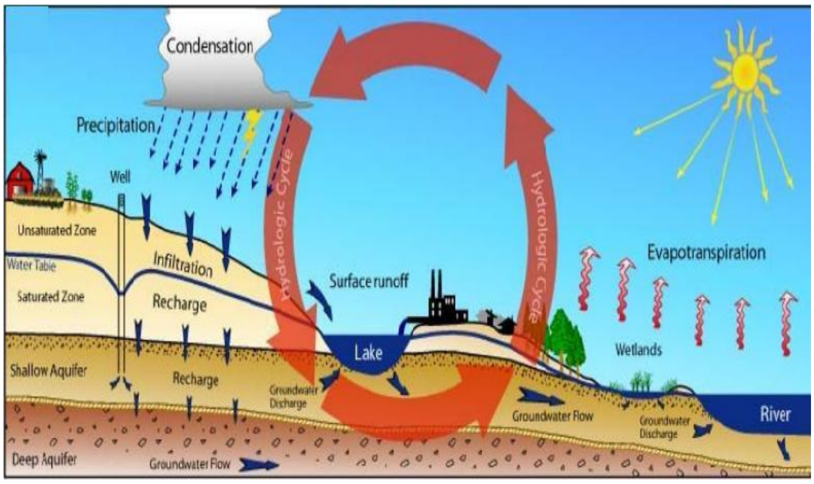

Fig. 3.1 Showing Basic Groundwater Occurrence and Movement

Figure 3.1 shows the essential elements of the hydrologic cycle and the relationship between surface water, climate and groundwater. Groundwater is formed by rain and infiltration during an ordinary hydrological cycle and as rain drops and extends to the ground, some water runs along the surface of the land into lakes and streams in the form of surface runoff. Some of it evaporates into the air, while others are taken up by plants and some of it seeps into ground. When water begins to penetrate into the soil and enters an area that is a mix of air and air, known as the vadose zone or the unsaturated zone. Through this zone water is able to move through the saturated zone in which all the openings between soil and rock particles contain water. In this zone of saturated in this zone that "groundwater" is a good equivalence. Groundwater is contained within the interconnected pores of soil and rock beneath the ground surface, also known as aquifers. They can be either a confined or unconfined aquifer that is usually bound by confining beds above and below by bed confining and are located at a significant depth beneath the surface, or an unconfined aquifer which is also known as water-table aquifer that includes water tables as their top boundary and is located close to the surface of the earth.

As areas are developed, is covered with impermeable soil like asphalt and concrete foundations that tends to increase surface runoff (Fetter 2003). Runoff is the process of draining rainwater from catchments that is discharged through the naturally-occurring drainage systems. Following the flooding and other losses resulting surface of the land towards an main drain channel. Runoff is among the most crucial hydrologic variables that are used in the majority of the water resources-related applications.

A reliable prediction of the amount and amount of runoff from the surface of the earth or other sources is essential in tackling numerous water management and issues, especially in urban areas, where numerous issues such as storm-water drainage, water logging and water shortages are prevalent.

Groundwater resource is recharged naturally by percolation. However, due to unintentional expansion and rapid urbanization in cities, the surface exposed for soil has drastically decreased which has led to a reduction in the rainwater percolation, thereby diminishing the groundwater resource, as is evident on Figure 1.2.When the pressure of urbanization exceeds recharge and discharge is minimal in contrast to the natural circumstances in which recharge and discharge are on par and discharge is sustainable, unsustainable conditions for groundwater prevail.

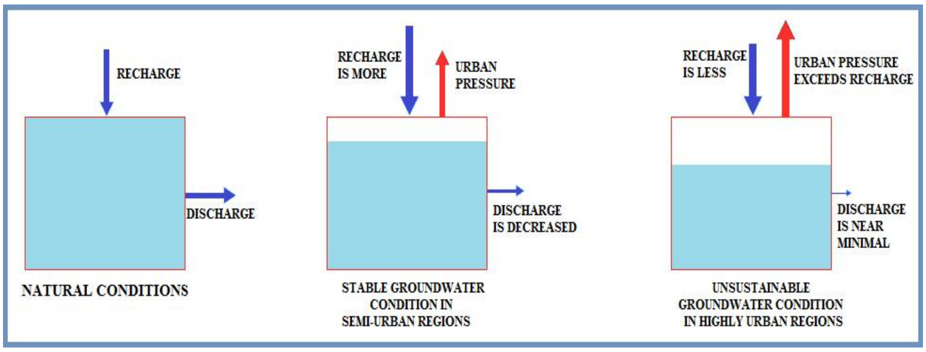

Fig 3.2 Urban Pressure and Related Groundwater Conditions

Urbanization usually boosts the amount and the peak of direct runoff that occurs for an event of rain. Since the process of removing storm water is increased the time it travels is reduced, which results in less lag time and less concentration times. It is possible to reverse the impacts by expanding the storage capacity of the area and delay the water flow, the maximum of direct runoff could be reduced and its duration increased. This is done through the provision of storage for detention, or altering the terrain and increasing the size of storm drains.

3.3. Rain Water Harvesting

Rain water harvesting is simple to comprehend from the name or by reversing one. "Harvesting rainwater" makes it clearer. In urban areas, it can be accomplished through the collection of rainwater from surfaces such as roofs. The collection and distribution of rainwater can be carried out either indoors or outdoors. Rainwater harvesting is easy and a most ancient methods to conserve the water and is also a cost-effective as well as a secure and environmentally sustainable water resource. In urban areas water storage and the direct use of rainwater is a problem primarily due to the restrictions in the preservation and maintenance. In such environments the quality of rainwater is likely be poor and might even contain physicochemical and biological pollutants that have been absorbed from the surrounding environment. Rainwater collection on roofs could provide water of good quality suitable for drinking in the event that the roof is impervious, clean, and constructed from non-toxic materials. If the right devices such as water diverters or first flush systems are put in place correctly, they will be able to flush out the first stream of rainwater quickly and this issue will be solved thus stopping the mixing of dirt, contaminants and pollens that are already on the roofs of buildings to enter to the tanks for storage.

In general, during the time of rain without RWH structures, rainwater is able to flow down as the run-off of storm water drainage, without helping the area in which rain has fallen. RWH plays an important role in the management of the water shortage and it also improves the aquifers in particular urban regions. Implementing and applying RWH in the country is essential to ensure long-term sustainability of the water resource. Rainwater harvesting has become a major focus and several governments and non-governmental organizations have come up with and published guidelines to promote rain water harvesting across our country (CGWB 2017).

The diagrammatic representation of RWH and AR to groundwater is illustrated in Figure 3.3. A look at the figure 1.3 shows that rainwater is taken from the cleaned roofs and through conduits, it is transferred into beneath the surface zone and can be used to enhance the recharge of groundwater by artificially recharging within a specific area. Roof water that is collected directly from buildings is generally the most clean water source, and requires minimal treatment prior to being appropriate for a range of applications.

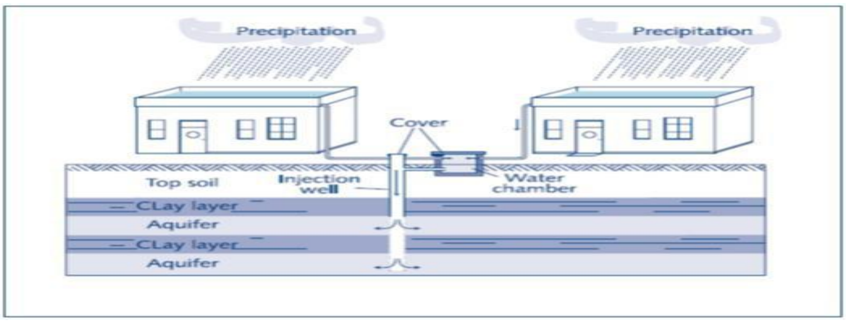

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Fig.3.3 Systematic Presentation of Rooftop RWH and Artificial Recharge (AR) to Groundwater.

Therefore, Rain Water Harvesting and Artificial recharge can have countless roles for sustaining water resource management in our country, in the perspective of rising demands on existing freshwater resources. Rainwater use combined with artificial recharge strategy not only contributes to lessen water use problems in the area, but also provides positive and long-term efficient water gains. To know the overall benefits and impacts occurred on environment due to RWH it is necessary to study all the parameters linked like climatic conditions, site characteristics along with socio-economic scenario. Figure 3.4 is a flow chart showing various steps to study proper functioning and suitability of RWH and AR system in any region. RWH and AR take into consideration the water level data collection along with its quality assessment, distinguishing the various aquifers and their recharge potential in the area under investigation and finally its suitability in that particular area.

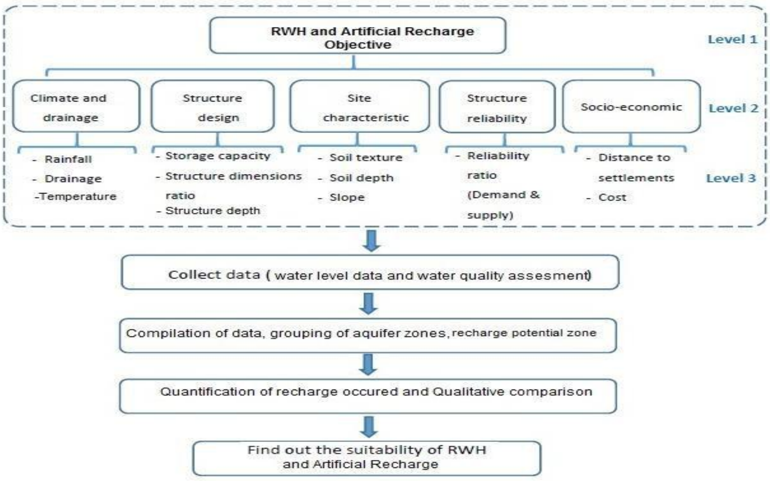

Fig.3.4 Flow Chart Showing Various Steps to Study Proper Functioning and Suitability of RWH and AR System.

II. IMPACT OF RWH ON GROUNDWATER POTENTIAL

Rainwater Harvesting is an exceptionally effective instrument to predict the fast depleting groundwater holds. To study the effect of rainwater harvesting on the groundwater table, the water levels in the perception wells will be gathered. Effect of RWH will be concentrated principally by investigating the groundwater levels temporally and spatially. Worldly analysis of groundwater will be completed utilizing trend analysis and moving average for pre RWH and post RWH periods.

Spatial planning of groundwater table will be likewise drawn utilizing GIS software 9.3 to know the fluctuations of water level taking all things together watersheds.

III. GROUNDWATER MODELING

Groundwater Modeling is a proficient device for groundwater management and remediation. Models are an improvement of reality to research certain phenomena or to foresee the future conduct. In this examination, Groundwater flow model will be worked to simulate the behaviour of RWH utilizing Visual MODFLOW. It will likewise used to anticipate the RWH impact situation for future.

Groundwater models can be interpretive, prescient or generic. Interpretive models are used to examine a specific case and to break down groundwater flow or contaminant transport. Prescient models are utilized to see the change in groundwater head in the future. Generic models are used to dissect various situations of water resource management or remediation schemes.

In this study, importance is given to predict the flow of groundwater and the head temporally and spatially, as well as to investigate the effects of recharge and deliberation at an oil level on flow systems as well as forecasting the drawdown that results from it using different management scenarios.

The bit by bit technique received in this examination will definite in Figure 1. Base guide of the examination area will be made in Arc GIS software and the equivalent will be imported to the visual MODFLOW. The examination area will be partitioned into a matrix of size 100m x100m. The boundary conditions, like flow boundary and no flow boundary active and idle cells will be set. Data on the elevation for the study area will be recorded. The number of layers of the aquifer along its thickness will be determined. Pumping and observation wells will be placed along their screen's thickness as well as the maximum depth.

The aquifer's properties, including water-powered explicit yield, conductivity and transmissivity as well as porosity will be listed as input. The river stage and rate of discharge for discharging wells are entered. The rainwater recharge, pumping rate, and evapotranspiration for the entire zone of investigation will be evaluated and reported as input. The parameters of the model will be evaluated and a perfect match between the measured and computed level of the water is found.

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Trends of Rainfall Distribution (1982-2017)

Large variation in the rainfall distribution in the study has been observed in the last three decades. The trend of annual rainfall distribution and average rainfall distribution during monsoon and non-monsoon seasons for last three decades (1982- 2017) is shown in fig. 1.8 and for the period 2010-2017 is shown in fig.1.9. Highest annual rainfall distribution was observed in the year 1988 (1882.8 mm) and lowestwas observed in the year 1987 (560.6 mm). During the monsoon season highest rainfall was observed in the year 1988 (1754.5 mm) and lowest was observed in the year 1987 (275.7 mm) while during the non-monsoon season highest rainfall was observed in the year 1982 (468.4 mm) and lowest was observed in the year 2010 (87.8 mm) (Table 3.8.1). Monthly rainfall distributions in Chandigarh (2013-2015) are shownin fig.1.10.

Table 3.8.1 Average Rainfall Distributions During Monsoon and Non-monsoonSeasons (1982-2015)

Year	Rainfall (mm)		
	Monsoon season	Non-monsoonseason	Annual
1982	495.2	**468.4**	963.6
1983	998.8	453.4	1452.2
1984	529.6	357.6	620.1
1985	714	149.1	863.1
1986	882.7	256.6	1139.3
1987	**275.7**	284.9	**560.6**
1988	**1754.5**	128.3	**1882.8**
1989	784	213.8	997.8
1990	1082.1	319.9	1402
1991	654.2	162.5	816.7
1992	658.1	166.5	824.6
1993	856.1	186.3	1042.4
1994	1315.7	154.9	1470.6
1995	1215	253.8	1468.8
1996	1253.5	257.4	1510.9

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1997	817	365.1	1182.1
1998	1172	293.4	1465.4
1999	724.7	110.3	835
2000	931.8	194.6	1126.4
2001	819.6	135	954.6
2002	809.8	207.2	1017
2003	635.4	243.2	878.6
2004	923.6	319.7	1243.3
2005	894.1	122.1	1016.2
2006	541.8	212.5	754.3
2007	645	322	967
2008	1112.8	111.6	1224.4
2009	758.9	115.9	874.8
2010	1164.1	**87.8**	1251.9
2011	772.9	125.7	898.6
2012	775.3	127	902.3
2013	841.3	270.5	1111.8
2014	300.4	405.3	705.7
2015	545.2	273.3	818.5
Min	**275.70**	**87.80**	**560.60**
Max	**1754.50**	**468.40**	**1882.80**
Mean	**842.79**	**231.05**	**1065.98**

(Source: Indian Meteorological Department, 2015)

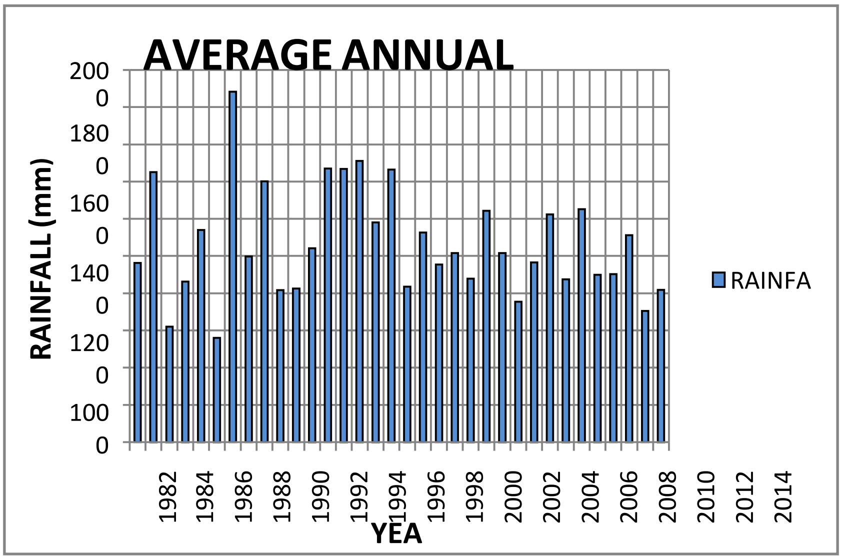

Fig 3.1.8 Average Annual Rainfall Distributions in West Bengal (1982-2015)

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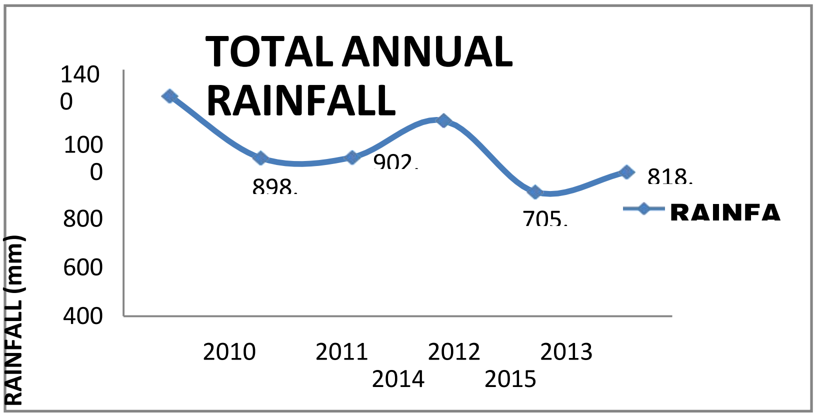

Fig.3. 1.9 Average Annual Rainfall Distributions in West Bengal(2010-2015)

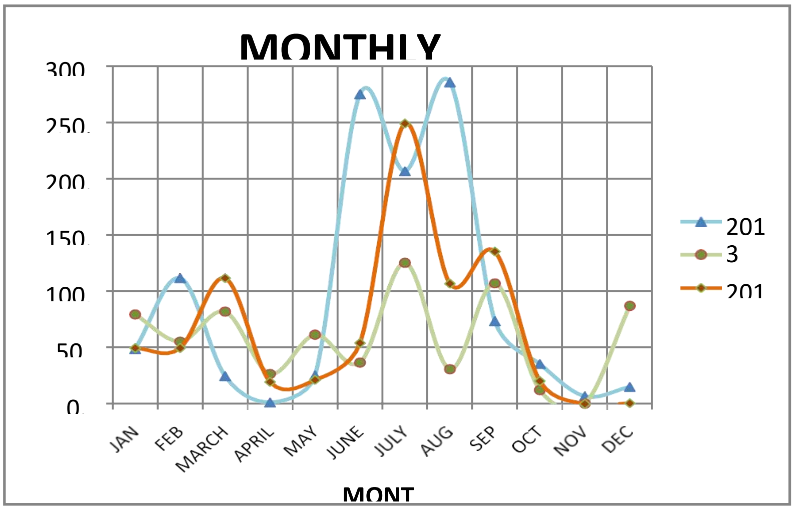

Fig..3.1.10 Monthly Rainfall Distributions in West Bengal (2013-2015)

Temperature

In the summer, heat wave in Chandigarh commences from mid-March until the final week of June. It's then followed by southwest monsoon, which runs until the middle of September. The months of June and May are the most humid seasons of the year with an average daily temperature of 39.0. C. In the summer, heat during the summer can be extremely hot. The period from September to November is referred to in the post monsoon season. The winter season starts in November, and runs through the beginning of March. January is usually the coldest month of the year, with daily mean and minimal temperatures of 20 zero and 7C respectively. Cold waves can impact the region during winter, and the minimum temperature could fall to a point that is near freezing. Winters

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and summers are marked by extreme temperatures, which are often accompanied by monsoon. The median maximum temperature for the city's temperature is 39.1 0.C (May as well as June) and the minimum is 6.1 0.01C (January).

Trend of Temperature Variation in West Bengal (1982-2018)

Average seasonal variation of temperature in Chandigarh (1982-2018) is shown in table 1.2. During the winter season the highest maximum temperature (23.65^{0}C) was observed in the year 1993 and the lowest maximum temperature (13.4^{0}C) was observed in the year 2015, highest minimum temperature (11.6^{0}C) was observed in the year 2014, while lowest minimum temperature (6.63^{0}C) was observed in the year 1997.

During the summer season the highest maximum temperature (36.95^{0}C) was observedin the year 1985 and the lowest maximum temperature (20.1^{0}C) was observed in the year 2015, highest minimum temperature (31.7^{0}C) was observed in the year 2015 while lowest minimum temperature (16.11^{0}C) was observed in the year 1995.

In the monsoon, the maximum temperatures (35.20 0C) was recorded in 1987 and the lowest temperatures (27 0C) was recorded in 2014, while the lowest temperatures for minimum (24.84 0C) was recorded in 1995, while the lowest temperatures (19 0C) was observed in 2014 (IMD 2015). Average year-long variations for temperatures (a) maximal (b) minima (2009-2015) are shown on fig.3.11 and 3.12.

A seasonal analysis has revealed it is evident that Chandigarh city is warming up in terms of minimum temperatures. The temperature range that is daily i.e. the difference between minimum and minimal temperatures displays declining trends throughout the months and seasons that can be caused by a the rise in minimum temperatures. The monthly value indicates that the decline rate is higher in May, followed by the months of October and January (IMD 2017).

Table 3.1.12 Average Seasonal Variation of Temperature in Chandigarh

(1982-2018)

Year	Temperature (^{0}C)					
	Winter Season		Summer Season		Monsoon Season	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1982	22.48	9.01	32.51	18.7	34.2	22.83

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1983	22.5	8.2	32.39	18.8	32.78	22.55
1984	21.17	6.9	36	21.8	32.8	21.74
1985	22.61	8.3	**36.95**	21.3	32.06	22.58
1986	20.72	7.64	36.76	20.36	30.32	22.22

Contd…

Year	Temperature (⁰C)					
	Winter Season		Summer Season		Monsoon Season	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1987	22.53	9.16	34.27	20	**35.2**	23.93
1988	23.47	8.93	36.54	21.81	32.33	23.77
1989	20.97	7.75	34.41	19.48	33.38	22.25
1990	21.67	9.42	34.49	20.3	32.55	22.73
1991	22.82	7.6	34.68	19.54	33.15	22.11
1992	22.41	8.05	35.38	21.59	33.14	22.15
1993	**23.65**	8.28	35.62	21.79	34.05	22.16
1994	22.69	9.13	35.43	21.36	32.27	22.48
1995	21.23	8.73	34.99	**16.11**	32.34	**24.84**
1996	23.15	7.41	33.88	20.79	32.8	21.69
1997	20.64	**6.63**	33.79	18.9	32.64	22.85
1998	21.14	7.97	34.37	20.94	32.79	23.65
1999	21.2	8.33	35.65	21.26	32.87	23
2000	20.6	7.28	34.24	20.4	32.63	21.66
2001	21.34	8.3	33.58	21.21	33.18	23.09
2002	21.92	8.48	35.26	21.84	33.33	22.84
2003	19.12	8.3	34.76	21.27	32.8	23
2004	21.34	9	35.72	22.12	32.84	23.04
2005	21.54	8.7	33.67	23.13	31.88	22.9
2006	23.31	8.68	33.11	20.65	33.69	22.58
2007	21.69	8.02	34.54	22.03	33.46	22.74
2008	21.58	7.7	34.2	20.51	32.77	22.7
2009	22.83	9.12	35.78	21.83	33.14	23.23
2010	21.31	7.94	35.77	21.85	32.74	23.27
2011	20.44	7.32	34.08	20.42	32.67	23.22
2012	20.98	7.6	34.35	19.59	32	22.53
2013	19.5	11.5	31.4	26.2	27.5	19.5

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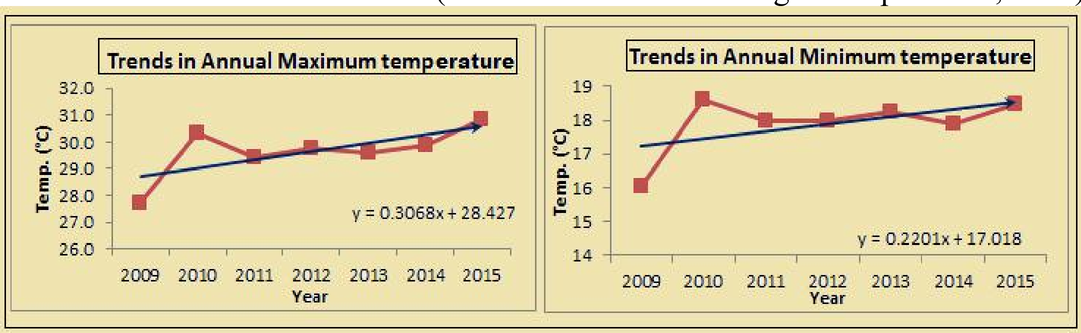
2014	19	**11.6**	20.5	31.2	**27**	**19**
2015	**13.4**	8.1	**20.1**	**31.7**	26.8	23.7
Lowest	**13.4**	**6.63**	**20.1**	**16.11**	**27**	**19**
Highest	**23.65**	**11.6**	**36.95**	**31.7**	**35.2**	**24.84**
Mean	**21.38**	**8.38**	**33.80**	**21.49**	**32.52**	**22.57**

(Source: Indian Meteorological Department, 2018)



(a) **(b)**

Fig. 1.11 Average Annual Trends in Temperature (a) Maximum (b) Minimum (2009-2015)

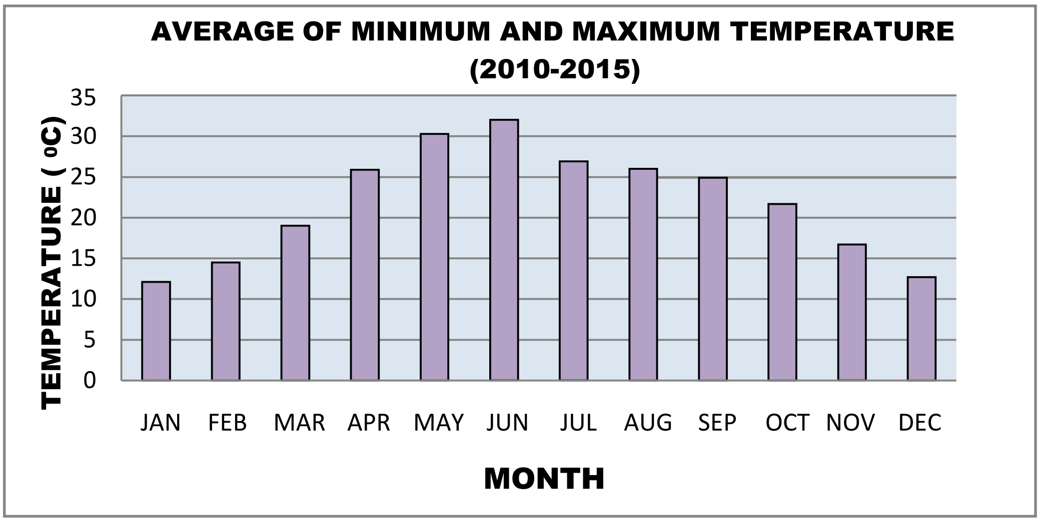


Fig. 3.1.12 Average Monthly Variation of Temperature in West Bengal

(2010-2015)

3.1.13. GEOLOGY AND GEOMORPHOLOGY OF THE AREA

In terms of geology, Chandigarh has been surrounded by semi-solidified structures from that of the higher Shivalik system dating from to the mid Miocene age.

CONCLUSION

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Statistical analysis of the results will be finished. Sensitivity analysis will be completed to test the effect of vulnerability in aquifer parameters and boundary and starting conditions on the model yields. Sensitivity analysis will demonstrate which boundary or parameters will have more noteworthy effect on the yield. Parameters with high impact on model yield will stand out enough to be noticed in the calibration interaction and data collection. The model will then approved by contrasting the consequences of the model and the data observed. At that point the model will run to foresee the draw down/water table and to estimate the effect of RWH.

REFERENCES

1. *Athavale, R.N., Chand, R. and Rangarajan, R. (1983). Groundwater recharge estimates for two basins in the Deccan Trap basalt formation, Hydrological Sciences Journal, 28(4), 525-538.*
2. *Anantharaman, S. (1980). Report on the geological and geomorphological studies inGhaggar basin in parts of Ambala District, Haryana and Patiala District, Punjab. Unpublished Report. Geological Survey of India, F.S, 1978-79.*
3. *Anonymous (2009). Status report on review of ground water resources estimation methodology (R and D Advisory Committee on Ground Water Estimation) Central Ground Water Board, Ministry of Water Resources).*
4. *Aswathanarayana, U. (1995). Geoenvironment - An introduction. A. A. Balkema, Rotterdam Netherlands and A. A Balkema Publishers, Brookfield USA, 73- 120.*
5. *B.I.S (2012). Indian Standard Drinking Water Specification. (2nd Edition.) IS:10500, Indian Standard Institute, New Delhi, 1-18.*
6. *Komariah, Komariah & Senge, Masateru. (2013). THE DEVELOPMENT OF WATER HARVESTING RESEARCH FOR AGRICULTURE. Reviews in*
7. *Agricultural Science. 1. 10.7831/ras.1.31.*
8. *Khare, Deepak & Ramakant, & Ojha, Chandra & Khairwar, V. & Srivastava, R.K.. (2004). Impact assessment of rainwater harvesting on ground water quality at Indore and Dewas, India. 36. 123-129.*
9. *Jothiprakash, Vinayakam & Sathe, Mandar. (2009). Evaluation of Rainwater Harvesting Methods and Structures Using Analytical Hierarchy Process for a Large Scale Industrial Area. J. Water Resource and Protection. 1. 427-438. 10.4236/jwarp.2009.16052.*