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Trends in Humidity, Rainfall and Groundwater data over Vidarbha Region of Maharashtra using Statistical Analysis

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Abstract: - The temperature of the atmosphere is growing day by day as a result of global warming and climate change, which is linked to rainfall variability. Understanding the climate system's transition is crucial to tackling major worldwide environmental challenges. Furthermore, because rainfall is the most common cause of stream flow in India, particularly flood flow, it is critical to understand its pattern integrated with groundwater recharge. Seasonally, the amount of rain that falls fluctuates. The volume of rainfall in different sections of a country at different times and locations throughout the year is complicated, and further research is needed. Various hydrological concerns, such as floods and droughts, are caused by this variation. Rainfall research in India during the monsoon season (June to September) and Temperature research in India during the summer season (Feb to May) is important for a variety of reasons, including economic development, disaster management, and hydrological planning. It's vital to understand mean rainfall and temperature variations on a smaller geographical scale. The seasonality index of rainfall and temperature can be used to investigate the changing pattern of rainfall and temperature. Vidharbha region has total 11 district divided into two divisions, Amravati division and Nagpur Division. Total 11 district are akola, Amravati, Buldana, Yavatmal, Washim, Bhandara, Chandrapur, Gadchiroli, Gondia, Nagpur and Wardha. Total Talukas are almost 120 as of July 2021. The main aim of this research is to study a yearly trend for rainfall pattern, humidity and groundwater level using different statistical model. We have also studied the district wise geology and river recharging pattern to understand the relation matrix and co-relation parameter. The observation shows direct dependability of river water flow with rainfall and groundwater recharge with 67% and 78% precision respectively. Humidity dataset shows heavy prediction prospective with 35% accuracy based on the 5-year timeline dataset. We have also verified the data redundancy and data inconsistency for obtaining 99% plus data efficient model. Keywords: Shunt Active Power Filter (SAPF), Intelligent Instantaneous Active and Reactive Power (IPQ) Theory, Hysteresis band current controller (HBCC), Variable Scaling Hybrid Differential Evolution (VSHDE) and Total Harmonic Distortion (THD), Power Quality (PQ).

KEYWORDS:- Data Analytics, Climate Trends, Autoregressive integrated moving average (ARIMA) model, Co-relation Matrix

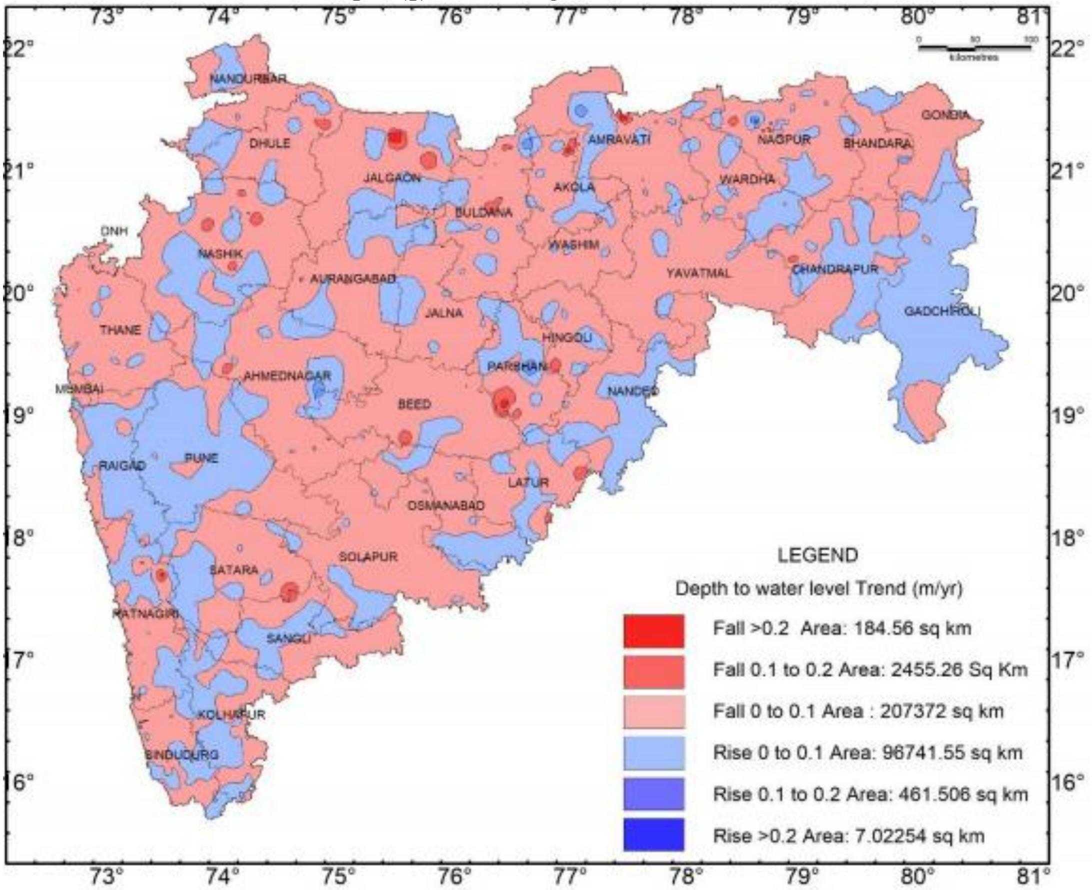
INTRODUCTION

Amravati division and Nagpur division are the two divisions that make up the Vidharbha area. There are 11 districts in all in the Vidharbha region. Akola, Amravati, Buldana, Yavatmal, Washim, Bhandara, Chandrapur, Gadchiroli, Gondia, Nagpur, and Wardha are among the 11 districts of the state. As of July 2021, there are about 120 Talukas in total.

Considering the atmosphere condition, the temperature of the atmosphere is increasing day by day as a result of global warming and climate change, which is connected to rainfall variability. Knowledge of this shift in the climate system is essential for resolving major environmental problems across the world. Also, since rainfall is most common cause of stream flow, particularly flood flow in the majority of rivers in India, it is critical to understand its pattern. The amount of rain that falls changes throughout time. Differences in rainfall magnitude in different areas of a nation at a particular time and location throughout various seasons of the year are varied and must be investigated further. Many hydrological issues, such as floods and droughts, are caused by this fluctuation. The study of rainfall during the monsoon season (June to September) in India is very important for economic growth, disaster management, and hydrological planning, among other things. It's crucial to understand mean rainfall and its variability on a smaller geographical scale. The seasonality index of rainfall may be used to examine the changing pattern of rainfall. The total annual rainfall data for the Vidarbha area of Maharashtra, which includes four districts: Akola, Wardha, Washim, and Yavatmal, is used in this study. To understand the rainfall variability of the area, the data is then examined for mean, standard deviation, and skewness of coefficient. The seasonality index, which is a measure of rainfall distribution across the seasonal cycle, is developed and used to categorise the various rainfall in the area using this study. The trend analysis is also used to identify long-term changes in the seasonality index in order to determine the changing pattern of rainfall at the district size. The current study will undoubtedly offer academics with a roadmap for the long-term development of Maharashtra's water resources.

Monsoon may be studied using daily and monthly rainfall records. Center for Climate Prediction (CPC) The two major data sets, Merged Analysis of Precipitation (CMAP), have been used in a variety of applications, including weather and climate monitoring, climate analysis, numerical model verifications, and hydrological research. To create rainfall analysis, three types of data sources are combined: gauge measurements, estimates based on satellite observations, and numerical model forecasts.

Figure(g): Monsoon patterns in Vidarbha



Figure(h): Ground water level in Maharashtra

METHODOLOGY

It is a term used to describe a large amount of data on a large scale that is structured, semistructured, or unstructured, and that is derived from a variety of sources such as media and public data, sensors data, warehouse data, and other sources, A large amount of data is gathered and produced at a very quick pace with the assistance of superfast and highly processed computers for real time and wide-ranging applications.

The whole data was consolidated and different data analytics were undertaken for four different parameters like rainfall, humidity, temperature and groundwater level. Percentage wise analysis for rainfall dataset clearly shows the direct and proportional relationship. As per the table 2, buldhana region has shown the heavy deficiency of rainfall followed by Amravati, Wardha, Yavatmal, Gondia and so on. The average rainfall at normal category was best in Nagpur followed by Akola and Gadchiroli. Data analytics for three year humidity data shows highest saturation of humidity in the month of September giving direct co-relation to rainfall increment density (Table 3,4,5).

drinking water close to the site of use for residential, agricultural, and industrial uses. Groundwater recharge, in part, regulates the sustainability of groundwater withdrawals, but the conversion of rainfall into recharge is poorly understood, particularly in the tropics. Annual recharge to groundwater sources of Quaternary sands may be as high as 40% of annual rainfall, while annual percentages of rainfall producing recharge in deeper aquifers of Mio-Pliocene sandstone and worn crystalline rocks are 13 and 4%, respectively. The variations are primarily caused by the thickness of the unsaturated zone, as well as lithological constraints on the conveyance and storage of rain-fed recharge. Droughts, seasonal variations in rainfall, and pumping all have an effect on the depth of groundwater under the surface. Water levels in a well may be decreased if it is pumped quicker than the aquifer around it can replace itself via precipitation or other underground activity. Groundwater is a dynamic natural resource that may be replenished by precipitation during the rainy season throughout the rest of the year. Overdrawing groundwater strains the aquifer, producing a decrease in the water table and aquifer distortion, as well as severe surface and subterranean environmental consequences. The presence of humidity is an inevitable part of existence. When it rains, the humidity in the air may change dramatically. It may generate an excessive amount of humidity, resulting in an excess of moisture in the air. Learn more about the interaction of rain and humidity and how it affects them. As a consequence, managing humidity in your workplace will be straightforward. You may be surprised at how fast the weather may alter the humidity. When it rains, the humidity rises to 100 percent, causing the clouds to become unable to hold any more water. Evaporation causes the relative humidity to increase when it rains. It's conceivable that the rain-soaked air isn't completely saturated with water vapour. However, since the air is constantly sucking water from the ground, the humidity will increase as the rain continues. Evaporation cools the air and increases the absolute moisture content of the surrounding air. Rain collects water vapour from the sky and deposits it on the earth's surface on a larger scale. This shows that rain reduces the average relative humidity across a larger region. Water evaporates more rapidly in hotter air, resulting in a greater level of humidity. If the air is colder, the water reduces humidity, making it seem cooler than the outside temperature. The dewpoint temperature is similarly concerned with moisture and the quantity of water vapour in the atmosphere. It is the temperature at which air must be cooled before saturation occurs. Dewpoint may vary from the mid-60s to the high 80s depending on the area and time of year. It's also important to remember that various humidity levels affect different individuals in different ways. Table 6 shows the direct relation of monitored well dataset in total 8 district. The well dataset can be linked with prediction model in future for direct relation to water scarcity with the help of geology mapping.

Following is the data of Rainfall, Humidity ang Groundwater level-

Sr.No.	Region	Normal Rainfall (mm)	Actual Rainfall (mm)	% Departure of RF wrt Normal	Category
1	Vidarbha	954.6	875.4	-8	Normal

Table-1: Rainfall of Vidarbha

Sl No.	District	% Departure of RF wrt Normal	Category
1	Akola	2	Normal
2	Amravati	-18	Normal
3	Bhandara	-9	Normal
4	Buldhana	-26	Deficient
5	Chandrapur	-3	Normal
6	Gadchiroli	0	Normal
7	Gondia	-8	Normal
8	Nagpur	7	Normal
9	Wardha	-17	Normal
10	Washim	-1	Normal
11	Yavatmal	-15	Normal

Table-2: District wise percentage departure of rainfallwrt normal rainfall (up to 26/12/2020)

Humidity 2018	
MONTHS	AVERAGE
January	59%
February	52%
March	34%
April	26%
May	34%
June	60%
July	89%
August	70%
September	80%
October	79%
November	69%
December	79%

Humidity 2019	
MONTHS	AVERAGE
January	52%
February	48%
March	26%
April	20%
May	29%
June	67%
July	82%
August	76%
September	79%
October	70%
November	62%
December	68%

Humidity 2020	
Month	AVERAGE
January	58%
February	42%
March	30%
April	22%
May	25%
June	59%
July	79%
August	80%
September	78%
October	60%
November	58%
December	59%

Sr. No.	District	Active		Dry		Wells Not Monitored#		Total Wells (As on Jan 2019)		Total
		DW	Pz	DW	Pz	DW	Pz	DW	Pz	
1	AKOLA	25	6	5	0	2	3	32	9	41
2	AMRAVATI	73	7	1	0	8	12	82	19	101
3	BULDHANA	45	10	2	0	5	3	52	13	65
4	CHANDRAPUR	49	11	1	0	3	0	53	11	64
5	GONDIA	24	4	0	0	7	1	31	5	36
6	NAGPUR	60	17	0	0	0	3	60	20	80
7	WARDHA	49	11	0	1	1	4	50	16	66
8	YAVATMAL	58	20	0	0	1	4	59	24	83
	TOTAL	**383**	**86**	**9**	**1**	**27**	**30**	**419**	**117**	**536**

Table-6: Groundwater level of Vidarbha 2019

Sl.No.	District	Abandoned		New wells		Total wells		Total Wells (As on 31st March 2020)
		DW	PZ	DW	PZ	DW	Pz	
1	AKOLA	0	0	3	0	32	9	41
2	AMRAVATI	14	1	0	0	69	18	87
3	BULDHANA	1		5	1	52	14	66
4	CHANDRAPUR	0	0	10	0	63	11	74
5	GONDIA	0	0	0	0	31	5	36
6	NAGPUR	2	1	6	0	65	19	84
7	WARDHA	2	0	3	0	48	16	64
8	YAVATMAL	0	0	3	0	58	24	82
	TOTAL	**19**	**2**	**30**	**1**	**418**	**116**	**534**

Table-7: Groundwater level of Vidarbha 2020

Sr. No.	District	Active		Dry		Wells Not Monitored#		Total Wells (As on Jan 2019)		Total
		DW	Pz	DW	Pz	DW	Pz	DW	Pz	
1	AKOLA	25	6	5	0	2	3	32	9	41
2	AMRAVATI	73	7	1	0	8	12	82	19	101
3	BULDHANA	45	10	2	0	5	3	52	13	65
4	CHANDRAPUR	49	11	1	0	3	0	53	11	64
5	GONDIA	24	4	0	0	7	1	31	5	36
6	NAGPUR	60	17	0	0	0	3	60	20	80
7	WARDHA	49	11	0	1	1	4	50	16	66
8	YAVATMAL	58	20	0	0	1	4	59	24	83
	TOTAL	**383**	**86**	**9**	**1**	**27**	**30**	**419**	**117**	**536**

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5	GONDIA	24	4	0	0	7	1	31	5	36
6	NAGPUR	60	17	0	0	0	3	60	20	80
7	WARDHA	49	11	0	1	1	4	50	16	66
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	TOTAL	**383**	**86**	**9**	**1**	**27**	**30**	**419**	**117**	**536**

RESULT

Ground Water Monitoring Wells Are Distributed Using a Basin-Wise Approach In the Godavari basin, there are 997 network stations, 317 in the Krishna basin, 316 in the Tapi basin, 277 in the Coastal basin, 7 in the Narmada basin, and 2 in the Mahanadi basin (Table 8 and 9). The basin-by-basin distribution of GWM wells is shown in Table 8. The well data analytics reveals a clear correlation between the rainfall dataset and the groundwater level, although with less precision since the groundwater level may be a result of river prospects, which might vary depending on the terrain or the source of the river.

District	**Godavari**	**Mahanadi**	**Tapi**	**Grand Total**
Akola	NAN	NAN	37	37
Amravati	46	NAN	58	104
Bhandara	41	NAN	NAN	41
Buldhana	42	NAN	44	68
Chandrapur	74	NAN	NAN	74
Gadchiroli	64	2	NAN	66
Gondia	37	NAN	NAN	37
Nagpur	94	NAN	NAN	94
Wardha	67	NAN	NAN	67
Washim	32	NAN	18	50
Yavatmal	96	NAN	NAN	96
Total	**593**	**2**	**157**	**734**

Table-8: Basin wise distribution of Ground Water Monitoring Wells in Vidarbha during the year 2018-19

Sr. No	**District**	**Number of Point Observer**
1	Akola	7
2	Amravati	39
3	Bhandara	6
4	Buldhana	10
5	Chandrapur	10
6	Gadchiroli	10
7	Gondia	1
8	Nagpur	7
9	Wardha	5
10	Washim	9
11	Yavatmal	6
	Total	**110**

Table-9: District wise Status of Participatory Ground Water Monitoring Point Observers in Vidarbha during the year 2018-19

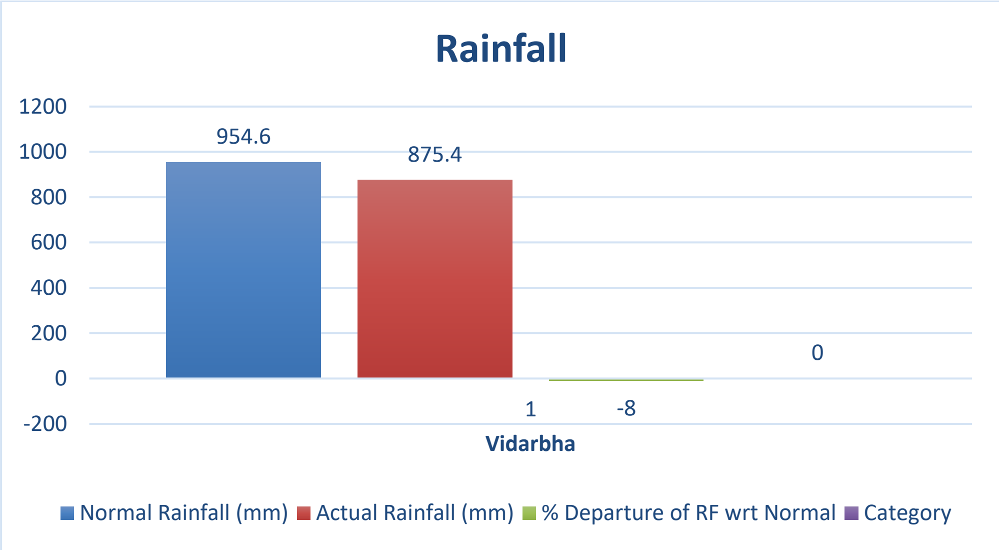

Fig – 1: Rainfall of Vidarbha

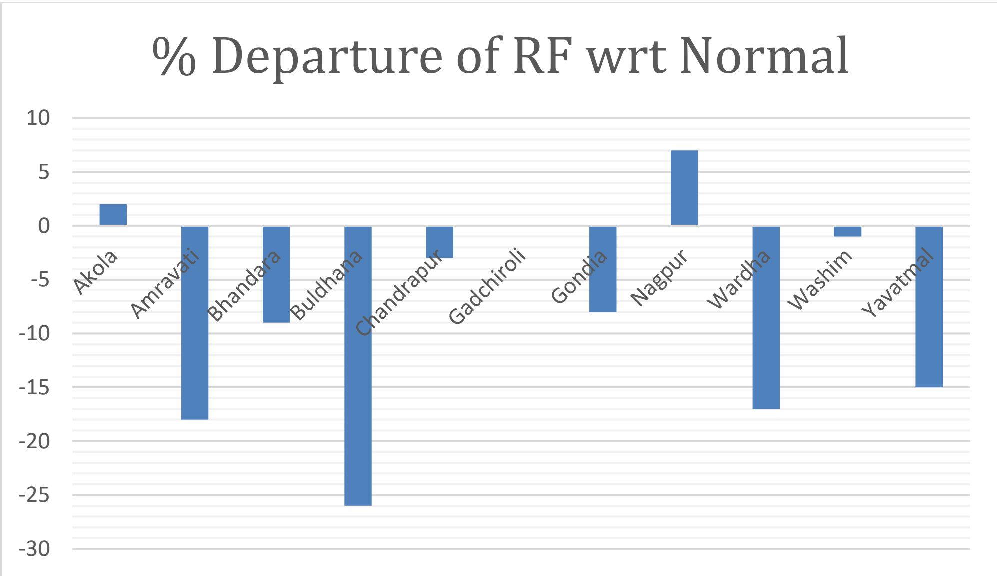

Fig-2: District wise percentage departure of rainfall wrt normal rainfall (up to 26/9/2020)

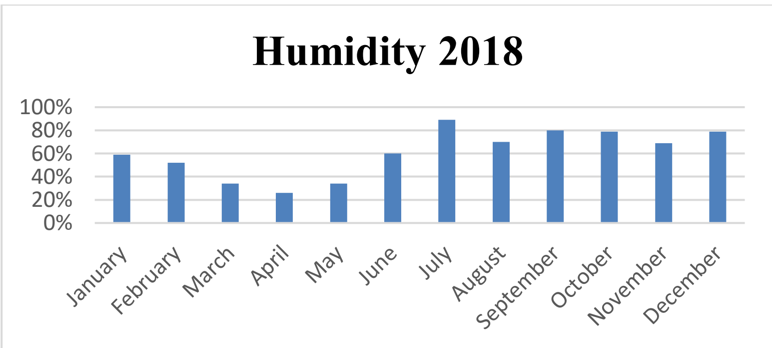

Fig-3 Humidity 2018

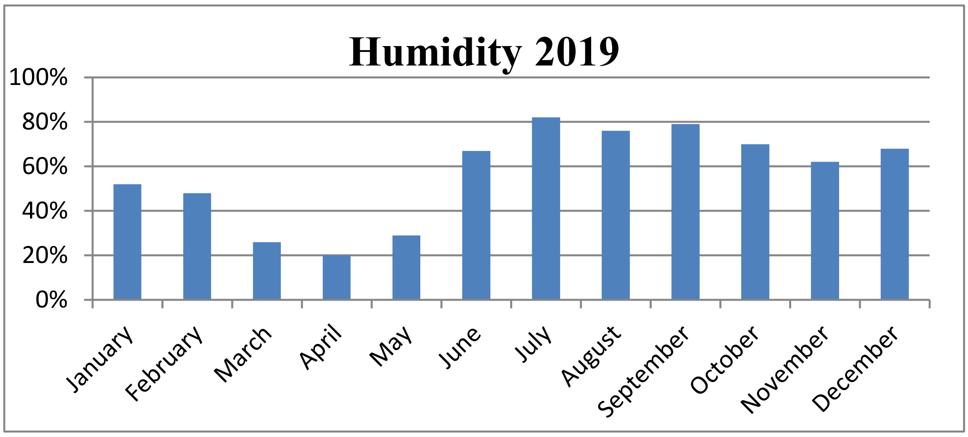

Fig-4 Humidity 2019

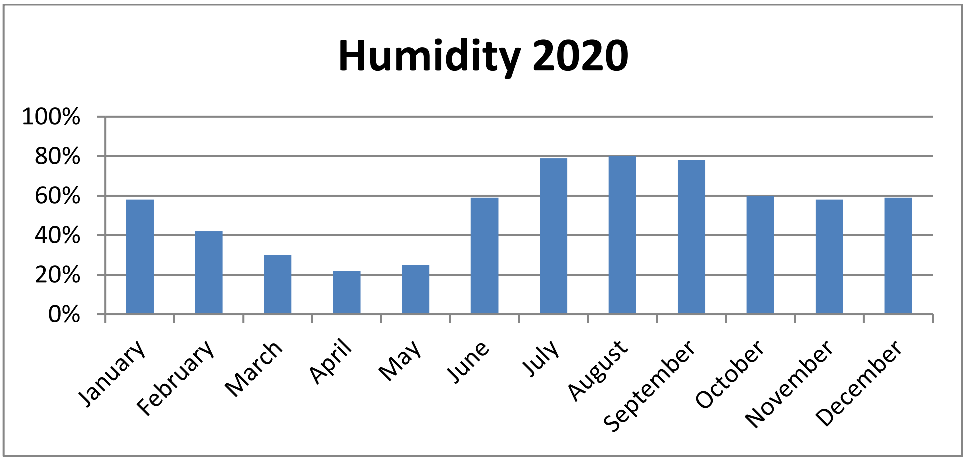

Fig-5 Humidity 2020

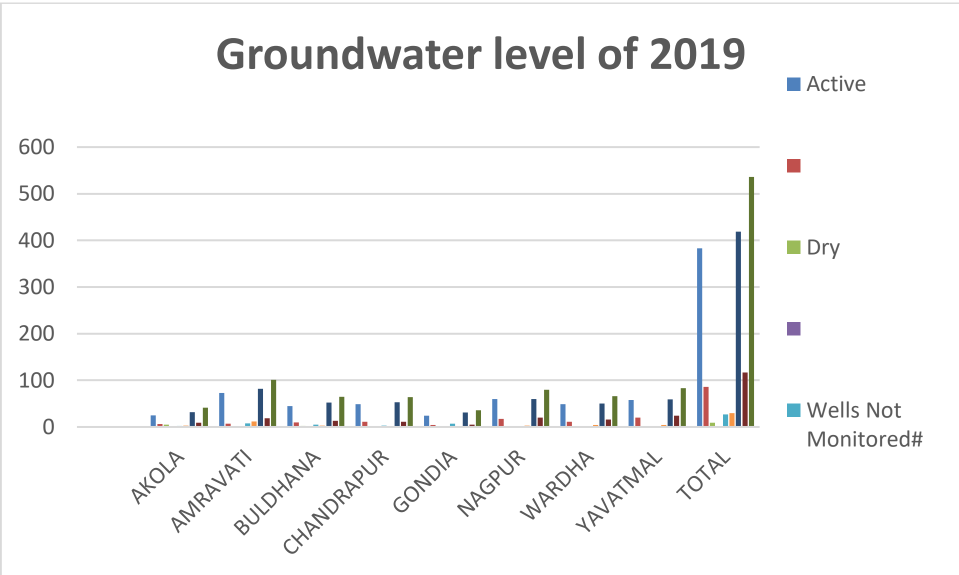

Fig-6 Ground Water level of 2019

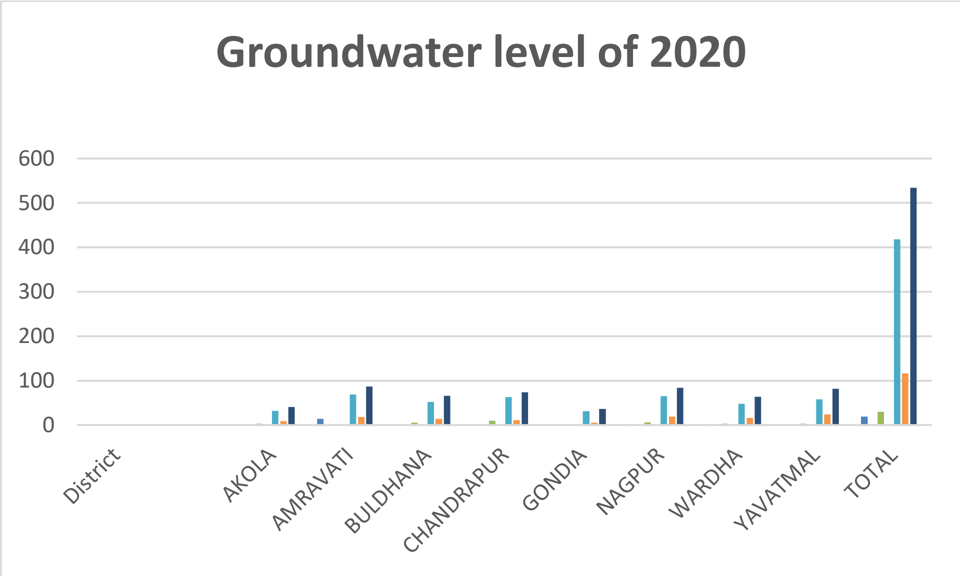

Fig-7 Ground Water level of 2020

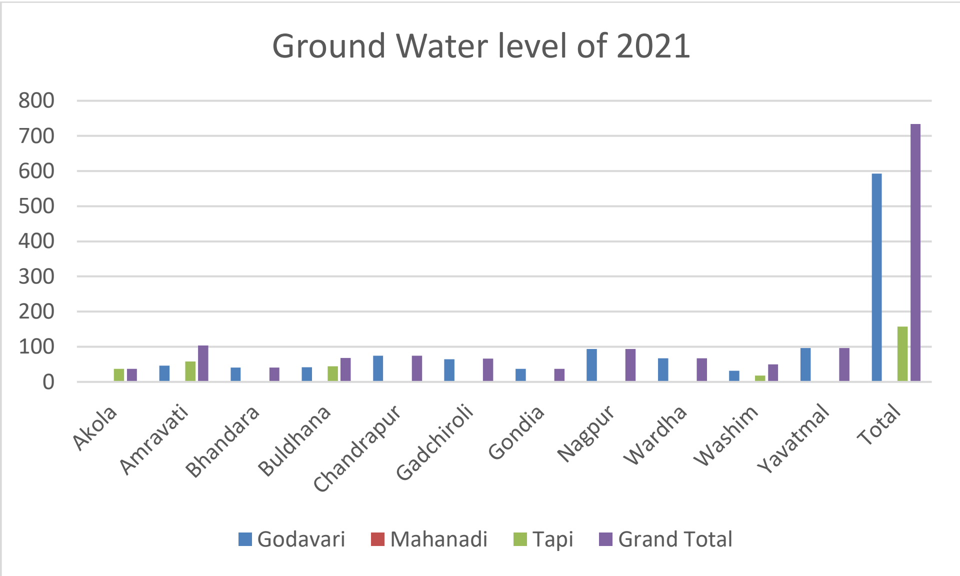

Fig-8

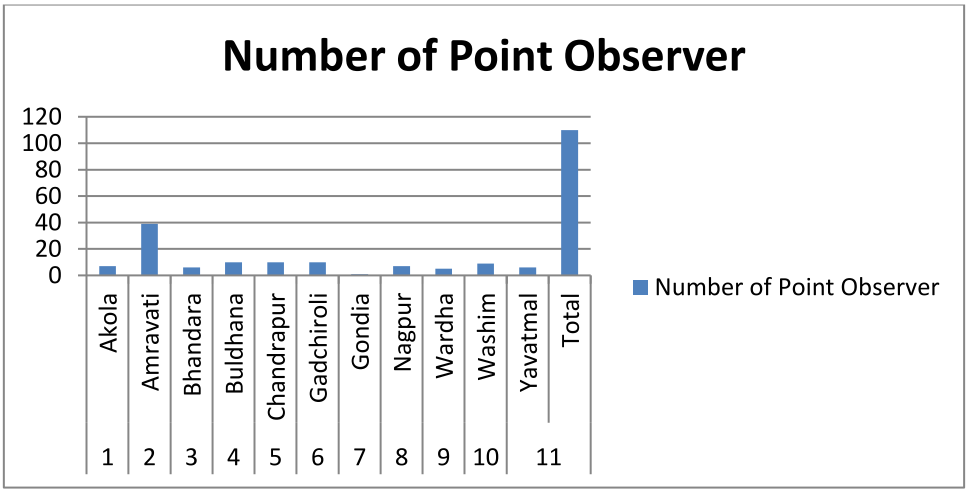

Fig-9

Fig 1 shows the overall average plot for the vidharbha region for rainfall dataset, the difference between expected is 22% less than actual rainfall. The percentage distribution in fig 2 clearly states the uneven distribution of the rainfall in overall geography of vidharbha region. Fig 3,4,5 shows the trend in humidity and shows highest saturation in the month of august or September, which in fact show the direct co-relation with groundwater recharge as shown in fig 6 and 7. The relation for river roles for groundwater recharge and well dataset doesn't shows direct relation as river are combination of various geography and none of them have origin in vidharbha region (Fig 8 and Fig 9).

CONCLUSION

It was necessary to combine all of the data and conduct several data analyses in order to determine the levels of four distinct factors such as rainfall, humidity, temperature, and groundwater level. The direct and proportionate connection between rainfall and temperature is clearly shown by a percentage-wise examination of the rainfall dataset. Buldhana is the area with the greatest lack of rainfall, followed by Amravati, Wardha, Yavatmal, and Gondia, which are all in the same boat. The average rainfall in the normal category was highest in Nagpur, followed by Akola and Gadchiroli, according to the Met Office. Analytics of three-year humidity data reveals that the month of September has the greatest saturation of humidity, which has a direct relationship with the amount of rainfall that has fallen. In the well data analysis, it is shown that there is a strong connection between the rainfall dataset and the groundwater level. However, the accuracy is reduced since the groundwater level may be a consequence of river prospective, which may change based on topography or the source of the river. Due to the fact that rivers are a mix of many geographies and none of them have their origin in the Vidharbha area, the relationship between river responsibilities for groundwater recharge and well dataset does not exhibit a clear correlation. In order to comprehend the relation matrix and co-relation parameter, we have also examined the geology of each area as well as the river recharge pattern. The finding demonstrates that river water flow is directly dependent on rainfall and groundwater recharge, with accuracy of 67 percent and 78 percent, respectively. Based on the 5-year timeline dataset, the humidity dataset indicates a heavy forecast potential with a 35 percent accuracy rate for heavy rainfall. We have also validated the data redundancy and data inconsistency in order to get a data efficient model that is 99 percent or better.

FUTURE SCOPE

The data analytics on rainfall, river, water-well, humidity, temperature data can directly be used to predict the natural disaster like drought, flood, cloud bust, extreme temperature; as there is direct co-relation of various parameter with respect to time-line of year. Geography and geology has similar trend over vidharbha region so studying and predicting natural disaster like drough, flood, cloud bust, extreme temperature finds the possibility in vidharbha region based on above data-analytics which is carried out for future prospects.

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