ENVIRONMENTAL CONSEQUENCES OF RAINFALL VARIABILITY GROUND WATER SYSTEM IN MEGHNAGAR REGION, JHABUA DISTRICT, MADHYA PRADESH

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ABSTRACT

The study combines findings of the rainfall variation data analysis over a period of 20 years in respect of Meghnagar region situated in Jhabua District, Madhya Pradesh, India. The rainfall data have been submitted to both mathematical and statistical methodologies of data analysis. The mathematical research suggests a rainfall variations ranging from 392.4 to 1562.34 mm with an annual average of 902.85 mm. The deviation and cumulative departure from the yearly average rainfall reflect positive and negative trends. The statistical analysis of rainfall data includes the determination of mean = 910 mm, median = 925 mm, mode = 1100 mm, standard deviation = 372.021 mm, co-efficient of dispersion = 0.40 and co-efficient of variation = 40.88 and co- factor of skewness = -0510. The findings of statistical analysis give more précised values, which are of tremendous importance in data verification.

The environmental consequences of rainfall data on groundwater system have been examined. It has been claimed that the adoption of a program for rainwater collecting and augmentation of groundwater resource by the building of artificial recharge structures will answer the present challenges of sustained water supply.

INTRODUCTION

Rainfall is a key meteorological element in groundwater reservoir recharge and basin water balance estimates. Weisner (1970) described rainfall as "atmospheric water deposition. Precipitation comes from liquid or solid deposits." It rains in Monsoon rains dominate India. Dhar and Rakhecha (1975) evaluated Indian rainfall hydro-meteorological research. Analyzed Meghnagar rainfall statistics and their effects on groundwater recharging are shown here..

RAINFALL DATA ANALYSIS:

Solid, liquid, gas. Rainfall is liquid precipitation. Gauges measure rainfall. Inches or millimeters are recorded. Rainfall data show that amounts and frequency vary widely. Rainfall duration, volume, and frequency accelerate surface runoff for groundwater replenishment.

The District Collector, Jhabua, gathered Meghnagar's rainfall records from 1992 to 2011 and evaluated them using mathematical and statistical methodologies.

(A). Mathematical Analysis:

The most common rainfall data analysis approach is arithmetic analysis, which calculates the mean for certain months or years. Computations are normally in mm, cm, or inch. Stable mean rainfall indicates variance. The arithmetic mean uses a 20–50-year rainfall record.

Mathematically evaluated Meghnagar rainfall data from 1992 to 2011. Analysis shows a 392.4–1562.34 mm variation. 2000 had the lowest rainfall of 392.34, while 2006 had the highest. Mathematical study shows 902.85 mm yearly average rainfall (Table .1, Figure 1). Rainfall pattern depends on rainfall deviation from average. Cumulative rainfall deviation

gives the overall departure from the mean over a time.

Table 1 Annual Rainfall, Departure and cumulative departure from annual average rainfall of Meghnagar area, Jhabua district (M.P.)

S.No.	Year	Total Rainfall	Departure Rainfall	Cumulative Departure
1.	1992	696	- 206.85	-206.857
2.	1993	1068.8	165.94	-40.914
3.	1994	1360	457.14	416.229
4.	1995	724	-178.85	237.372
5.	1996	1096	193.14	430.515
6.	1997	942.4	39.543	470.058
7.	1998	995.4	92.54	562.601
8.	1999	734.9	-167.95	394.644
9.	2000	392.4	-510.457	-115.813
10.	2001	549.2	-353.65	-469.47
11.	2002	738.4	-164.45	-633.927
12.	2003	1101	198.14	-435.784
13.	2004	1265.4	362.54	-73.241
14.	2005	678.9	-223.95	-297.198
15.	2006	1562.34	659.48	362.285
16.	2007	1037.4	134.54	496.828
17.	2008	730	-172.85	323.971
18.	2009	721.8	-181.05	142.914
19.	2010	823	-79.85	63.05
20.	2011	839.8	-63.05	0
	Total	18057.14/20 = 902.85		

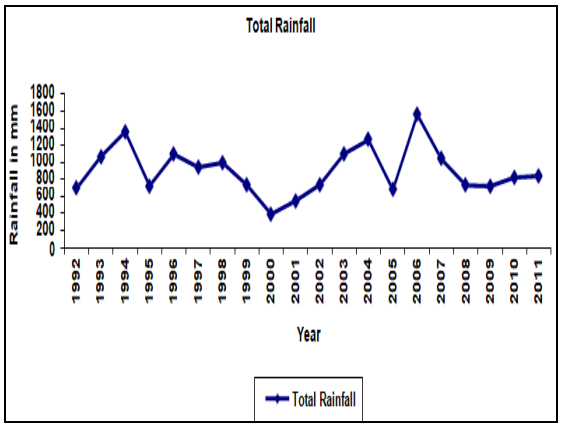

Figure 1: Total annual rainfall of Meghnagar area, Jhabua district (M.P.)

The years 1993,1994, 1996, 1997, 1998, 2003, 2004, 2006, and 2007 show departures greater than the yearly average rainfall value to replenish the ground water system. The cumulative departure from the study area's average rainfall is also shown in Figure 2 and Figure 3.

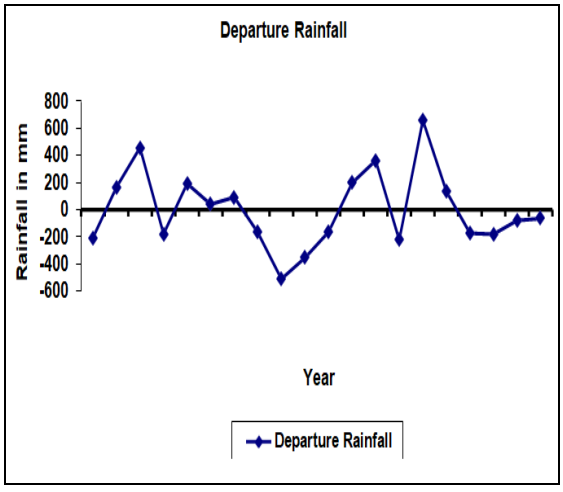

Figure 2: Departure from average rainfall in Meghnagar area, Jhabua district (M.P.)

Less rainfall than the normal annual amount was recorded in 1992, 1995, 1999, 2000, 2001, 2002, 2005, 2008, 2009, 2010, and 2011, indicating a downward trend (Figure 2).

The cumulative departure graph shows that the yearly average value is greater in the following years: 1994, 1995, 1995, 1997, 1998, 1999, 2006, 2007, 2008, 2009, 2010, and
2011.

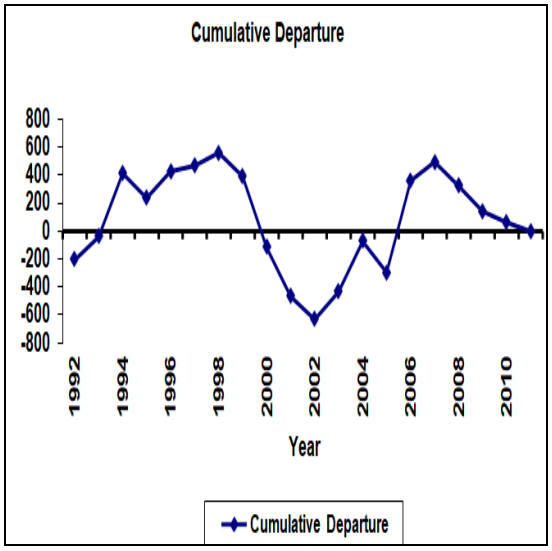

Figure 3 Cumulative departure from average rainfall of Meghnagar area, Jhabua district (M.P.).

Statistical Analysis:

The statistical study of the Meghnagar area's rainfall data included calculating the mean, median, mode, standard deviation, coefficient of dispersion, coefficient of variation, and coefficient of skewness, among other metrics. Here, the statistical analysis techniques utilized by Croxton et al., 1988 and Davis (1986, 2002) have been applied..

Table 2: Showing computation of statistical parameters of rainfall data of Meghnagar area, Jhabua district (M.P.)

S. No.	Class Interval	Mid Value (X)	Frequency (F)	dx=(x-a)/I	Fu	u2	Fu2	C.F.
1.	300-500	400	1	-3	3	9	9	1
2.	500-700	600	3	-2	6	4	12	4
3.	700-900	800	7	-1	7	1	7	11
4.	900-1100	1000	5	0	0	0	0	16
5.	1100-1300	1200	2	1	2	2	2	18
6.	1300-	1400	1	2	2	4	4	19

	1500							
7.	1500-1700	1600	1	3	3	9	9	20
	Total	7000	20	$\sum u = 0$	$\sum Fu = -9$	28	43	

$$\text{Mean}(\bar{x}) = A + \frac{\sum Fu}{N} \times I$$

Where,

A = Assumed mean = 1000

I = Class interval = 200

$\sum Fu = -9$

N = Total frequency = 20

$$\bar{x} = 1000 + \frac{(-9)}{20} \times 200$$

$$\bar{x} = 1000 + \frac{(-1800)}{20}$$

$$\bar{x} = 1000 + (-90)$$

$$\bar{x} = 910$$

The mean rainfall of the arc is calculated as 910 mm.

Median:

The factor that split a collection of observations into two equal portions was the median. It is determined using the formula.

$$\text{Median (MD)} = L + \frac{½N - F}{F} \times I$$

Where,

L = Lower Limit of Median

Class = 900

I = Class interval = 200

N = Total frequency = 20

F = Frequencyof median class = 16

$$\frac{N}{2} = \frac{20}{2} = 10$$

$$MD = 900 + \frac{½(20-16)}{16} \times 200$$

$$= 900 + \frac{800/2}{16}$$

$$= 900 + \frac{400}{16}$$

$$= 900 + 25$$

$$= 925 \text{ mm}$$

Median = 925 mm

Mode:

It is the value, which occurs most frequency a given set of observation. The formula is used to compute it.

$$\text{Mode (MO)} = \frac{L_1 + F_0 - F_1}{2F_0 - F_{-1} - F_1} \times I$$

Where,

L_1 = Lower limit of model class.

F = Frequency of the mode class.

F_{-1} = Frequency of the pre mode class.

F_2 = Frequency of the post mode class.

I=Class interval

$$MO = 900 + \frac{5-7}{2 \times 5 - 7 - 5} \times 200$$

$$= 900 + \frac{400}{2}$$

$$= 900 + 200$$

Mode = 1100 mm

Both mathematical and statistical methods have been used to analyze the data on rainfall. The statistics on rainfall show a range of 392.4 to 1562.34 mm. The results of the mathematical study show that the ground water system's recharge trend and average annual rainfall value are both 902.85 mm. The results of the statistical analysis show that the mean (910 mm), median (925 mm), and mode (1100 mm), as well as the standard deviation (372.021 mm), coefficient of dispersion (0.4), coefficient of variation (40.88), and coefficient of skewness (-0510), are all within acceptable ranges.

STANDARD DEVIATION:

The departure from the specified value for their arithmetic mean has a positive square root. It is computed using the formula and is shown by the Standard deviation.

Standard Deviation

$$(\delta) = I\sqrt{\frac{(\sum fu^2)}{\sum f} - \frac{(\sum fu)^2}{\sum f}}$$

Where,

δ = Standard deviation
I = Class Interval
$\sum f$ =N= Number of total sample

$\sum fu^2$ = 43

$\sum fu$ = -9

$$\delta = 200\sqrt{\frac{(43)}{11} - \frac{(-9)^2}{11}}$$

$$\delta = 200\sqrt{3.90 - 7.36}$$

$$\delta = 200\sqrt{3.46}$$

$$\delta = 200\ x\ 1.86$$

$\delta = 372.021$ Standard Deviation

Co-Efficient of Dispersion:

It is the measure of scatteredness and is calculated by following formula:-

$$CD = \sigma / M$$

Where,

σ = Standard deviation
M = Mean
CD = 372.021/910
CD = 0.40

Co-Efficient of Variation:

The formula calculates the standard deviation in the mean co-efficient of variation, which is the percentage variance in the mean.

$$\text{Co-efficient of variation (CV)} = \frac{\delta}{M}\ x\ 100$$

Where,

δ = Standard deviation = 372.02
M = Mean = 910
CV = $\frac{372.021\ x100}{910}$
CV = 40.88

The estimated co-efficient of variability shows that rainfall amounts may vary by up to 40.88 mm.

Co-efficient of Skewness:

The given distribution lacks symmetry, which is indicated by the symbol Sk and calculated using the following formula:

$$\text{Co-efficient of Skewness SK} = \frac{M - Mo}{\delta}$$

Where,

Mean = 910
Mode = 1100
Standard Deviation = 372.02

$$Sk = \frac{910 - 1100}{372.02}$$

$$Sk = \frac{-190}{372.02}$$

Sk = -0.510

The lack of symmetry in the quantity of rainfall is indicated by the Co-efficient of Skewness, which was found to be -0.510. The Meghnagar area's rainfall data, according to statistical analysis, show that the Mean is 910 mm, the Median is 925 mm, the Mode is 1100 mm, the Standard Deviation is 372.021 mm, the Coefficient of Dispersion is 0.40, the Coefficient of Variation is 40.88, and the Coefficient of Skewness is -0510.

Environmental Impacts;

Rainfall above and below the yearly average has both positive and negative consequences on the ecosystem, including drought. Groundwater recharging depends on rainfall patterns. Meghnagar rainfall data shows positive and negative patterns that effect groundwater recharging. Overexploitation and little rainfall are rapidly depleting groundwater levels. 'Ground water levels may demonstrate seasonal change owing to rainfall drought persisting over a period of many years, contributing to lowering water level', according to Todd (1980). Ground water levels deplete due to seasonal fluctuations

in precipitation penetration, which relies on rainfall volume and intensity.

Rainwater increases groundwater recharge. Implementing adequate measures may reduce the fast rising trend of ground water level depletion causing drought in Meghnagar area.

Conclusion

Rainfall is a crucial hydrometeorological component that recharges groundwater. Mathematical and statistical methods analyzed 20 years of rainfall data. Mathematical analysis yields 902.85 mm yearly rainfall. The groundwater system was recharged higher than usual in 1993, 1994, 1996, 1997, 1998, 2003, 2004, 2006, and 2007. These values indicate positive rainfall infiltration. In 1993, 1994, 1996, 2003, 2004, 2006, and 2007, rainfall maxima exceeded normal yearly rainfall. These numbers show good groundwater recharge. The statistical analysis of rainfall data yields the mean = 910 mm, median = 925 mm, mode = 1100 mm, standard deviation = 372.021 mm, co-efficient of dispersion = 0.40, variance = 40.88, and skewness = -0510. Rainfall parameter effects groundwater recharge environmental implications.

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