Determination of Seasonal Effects on the Ground Water Levels in Anantapuramu district

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Abstract— *Ground Water Levels is the most important in Primary Sector, especially Agricultural Sector its play a vital/crucial role. Present paper deals with the application of* ***'Time Series Analysis'*** *to analyze and predict Ground Water Levels (GWLs) in Anantapuramu district based on the data collected from January 2001 to November 2017. Through with* ***Simple Averages Method****, for the purpose of analysis the district is divided into five Zones or Revenue Divisions (RD) namely, 1. Anantapuramu RD 2. Penukonda RD 3. Kadiri RD 4. Kalyandurg RD 5. Dharmavaram RD. I have calculated for the values of the Seasonal Indices (S.I) and compared among them by using the data. Further, validation of the fitted method identified the best suitable Zone. In the present paper we analyze the data collected and identified* ***Seasonal effects*** *in Ground Water Levels and conclusions are drawn based on the results obtained.*

Keywords— *Ground Water Level, Time Series Analysis, Prediction, Simple Averages Method, Seasonal Indices.*

I. INTRODUCTION

In the present paper our concentration is diverted from determining trend values to determine the seasonal effects on Ground Water Levels of the Anantapuramu district. To have ready reference on seasonal effects now we proceed to explain some preliminaries and terminology methods of determining seasonal effects in **'Time Series Analysis'** is explained in the following section.

2. SOME PRELIMINARY DEFINITIONS AND TERMS USED IN MEASURING SEASONAL EFFECTS

Seasonal patterns are exhibited by most of the business and economic phenomenon and their study is necessitated by the following reasons:

(i) To isolate the seasonal variations, i.e., to determine the effect of seasons on the size of the variable , and

(ii) To eliminate them, i.e., to study as to what would be the value of the variable if there were no seasonal swings.

The determination of seasonal effects is of paramount importance in planning (i) business efficiency, or (ii) a production program. For example, the head of a departmental store would be interested to study the variations in the demands of different articles for different months in order to plan his future stocks to cater to the public demands due to seasonal swings. Moreover, the isolation and elimination of seasonal factor from the data is necessary to study the effect of cycles. Obviously for the study of seasonal variation the data must be given for 'parts' of year,

viz., monthly or quarterly, weekly, daily or hourly. Different methods for measuring seasonal variations are [1, 2, and 3]:

(i) Method of simple averages
(ii) Ratio to trend method
(iii) Ratio to moving average method
(iv) Link relative method.

In this paper we use Method of simple averages.

Method of Simple Averages:

This is the simplest of all the methods of measuring seasonality and consists in the following steps:

(i) Arrange the data by years and months (or quarters if quarterly data are given).
(ii) Compute the average $\bar{x}_i$, $(i = 1,2, \dots ,12)$ for the i^{th} month for all the years. [i^{th} month, $(i = 1,2, \dots ,12)$ represents January, February,…., December respectively].
(iii) Compute the average $\bar{x}$ of the monthly averages, i.e.,

$$\bar{x} = \frac{1}{12}\sum_{i=1}^{12} \bar{x}_i$$

(iv) Seasonal indices for different months are obtained by expressing monthly averages as percentage of $\bar{x}$. Thus

Seasonal Index for the i^{th} month = $\frac{\bar{x}_i}{\bar{x}} \times 100$, $(i = 1,2, \dots ,12)$.

Remarks:

1. If instead of monthly averages, we use monthly totals for all the years, the result remains the same.
2. Total of seasonal indices is 12 × 100 = 1200 for monthly data and 4 × 100 = 400 for quarterly data.

Merits and Demerits:

This method is based on the basic assumption that the data do not contain any trend and cyclic components and consists in eliminating irregular components by averaging the monthly (or quarterly) values over years. Since most of the economic time series have trends, these assumptions are not in general true and as such this method, through simple, is not of much practically utility[2,4,5,6,7,8].

3. DATA AND CALCULATIONS (MONTH-WISE) OF SEASONAL INDICES

Table: 3.1. Simple Averages Method for Ground Water Levels data for Zone–I

Years/ Months	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	8.15	5.16	12.16	13.42	13.7	8.87	12.27	8.08	9.17	11.24	11.27	12.78	13.25	15.36	14.94	13.11	16.42
Feb	8.35	6.11	13.97	14.44	14.08	9.52	12.18	8.34	10.45	12.4	11.78	14.47	14.16	15.19	15.9	14.15	16.99
Mar	8.55	7.09	12.85	15.36	14.64	10.12	12.82	9.88	11.09	12.92	12.1	15.73	14.9	15.57	15.85	15.7	18.02
Apr	8.94	7.16	12.56	16	15.34	9.94	13.4	10.23	11.78	14.3	12.51	15.58	16.66	16.59	16.02	16.73	18.9
May	9.63	8.5	13.4	15.08	15.97	11.02	13.91	10.12	12.32	15.49	12.52	16.75	17.19	15.66	16.37	16.99	19.63
Jun	10.33	7.54	13.76	14.58	16.08	11.32	12.48	10.44	12.67	14.54	12.85	18.09	17.47	17.24	16.44	16.52	18.86
Jul	10.77	8.03	14.08	13.36	16.2	11.6	10.68	10.67	14.23	13.4	12.88	16.84	18.04	17.63	16.72	14.96	19.54
Aug	11.08	8.71	14.31	13.92	14.81	12.79	11.09	11.65	14.92	13.4	13.11	16.89	18.62	15.57	15.86	15.69	20.24
Sep	9.92	9.69	15.36	13.8	12.18	12.1	7.58	10.09	13.65	12.61	13.05	14.48	16.92	15.82	14.34	15.6	16.96
Oct	4.77	9.36	12.92	13.89	9.31	11.86	6.67	10.28	12.35	11.85	12.52	13.49	14.12	16.45	12.28	15.64	11.4
Nov	4.83	9.16	13.76	13.81	9.31	11.32	7.21	10.19	12.04	10.55	13.43	12.84	14.71	15.19	11.77	15.97	9.94
Dec	4.89	9.52	13.7	13.42	8.86	12.04	6.97	9.65	11.44	10.22	14.29	12.28	15.5	15.87	12.14	15.82	

Table: 3.2. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–I

Months	Total	Avg($\bar{x}_i$)	S.I
Jan	199.35	11.73	90.27
Feb	212.48	12.50	96.22
Mar	223.19	13.13	101.07
Apr	232.64	13.68	105.35
May	240.55	14.15	108.93
Jun	241.21	14.19	109.23
Jul	239.63	14.10	108.51
Aug	242.66	14.27	109.89
Sep	224.15	13.19	101.50
Oct	199.16	11.72	90.19
Nov	196.03	11.53	88.77
Dec	186.61	11.66	89.79

$$\sum \bar{x}_i = 155.84$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{12} = 12.99$$

The total values of Seasonal Indices (S.I) = 1200

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{11.73}{12.99} \times 100 = 90.27$ and so on the required S.I.

Table: 3.3. Simple Averages Method for Ground Water Levels data for Zone–II

Years/ Months	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	13.78	10.39	12.67	20.7	25.02	16.26	22.16	21.9	15.89	15.4	12.08	18.51	23.09	19.98	27.62	19.99	36.12
Feb	13.98	10.85	13.39	21.77	25.66	17.39	23.77	21.84	17.15	16.33	13.36	19.73	21.49	20.26	28.79	21.95	36.92
Mar	14.55	11.8	20.76	23.01	27.24	18.18	24.75	22.95	17.5	15.91	13.93	19.35	22.89	20.7	28.27	24.27	40.02
Apr	14.53	12.56	21.09	23.36	27.96	19.55	25.7	22.69	18.07	16.29	14.67	19.61	24.9	24.28	29.11	26.37	41.63
May	15.14	13.23	21.73	22.25	28.26	19.52	25.89	23.49	18.75	16.36	15.45	20.84	26.85	20.73	29.09	26.18	42.01
Jun	15.27	13.47	22.57	22.26	29.47	20.49	24.62	23.51	18.55	15.67	15.54	21.4	28.4	23.13	28.39	25.14	41.68
Jul	16.82	14.09	23.35	22.56	29.59	19.98	24.77	23.73	19.56	15.88	16.45	21.8	28.01	24.48	29.48	27.34	43.23
Aug	17.41	14.61	23.28	22.67	26.28	20.7	23.97	22.97	20.25	15.44	16.54	22.37	24.71	25.73	30.06	25.15	44.76
Sep	16.68	15.99	23.81	22.07	21.24	21.63	22.17	18.12	18.23	15.64	15.48	21.44	19.9	25.97	26.83	27.86	43.23
Oct	11.42	16.48	23.85	22.53	17.3	21.24	18.33	16.22	15.35	14.8	15.74	20.15	18.71	25.19	24.11	31.83	34.83
Nov	10.29	16.67	20.05	23.04	17.3	21.35	17.28	15.82	15.38	11.44	16.03	19.82	18.53	24.83	20.87	33.65	26.54
Dec	10.36	18.14	20.11	24.6	15.58	19.73	17.61	15.46	15.66	11.66	16.72	20.98	19.6	25.78	18.88	33.65	

Table: 3.4. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–II

Months	Total	**Avg($\bar{x}_i$)**	**S.I**
Jan	331.56	19.50	90.93
Feb	344.63	20.27	94.51
Mar	366.08	21.53	100.39
Apr	382.37	22.49	104.86
May	385.77	22.69	105.79
Jun	389.56	22.92	106.83
Jul	401.12	23.60	110.00
Aug	396.9	23.35	108.84
Sep	376.29	22.13	103.19
Oct	348.08	20.48	95.46
Nov	328.89	19.35	90.19
Dec	304.52	19.03	88.73

$$\sum \bar{x}_i = 257.34$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{12} = 21.45$$

The total values of Seasonal Indices (S.I) = 1200

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{19.50}{21.45} \times 100 = 90.93$ and so on the required S.I.

Table: 3.5. Simple Averages Method for Ground Water Levels data for Zone–III

Years/ Months	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	10.41	6.17	14.61	13.63	17.75	7.95	13.84	8.8	8.67	11.05	7.49	13.07	18.14	12.49	27.85	9.73	22.7
Feb	10.61	6.74	15.73	14.66	18.29	8.75	14.56	9.53	9.95	11.58	9.2	14.36	20.05	13.8	28.67	11.8	26.68
Mar	10.9	7.99	13.39	15.67	18.76	9.42	15.5	9.51	10.82	13.46	10.71	15.69	18.52	14.84	31.74	12.59	26.33
Apr	11.2	8.21	13.85	15.96	19.53	10.23	16.48	9.81	11.65	14.25	11.76	15.95	23.5	14.63	32.17	13.54	28.86
May	12.28	9.04	14.4	14.72	20.78	10.85	16.6	10.53	12.21	14.58	12.43	15.95	24.81	18.51	33.5	13.94	29.15
Jun	11.71	8.88	15.19	15.58	21.09	10.89	15.82	10.35	10.24	14.46	13.12	16.82	24.75	17.93	27.56	13.89	31.2
Jul	13.17	9.56	15.91	15.76	21.32	11.4	15.51	11.63	12.15	13.34	14.11	17.46	25.22	20.93	27.8	14.43	31.2
Aug	12.71	10.25	15.89	16.37	18.66	12.16	14.72	11.49	13.29	13.34	12.57	17.02	22.56	23.71	30.97	13.89	32.7
Sep	12.67	11.08	16.85	16.6	15.05	12.72	13.18	8.3	12.3	12.94	11.58	17.65	17.28	24.96	27.81	15.41	22.58
Oct	5.75	10.35	13.15	15.14	8.22	12.87	12.05	7.19	10.78	12.68	12.43	17.08	12.14	25.44	25.07	19.94	17.26
Nov	5.1	10.37	12.46	16.13	8.22	12.91	10.91	7.36	10.8	6.34	11.53	16.26	10.97	24.28	14.27	23.78	15.66
Dec	5.8	10.8	12.57	17.24	7.46	10.87	11.61	6.9	10.15	6.34	10.74	16.26	11.16	25.63	9.24	21.25	

Table: 3.6. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–III

Months	Total	Avg($\bar{x}_i$)	S.I
Jan	224.35	13.20	87.57
Feb	244.96	14.41	95.62
Mar	255.84	15.05	99.86
Apr	271.58	15.98	106.01
May	284.28	16.72	110.96
Jun	279.48	16.44	109.09
Jul	290.9	17.11	113.55
Aug	292.3	17.19	114.10
Sep	268.96	15.82	104.98
Oct	237.54	13.97	92.72
Nov	217.35	12.79	84.84
Dec	194.02	12.13	80.47

$$\sum \bar{x}_i = 180.81$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{12} = 15.07$$

The total values of Seasonal Indices (S.I) = 1200

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{13.20}{15.07} \times 100 = 87.57$ and so on the required S.I.

Table: 3.7. Simple Averages Method for Ground Water Levels data for Zone–IV

Years/ Months	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	9.63	8.12	11.94	16.27	19.87	12.51	14.72	11.72	8.93	8.24	6.74	11.69	14.68	16.46	19.37	15.93	23.16
Feb	9.83	8.8	12.53	16.85	19.89	13.2	15.13	11.85	9.68	8.22	7.09	12.85	15.64	18.74	19.76	16.88	23.51
Mar	10.04	9.7	13.19	17.68	20.54	13.26	16.43	12.24	10.17	9.09	7.83	13.98	16.72	18.53	20.65	18.19	23.78
Apr	11.66	10.35	13.84	18.02	21.06	14.6	16.8	12.26	10.85	9.7	8.32	13.67	17.57	19.28	21.15	18.87	25.27
May	12.42	10.44	14.69	17.17	21.47	14.08	17.46	12.67	11.03	10.42	8.47	13.68	17.98	19.55	21.04	19.09	26.33
Jun	12.11	10.45	14.99	16.81	21.33	14.75	16.1	11.89	10.78	9.76	8.67	14.91	18.51	20.38	20.75	18.16	26.45
Jul	12.92	10.78	15.85	17.21	20.56	15.28	15.89	12.3	11.29	9.61	9.28	15.03	18.44	19.71	20.77	19.95	27.02
Aug	13.08	10.83	15.96	17.41	18.16	15.92	16.43	12.25	11.49	9.01	9.67	14.49	18.89	19.18	21.65	20.37	27.63
Sep	12.97	11.24	16.17	17.51	15.15	15.94	14.5	8.41	10.11	8.47	10.07	14.56	16.9	19.1	20.07	20.47	27.25
Oct	7.41	10.9	16.35	17.97	11.86	15.82	13.08	8.08	7.19	7.71	10.15	13.46	15.7	18.82	16.08	21.23	23.28
Nov	11.31	11.11	15.86	17.65	11.86	15.14	11.44	8.36	6.56	6.09	9.92	13.14	15.82	18.43	14.83	22.05	19.03
Dec	7.87	11.45	15.72	19.3	11.65	13.9	12.03	8.5	6.82	6.6	11.15	13.7	16.78	18.73	14.76	22.73	

Table: 3.8. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–IV

Months	Total	Avg($\bar{x}_i$)	S.I
Jan	229.98	13.53	91.59
Feb	240.45	14.14	95.76
Mar	252.02	14.82	100.37
Apr	263.27	15.49	104.85
May	267.99	15.76	106.73
Jun	266.8	15.69	106.26
Jul	271.89	15.99	108.28
Aug	272.42	16.02	108.49
Sep	258.89	15.23	103.11
Oct	235.09	13.83	93.63
Nov	228.6	13.45	91.04
Dec	211.69	13.23	89.58

$$\sum \bar{x}_i = 177.20$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{12} = 14.77$$

The total values of Seasonal Indices (S.I) = 1200

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{13.53}{14.77} \times 100 = 91.59$ and so on the required S.I.

Table: 3.9. Simple Averages Method for Ground Water Levels data for Zone–V

Years/ Months	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Jan	11.32	6.43	14.29	15.34	18.44	13.74	17.11	8.41	8.02	11.04	10.52	10.74	15.27	12.53	19.15	13.83	18.39
Feb	11.52	7.11	15.64	16	19.12	14.77	17.82	8.67	8.08	11.64	11.52	12.03	15.21	11.57	19.44	14.39	19.84
Mar	11.96	8.6	13.2	16.67	20.24	15.63	18.97	9.39	8.25	12.73	12.22	12.65	16.73	13.04	18.98	16.84	19.53
Apr	12.29	9.26	13.89	17.26	20.83	15.2	20.11	10.32	8.88	13.69	12.91	13.4	15.46	12.71	20.15	17.35	21.2
May	13.05	8.17	14.54	16.75	22.51	15.52	20.99	11.11	9.48	13.34	12.87	13.37	16.56	15.7	19.84	17.9	20.8
Jun	13.67	7.92	15.4	16.99	21.94	16.98	19.37	10.88	9.42	12.1	13.33	13.12	16.48	14.07	16.24	15.09	20.48
Jul	14.71	9.36	16.29	16.3	22.11	15.79	18.53	11.41	10.65	11.83	13.84	13.72	16.84	14.67	19.04	14.36	21.08
Aug	15.53	9.54	16.17	16.45	19.55	16.29	18.48	11.19	12.58	11.76	13.18	13.8	14.31	17.48	17.53	14.59	23.11
Sep	14.49	10.43	16.19	17.37	14.8	16.67	15.6	7.36	12.32	11.7	13.58	14.7	10.85	18.58	17.44	15.47	20.32
Oct	5.12	9.98	15.78	16.92	12.67	17.49	13.29	6.47	11.79	12.14	13.33	13.62	10.63	18.44	16.42	16.35	12.65
Nov	4.81	10.35	14.23	17.39	12.67	18.17	11.88	7.26	11.93	9.36	12.74	13.75	10.91	16.99	14.25	18.75	8.72
Dec	6.18	10.87	14.4	18.33	12.49	21.32	12.17	6.57	11.54	10.16	13.72	13.45	11.52	18.71	13.61	18.71	

Table: 3.10. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–V

Months	Total	Avg($\bar{x}_i$)	S.I
Jan	224.57	13.21	92.64
Feb	234.37	13.79	96.68
Mar	245.63	14.45	101.32
Apr	254.91	14.99	105.15
May	262.5	15.44	108.28
Jun	253.48	14.91	104.56
Jul	260.53	15.33	107.47
Aug	261.54	15.38	107.89
Sep	247.87	14.58	102.25
Oct	223.09	13.12	92.03
Nov	214.16	12.60	88.34
Dec	213.75	13.36	93.68

$$\sum \bar{x}_i = 171.16$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{12} = 14.26$$

The total values of Seasonal Indices (S.I) = 1200

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{13.21}{14.26} \times 100 = 92.64$ and so on the required S.I.

4. DATA AND CALCULATIONS (QUARTER-WISE) OF SEASONAL INDICES

Table: 4.1. Simple Averages Method for Ground Water Levels data for Zone–I

Years/ Quarters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Q_1	25.05	18.36	38.98	43.22	42.42	28.51	37.27	26.3	30.71	36.56	35.15	42.98	42.31	46.12	46.69	42.96	51.43
Q_2	28.9	23.2	39.72	45.66	47.39	32.28	39.79	30.79	36.77	44.33	37.88	50.42	51.32	49.49	48.83	50.24	57.39
Q_3	31.77	26.43	43.75	41.08	43.19	36.49	29.35	32.41	42.8	39.41	39.04	48.21	53.58	49.02	46.92	46.25	56.74
Q_4	14.49	28.04	40.38	41.12	27.48	35.22	20.85	30.12	35.83	32.62	40.24	38.61	44.33	47.51	36.19	47.43	21.34

Table: 4.2. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–I

Quarters	Total	Avg($\bar{x}_i$)	S.I
Q_1	635.02	37.35	96.30
Q_2	714.4	42.02	108.34
Q_3	706.44	41.56	107.13
Q_4	581.8	34.22	88.23

$$\sum \bar{x}_i = 155.16$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{4} = 38.79$$

The total values of Seasonal Indices (S.I) = 400

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{37.35}{38.79} \times 100 = 96.30$ and so on the required S.I.

Table: 4.3. Simple Averages Method for Ground Water Levels data for Zone–II

Years/ Quarters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Q_1	42.31	33.04	46.82	65.48	77.92	51.83	70.68	66.69	50.54	47.64	39.37	57.59	67.47	60.94	84.68	66.21	113.06
Q_2	44.94	39.26	65.39	67.87	85.69	59.56	76.21	69.69	55.37	48.32	45.66	61.85	80.15	68.14	86.59	77.69	125.32
Q_3	50.91	44.69	70.44	67.3	77.11	62.31	70.91	64.82	58.04	46.96	48.47	65.61	72.62	76.18	86.37	80.35	131.22
Q_4	32.07	51.29	64.01	70.17	50.18	62.32	53.22	47.5	46.39	37.9	48.49	60.95	56.84	75.8	63.86	99.13	61.37

Table: 4.4. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–II

Quarters	Total	Avg($\bar{x}_i$)	S.I
Q_1	1042.27	61.31	95.71
Q_2	1157.7	68.10	106.31
Q_3	1174.31	69.08	107.83
Q_4	981.49	57.73	90.13

$$\sum \bar{x}_i = 256.22$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{4} = 64.06$$

The total values of Seasonal Indices (S.I) = 400

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{61.31}{64.06} \times 100 = 95.71$ and so on the required S.I.

Table: 4.5. Simple Averages Method for Ground Water Levels data for Zone–III

Years/ Quarters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Q_1	31.92	20.9	43.73	43.96	54.8	26.12	43.9	27.84	29.44	36.09	27.4	43.12	56.71	41.13	88.26	34.12	75.71
Q_2	35.19	26.13	43.44	46.26	61.4	31.97	48.9	30.69	34.1	43.29	37.31	48.72	73.06	51.07	93.23	41.37	89.21
Q_3	38.55	30.89	48.65	48.73	55.03	36.28	43.41	31.42	37.74	39.62	38.26	52.13	65.06	69.6	86.58	43.73	86.48
Q_4	16.65	31.52	38.18	48.51	23.9	36.65	34.57	21.45	31.73	25.36	34.7	49.6	34.27	75.35	48.58	64.97	32.92

Table: 4.6. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–III

Quarters	Total	Avg($\bar{x}_i$)	S.I
Q_1	725.15	42.66	94.75
Q_2	835.34	49.14	109.15
Q_3	852.16	50.13	111.34
Q_4	648.91	38.17	84.79

$$\sum \bar{x}_i = 180.09$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{4} = 45.02$$

The total values of Seasonal Indices (S.I) = 400

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{42.66}{45.02} \times 100 = 94.75$ and so on the required S.I.

Table: 4.7. Simple Averages Method for Ground Water Levels data for Zone–IV

Years/ Quarters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Q_1	29.5	26.62	37.66	50.8	60.3	38.97	46.28	35.81	28.78	25.55	21.66	38.52	47.04	53.73	59.78	51	70.45
Q_2	36.19	31.24	43.52	52	63.86	43.43	50.36	36.82	32.66	29.88	25.46	42.26	54.06	59.21	62.94	56.12	78.05
Q_3	38.97	32.85	47.98	52.13	53.87	47.14	46.82	32.96	32.89	27.09	29.02	44.08	54.23	57.99	62.49	60.79	81.9
Q_4	26.59	33.46	47.93	54.92	35.37	44.86	36.55	24.94	20.57	20.4	31.22	40.3	48.3	55.98	45.67	66.01	42.31

Table: 4.8. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–IV

Quarters	Total	Avg($\bar{x}_i$)	S.I
Q_1	722.45	42.50	96.34
Q_2	798.06	46.94	106.43
Q_3	803.2	47.25	107.11
Q_4	675.38	39.73	90.07

$$\sum \bar{x}_i = 176.42$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{4} = 44.11$$

The total values of Seasonal Indices (S.I) = 400

Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{42.50}{44.11} \times 100 = 96.34$ and so on the required S.I.

Table: 4.9. Simple Averages Method for Ground Water Levels data for Zone–V

Years/ Quarters	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Q_1	34.8	22.14	43.13	48.01	57.8	44.14	53.9	26.47	24.35	35.41	34.26	35.42	47.21	37.14	57.57	45.06	57.76
Q_2	39.01	25.35	43.83	51	65.28	47.7	60.47	32.31	27.78	39.13	39.11	39.89	48.5	42.48	56.23	50.34	62.48
Q_3	44.73	29.33	48.65	50.12	56.46	48.75	52.61	29.96	35.55	35.29	40.6	42.22	42	50.73	54.01	44.42	64.51
Q_4	16.11	31.2	44.41	52.64	37.83	56.98	37.34	20.3	35.26	31.66	39.79	40.82	33.06	54.14	44.28	53.81	21.37

Table: 4.10. Simple Averages Method Calculations of Seasonal Indices (S.I) for Ground Water Levels for Zone–V

Quarters	Total	Avg($\bar{x}_i$)	S.I
Q_1	704.57	41.45	97.29
Q_2	770.89	45.35	106.45
Q_3	769.94	45.29	106.32
Q_4	651	38.29	89.89

$$\sum \bar{x}_i = 170.38$$

$$\bar{\bar{x}} = \frac{\sum \bar{x}_i}{4} = 42.60$$

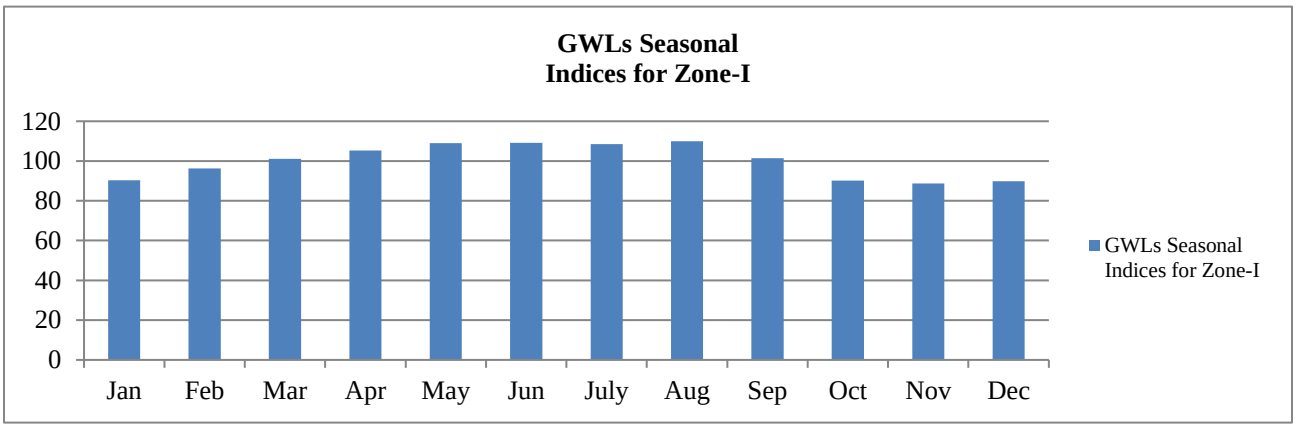
The total values of Seasonal Indices (S.I) = 400

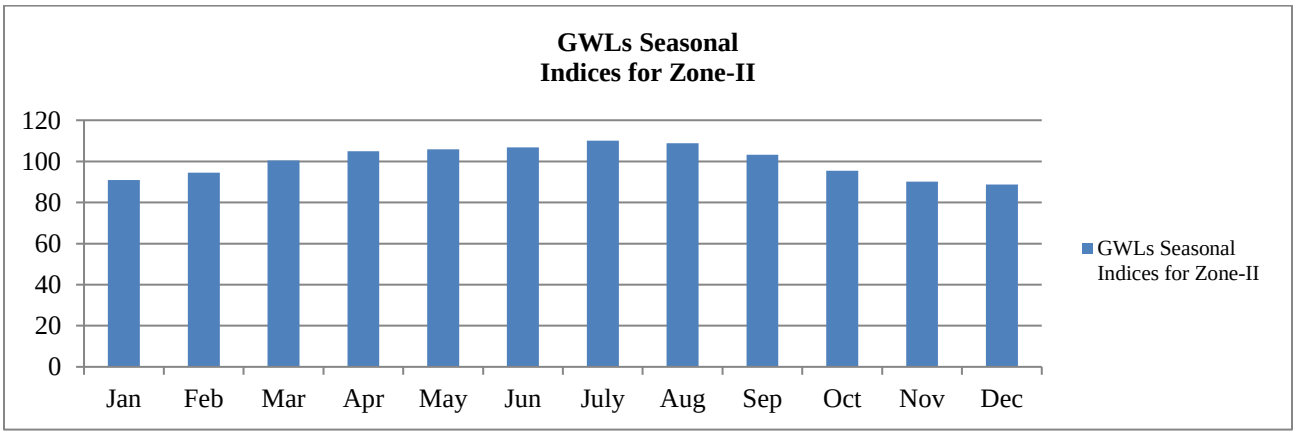
Calculations of S.I = $\frac{\bar{x}_i}{\bar{\bar{x}}} \times 100 = \frac{41.45}{42.60} \times 100 = 97.29$ and so on the required S.I.

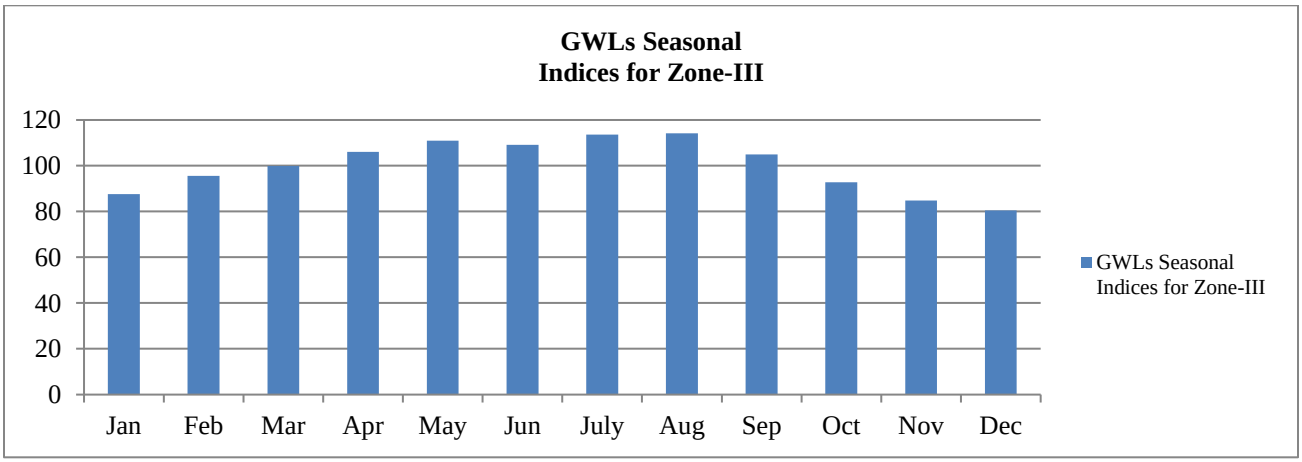
The Seasonal indices calculated

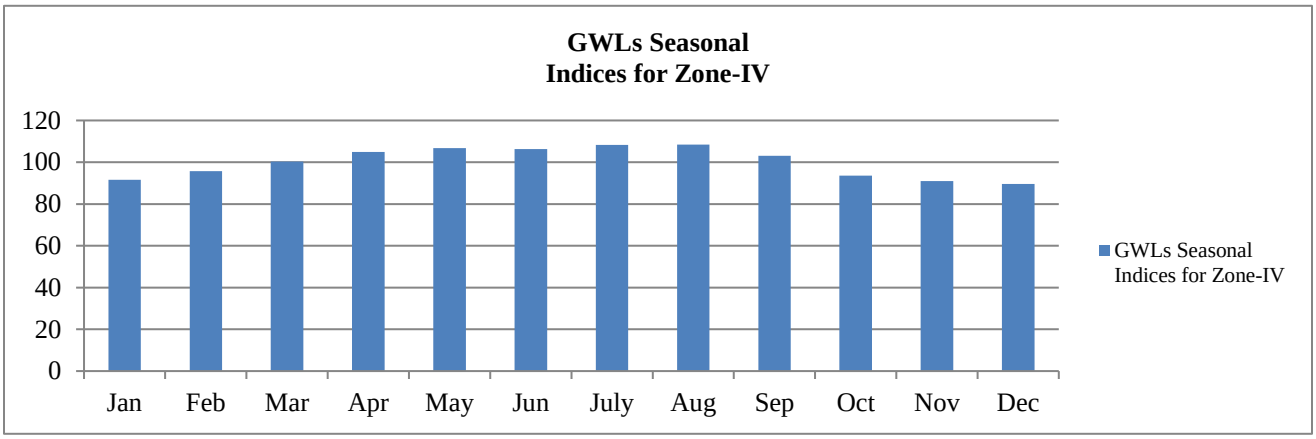
1. For month-wise
2. For Quarter-wise are represented in the following figures.

Figure: 1 to 5. Seasonal Indices of Month -wise Graphs for Ground Water Levels









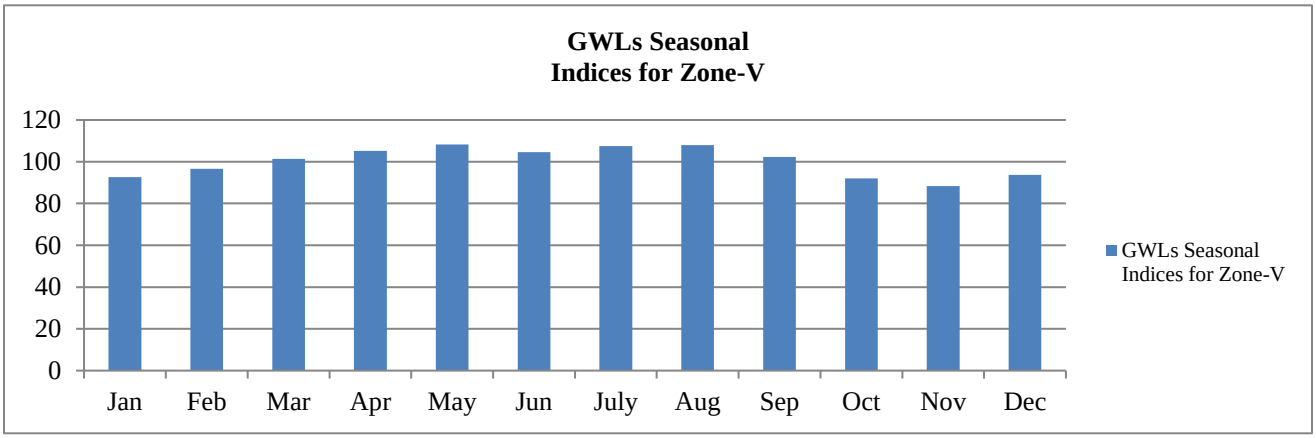
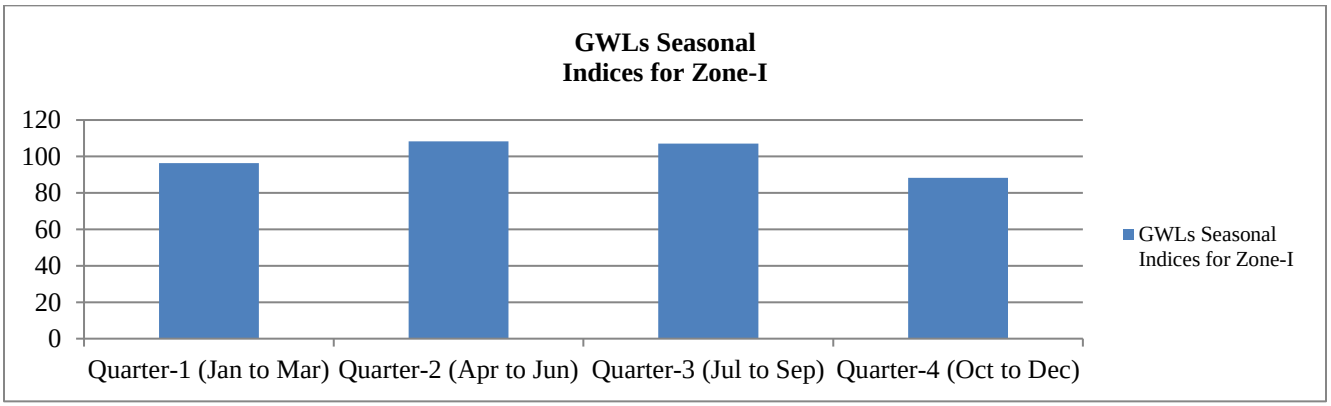
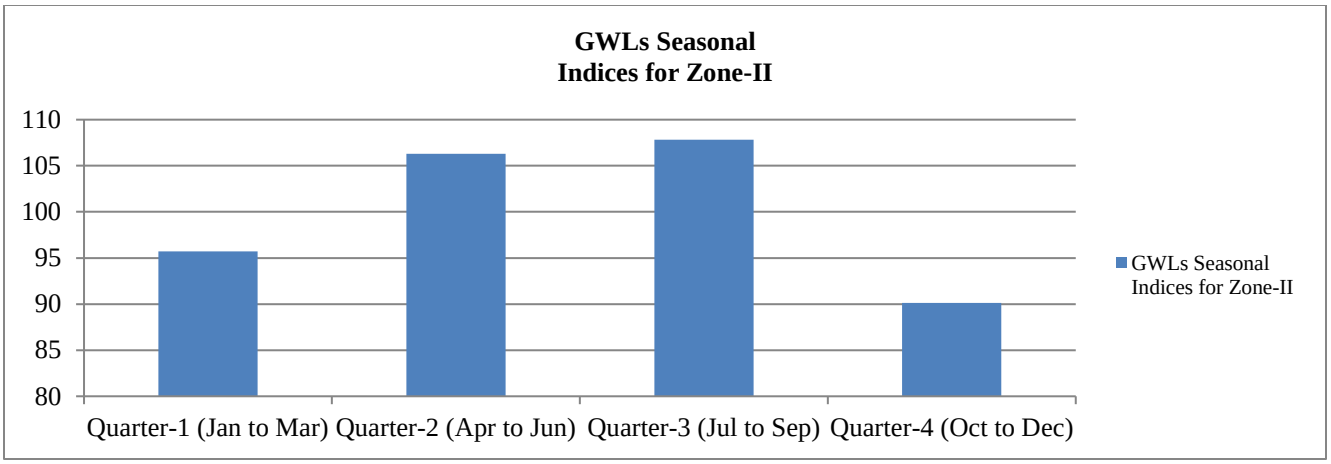
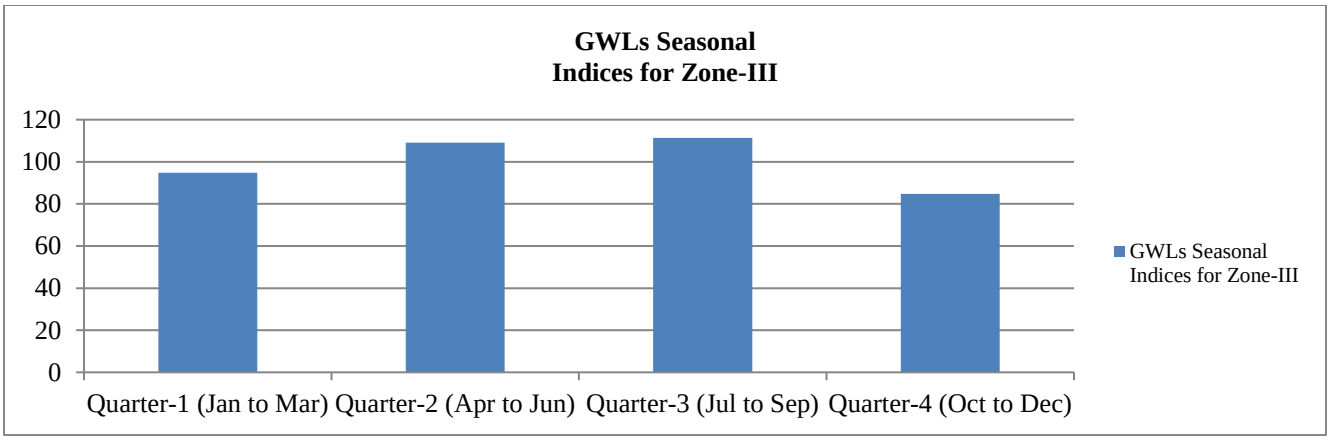
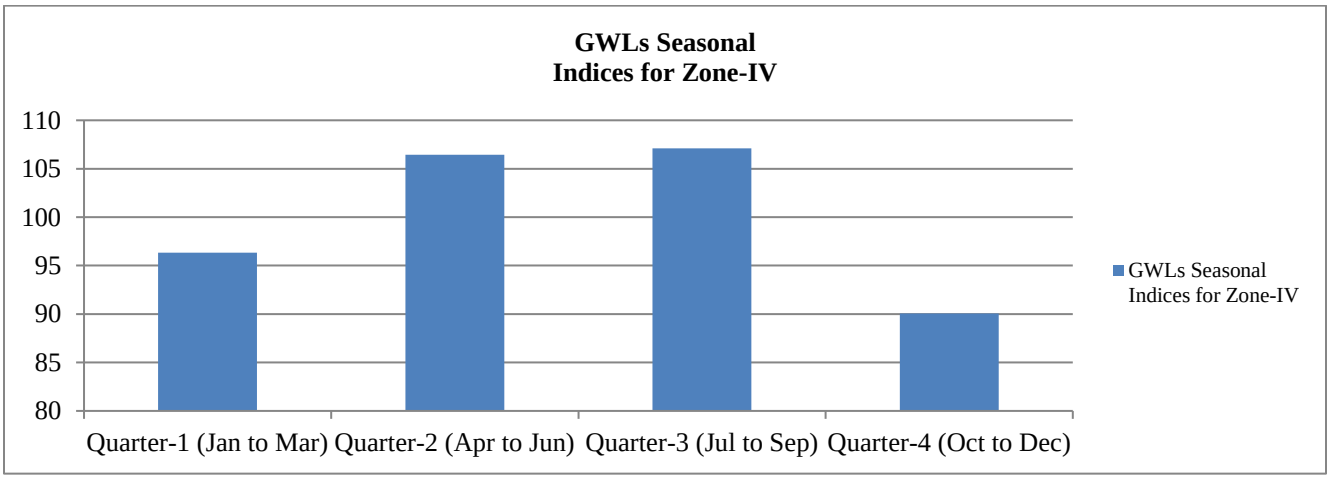


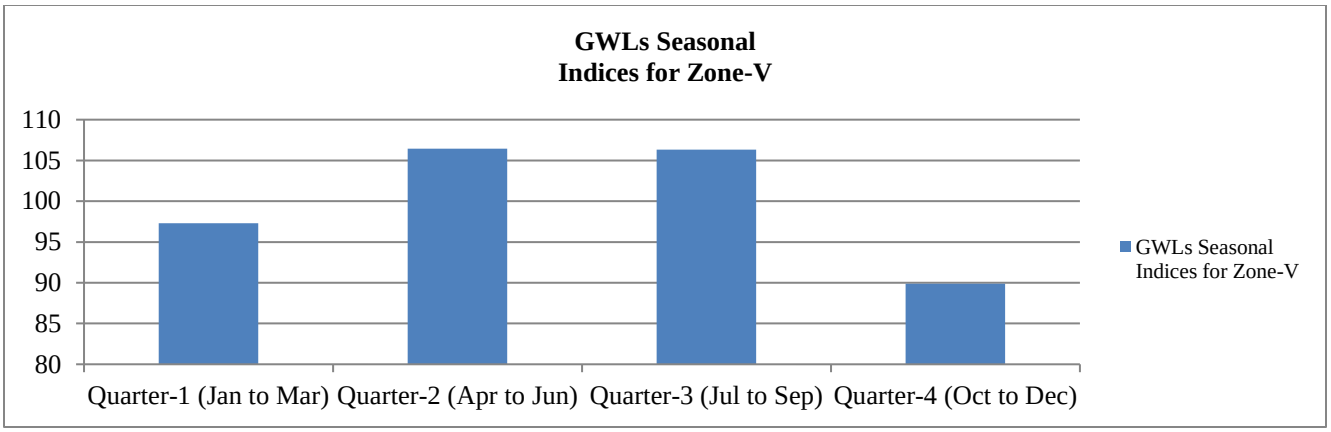
Figure: 2 to 5. Seasonal Indices of Quarter -wise Graphs for Ground Water Levels




GWLs Seasonal
Indices for Zone-II
110
105
100
95
90
85
80
Quarter-1 (Jan to Mar)
Quarter-2 (Apr to Jun)
Quarter-3 (Jul to Sep)
Quarter-4 (Oct to Dec)
GWLs Seasonal
Indices for Zone-II


GWLs Seasonal
Indices for Zone-III
120
100
80
60
40
20
0
Quarter-1 (Jan to Mar)
Quarter-2 (Apr to Jun)
Quarter-3 (Jul to Sep)
Quarter-4 (Oct to Dec)
GWLs Seasonal
Indices for Zone-III


GWLs Seasonal
Indices for Zone-IV
110
105
100
95
90
85
80
Quarter-1 (Jan to Mar)
Quarter-2 (Apr to Jun)
Quarter-3 (Jul to Sep)
Quarter-4 (Oct to Dec)
GWLs Seasonal
Indices for Zone-IV



RESULTS AND DISCUSSION

By comparing critically Monthly Seasonal Indices for Ground Water Levels data in all Zones that is April, May, June, July, August, September months Ground Water Levels is high. Similarly by comparing Quarterly Seasonal Indices for Ground Water Levels data in all Zones Quarter-2 and Quarter-3 Ground Water Levels is high. This is because of the fact that in every year especially hot weather season (summer) the Ground Water Levels is very high. Here high means the water level is going deeper and deeper. In general we can observe that as the Rainfall is increasing the depth of the Ground Water Level will be decreasing. It can observe through these graphs, in all the Zones under consideration the Ground Water Levels from 2001 January to 2017 November which is resulted in increasing the depth if the Ground Water Levels. Hence Ground Water Levels are showing increasing trend that is increasing in depth this is our conclusion.

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