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ASSESSMENT OF DROUGHT IN AHMEDNAGAR DISTRICT USING PRECIPITATION DECILE INDEX (PD)

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(Date of Receiving-13-04-2024; Date of Acceptance- 01-07-2024)

ABSTRACT

Long term data about weather parameters are found to be useful to predict and mitigate natural disaster such as drought in any region, so that appropriate mitigation practices can be followed to minimize the losses. For assessment of drought condition Precipitation Decile (PD) is one of the indices used to predict drought condition in region ondecadal basis. The present study target to assess drought condition by using precipitation decile (PD) on decadal scale for Ahmednagar district of Maharashtra by using daily rainfall data collected from India meteorological department and Dept. of Agricultural meteorology Pune. Results from analysis showed that year 1972 and 2018 was the year of severe drought condition

Key words : Drought, Precipitation Decile (PD), PD value, Decades.

Introduction

Drought is a recurring natural phenomenon; its occurrence can be determined by studying past occurrences of the event and its frequency. The severity of the drought is determined by a variety of factors such as rainfall variation, rainfall deficiency, the length of the dry spell, the population of the affected area and the availability of irrigation and other drought-proofing facilities. The effect of drought on crops leads to many consequences like low production, food scarcity, malnutrition, nutrient deficiency, economic degradation, forced migration and the loss of lives, which can turn into social and economic conflicts.

There is need to measure such drought conditions and its effect, there are some indices which are used for this purpose. Indices are indicators that are used to determine certain conditions quantitatively as well as qualitatively. Indices are indicators that are used to determine certain conditions quantitatively as well as qualitatively. Drought can be determined using various indicators, which help to indicate drought conditions regarding geographical area, time of occurrence, duration,

etc. From the various indices which are used for drought monitoring, Precipitation Decile is one of the indices used world over, for this research work Precipitation Decile index is used to characterize drought in Ahmednagar district of Maharashtra.

Materials and Methods

Study area

Ahmednagar district is a district of Maharashtra state in west-central India. It is situated between the latitude 19º09'N and longitudinal of 74º74'East.There are 14 tehsils in Ahmednagar district *viz*, (1) Ahmednagar (2) Akole (3) Jamkhed (4) Karjat (5) Kopergaon (6) Newasa (7) Parner (8) Pathardi (9) Rahata (10) Rahuri (11) Sangamner (12) Shevgaon (13) Shrigonda and (14) Shrirampur.

Climate and rainfall

The climate of the Ahmednagar district is hot and dry. During the year there is little rainfall. June to September are the months of the rainy season. The district receives rain mostly from the South-West monsoons. The rainfall in the western part of the district near the Western
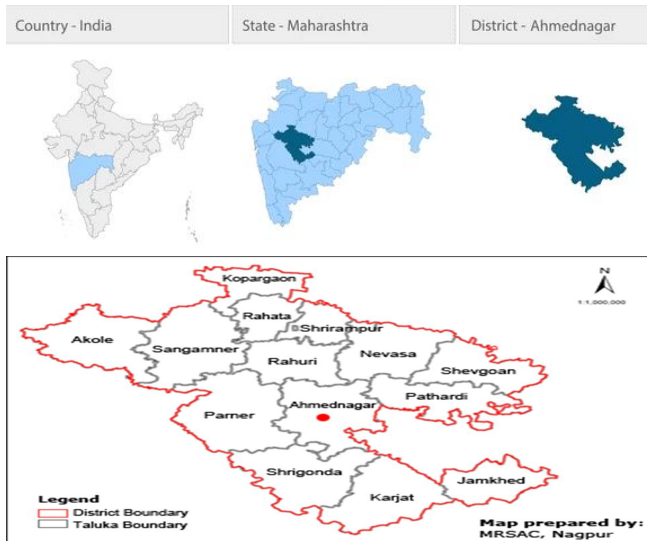
Fig. 1 : Map of Tehsils of Ahmednagar district.

Ghats is higher than in the rest of the district. The rainfall is comparatively less as we go from the Western Ghats to the eastern part of the district.

Data Acquisition

The daily rainfall data of all tahsils in Ahmednagar district was collected from

1. Department of Agricultural Meteorology, College of Agriculture, Pune
2. India Meteorological Department, Pune
3. Downloaded from www.maharain.gov.in (www.krishi.maharashtra.gov.in) from January to December. Rain gauges are located at the headquarters of tahsils.

Collected data was used for analysis of Precipitation Decile Index (PD).

Software used for study

The Drin C (drought indices calculator) software developed at National Technical University of Athens was used for analysis of drought using Precipitation Deciles Index.

Statistical characteristics of Climatological data

The statistical behaviour or characteristics of series of any climatological variables can be described on the basis of several parameters. These parameters are mean, standard deviation, coefficient of variation. All these parameters were used to describe the variability of climatological variables (rainfall) in this study. The statistical characteristics of rainfall of stations will be determined on a weekly, monthly, seasonal and annual basis *viz*; Ahmednagar, Akole, Jamkhed, Karjat, Kopergaon, Newasa, Parner, Pathardi, Rahata, Rahuri, Sangamner, Shevgaon, Shrigonda and Shrirampur. (www.maharain.gov.in).

Mean

Mean represents the measure of central tendency. It is the average of given values and given by,

$$X = \frac{\sum_{(i=1)}^{n} X_i}{n}$$

Where,

X = Mean

i = Variables

n = Total number of variables

Table 1 : The location of rain gauge station, Geographical area, location and availability of data.

S. no.	Name of tehsils	Geographical area (Km²)	Latitude	Longitude	Period of year	No. of years
1	Ahmednagar	1605.74	19.09°N	73.74°E	1961-2021	61
2	Akole	1505.08	19.85°N	74.0°E	1961-2021	61
3	Jamkhed	878.62	19.69°N	73.56°E	1961-2021	61
4	Karjat	1503.61	19.56°N	73.32°E	1961-2021	61
5	Kopergaon	725.16	20.08°N	74.11°E	1961-2021	61
6	Newasa	1343.43	20.04°N	74.48°E	1961-2021	61
7	Parner	1930.28	18.93°N	73.92°E	1961-2021	61
8	Pathardi	1214.1	20.20°N	73.83°E	1961-2021	61
9	Rahata	759.19	20.32°N	74.25°E	1998-2021	24
10	Rahuri	1035.11	20.58°N	74.22°E	1961-2021	61
11	Sangamner	1705.06	20.46°N	74.18°E	1961-2021	61
12	Shevgaon	1031.85	20.47°N	74.02°E	1998-2021	24
13	Shrigonda	1605.61	20.54°N	74.32°E	1961-2021	61
14	Shrirampur	569.87	20.30°N	74.65°E	1961-2021	61

Standard deviation

Standard deviation is the best measure of dispersion. It gives more weight to extreme items and less to those which are near the mean. It is defined as the positive square root of the arithmetic mean of the squares of the deviations of the given values from the arithmetic mean.

$$\sigma = \sqrt{\frac{(\Sigma x_i - x)^2}{n-1}}$$

Where,

σ = Standard deviation

X_i= Variables

X = Mean

n = Total number of variables

Coefficient of variation

The coefficient of variation is the percentage of variation in the mean, the standard deviation being treated as the total variation in the mean. The coefficient of variation (CV) is a statistical measure of how the individual data points vary about the mean value.

$$CV = \frac{\sigma}{x}\ 100$$

Where,

CV = Coefficient of variation

X = Mean

σ = Standard deviation

This measure is indicative of dependability of variable expressed in percentage. The threshold levels for CV for any interpretation are <25, <50, <100, <150 and <250% for yearly, seasonal, monthly, weekly and daily rainfall, respectively (Manorama *et al.*, 2007).

Methodology

Meteorological drought by Precipitation Decile Indices

Meteorological drought was analyzed by using Precipitation Decile Index (PD) for Ahmednagar district.

Precipitation deciles

One of the simplest meteorological drought indices is the Precipitation Deciles which was introduced by Gibbs and Maher (1967). The precipitation totals for the preceding three months are ranked against climatological records and if the sum falls within the lowest decile of the historical distribution of 3-month totals, then the region is considered to be under drought conditions (Kininmonth *et al.*, 2000). The drought ends when:

Table 2 : Classification of drought conditions according to deciles.

Decile Class	Description
Deciles 1-2: lowest 20%	Much below normal
Deciles 3-4: next lowest20%	Below normal
Deciles 5-6: middle 20%	Near normal
Deciles 7-8: next highest 20%	Above normal
Deciles 9-10: highest 20%	Much above normal

   i.   The precipitation measured during the past month already places the 3-month total in or above the fourth decile.

   ii.   The precipitation total for the past three months is in or above the eighth decile.

The advantage of the method of deciles is its computational ease, but its simplicity can lead to conceptual difficulties. The deciles are grouped into five classes as presented in Table 2.

Results and Discussion

A decile is a meteorological drought measurement tool that uses rainfall. The threshold ranges of Deciles used to define drought conditionsin this study given in Table 2. Deciles 1-2 and Deciles 3-4 were considered drought events. The advantage of the method of Deciles is its computational ease. The precipitation deciles for different tehsils of Ahmednagar district are calculated and the results are discussed below.

Precipitation Decile (PD) for Ahmednagar Tehsil

For the calculation of the precipitation decile of Ahmednagar tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under Deciles 1-2 and 3-4. From Table 3, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1966, 1972,1977, 1980, 1982, 1983, 1985, 1987, 2002, 2003, 2011, 2012, 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1974, 1975, 1983, 1988, 1990, 1991, 1997, 1998, 2006, 2010 and 2020) same was depicted in Fig. 2.

Precipitation Decile (PD) for Akole Tehsil

For the calculation of the precipitation decile of Akole tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table 3, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles1-2) condition was observed for 12 years (1963, 1966, 1972, 1977, 1978, 1980, 1982, 1984, 1987, 1989, 1992 and 1997) and much

Table 3 : Precipitation Deciles values of different tehsils of Ahmednagar district (1961-2021).

Years	Ahmednagar	Akole	Jamkhed	Karjat	Kopergaon
1961	5	4	4	5	8
1962	8	4	8	8	8
1963	3	1	6	3	2
1964	5	5	8	5	7
1965	4	4	1	4	9
1966	2	2	3	2	9
1967	6	6	8	6	9
1968	5	5	3	5	2
1969	7	7	7	7	8
1970	7	7	6	7	1
1971	4	4	5	4	5
1972	1	1	1	1	1
1973	4	3	6	4	4
1974	10	8	5	10	10
1975	9	8	10	9	7
1976	3	3	2	3	2
1977	1	1	7	1	5
1978	3	2	5	3	3
1979	7	7	10	7	9
1980	2	2	7	2	5
1981	6	7	2	6	4
1982	2	1	2	2	3
1983	9	3	10	9	7
1984	4	1	7	4	1
1985	2	5	4	2	1
1986	5	5	10	5	10
1987	2	2	1	2	6
1988	9	3	10	9	7
1989	7	1	9	7	9
1990	10	6	3	10	6
1991	10	6	3	10	2
1992	6	2	4	6	5
1993	8	3	9	8	1
1994	3	5	2	3	6
1995	8	6	4	8	2
1996	8	7	9	8	8
1997	10	2	4	10	5
1998	9	8	10	9	10
1999	10	4	9	10	8
2000	6	7	5	6	5
2001	4	6	2	4	3
2002	2	3	2	2	2
2003	1	8	3	1	3
2004	5	10	5	5	6

Table 3 continued....

Table 3 continued....

Years	Ahmednagar	Akole	Jamkhed	Karjat	Kopergaon
2005	4	10	5	4	4
2006	9	10	10	9	8
2007	8	9	7	8	9
2008	7	9	7	7	4
2009	6	8	6	6	7
2010	10	10	8	10	10
2011	1	4	6	1	6
2012	1	6	1	1	4
2013	5	9	4	5	4
2014	3	8	3	3	1
2015	3	9	1	3	3
2016	6	9	8	6	6
2017	8	10	8	8	7
2018	1	9	1	1	3
2019	7	10	6	7	10
2020	10	5	9	10	10
2021	9	10	9	9	10

above normal (Deciles 9-10) condition was observed for 12 years (2004, 2005, 2006, 2007, 2008, 2010, 2013, 2015, 2016, 2017, 2018 and 2019)same was depicted in Fig. 3.

Precipitation Decile (PD) for Jamkhed Tehsil

For the calculation of the decile of Jamkhed tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table 3, it is observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1965, 1972, 1976, 1981, 1982, 1987, 1994, 2001, 2002, 2012, 2015 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1975, 1979, 1983, 1986, 1988, 1989, 1993, 1996, 1998, 1999, 2006 and 2020)same was depicted in Fig. 4.

Precipitation Decile (PD) for Karjat Tehsil

For the calculation of the decile of Karjat tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under Deciles 1-2 and 3-4. From Table 3, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1966, 1972, 1977, 1980, 1982, 1985, 1987, 2002, 2003, 2011, 2012 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1974, 1975, 1983, 1988, 1990, 1991, 1997, 1998, 1999, 2006, 2010, 2011, 2012 and 2020)same was depicted in Fig. 5.

Precipitation Decile (PD) for Kopergaon Tehsil

For the calculation of the decile of Kopergaon tehsil,

Table 4 : Precipitation Deciles values of different tehsils of Ahmednagar district (1961-2021).

Years	Newasa	Parner	Pathardi	Rahata	Rahuri
1961	9	4	7	NA	3
1962	10	9	9	NA	1
1963	8	4	9	NA	3
1964	4	4	8	NA	6
1965	4	5	7	NA	5
1966	6	4	5	NA	4
1967	4	8	6	NA	5
1968	7	1	4	NA	8
1969	10	4	4	NA	9
1970	6	9	5	NA	4
1971	6	6	1	NA	6
1972	3	1	1	NA	1
1973	8	7	6	NA	10
1974	5	8	7	NA	10
1975	7	5	9	NA	8
1976	1	6	4	NA	3
1977	3	8	4	NA	6
1978	3	3	2	NA	2
1979	10	10	3	NA	9
1980	1	9	2	NA	4
1981	2	8	3	NA	8
1982	1	1	1	NA	3
1983	9	6	10	NA	9
1984	2	7	3	NA	4
1985	1	3	9	NA	1
1986	9	8	4	NA	1
1987	5	2	3	NA	2
1988	9	6	10	NA	9
1989	6	10	8	NA	5
1990	9	8	8	NA	9
1991	7	4	5	NA	5
1992	2	6	2	NA	3
1993	2	10	1	NA	1
1994	2	2	3	NA	2
1995	9	2	7	NA	6
1996	7	9	10	NA	6
1997	5	7	6	NA	4
1998	8	9	10	7	7
1999	8	2	3	7	10
2000	6	6	4	3	7
2001	3	5	8	5	7
2002	2	5	5	4	2
2003	1	1	5	1	2
2004	6	10	7	8	7
2005	4	5	2	8	4

Table 4 continued....

Table 4 continued....

Years	Newasa	Parner	Pathardi	Rahata	Rahuri
2006	8	10	9	9	10
2007	3	3	6	6	10
2008	7	3	8	2	8
2009	5	7	9	4	8
2010	10	9	10	10	10
2011	4	2	6	3	7
2012	4	1	1	6	5
2013	5	6	5	6	5
2014	5	2	2	1	3
2015	3	3	2	2	2
2016	7	3	8	5	6
2017	10	7	6	10	8
2018	1	1	1	1	1
2019	8	7	7	10	7
2020	10	10	10	10	10
2021	10	10	10	10	9

rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under Deciles 1-2 and 3-4. From Table 3, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1963, 1968, 1970, 1972, 1976, 1984, 1985, 1991, 1993, 1995, 2002 and 2014) and much above normal (Deciles 9-10) condition was observed for 12 years (195,196,1967, 1974,1979, 1986, 1989, 1998, 2007, 2010, 2019 and 2020)same was depicted in Fig. 6.

Precipitation Decile (PD) for Newasa Tehsil

For the calculation of the decile of Newasa tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under Deciles 1-2 and 3-4. From Table 4, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1976, 1980,1981, 1982, 1984, 1985, 1992, 1993, 1994, 2002, 2003 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1961, 1962, 1969, 1979, 1983, 1986, 1988, 1990, 1995, 1997, 2010, 2017 and 2020) same was depicted in Fig. 7.

Precipitation Decile (PD) for Parner Tehsil

For the calculation of the decile of Parner tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under Deciles 1-2 and 3-4. From Table 4, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1968, 1972, 1982, 1987, 1994, 1995, 1999, 2003, 2011, 2012, 2014 and 2018) and much above normal
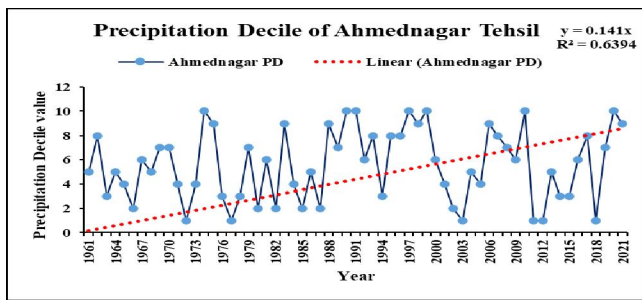
Fig. 2 : PD for the period of 1961-2021 of Ahmednagar station of Ahmednagar district.
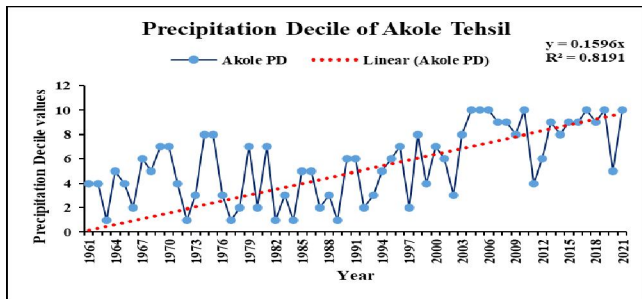

Fig. 3 : PD for the period of 1961-2021 of Akole station of Ahmednagar district.
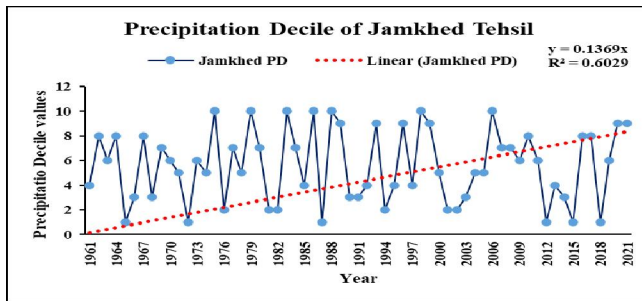

Fig. 4 : PD for the period of 1961-2021 of Jamkhed station of Ahmednagar district.
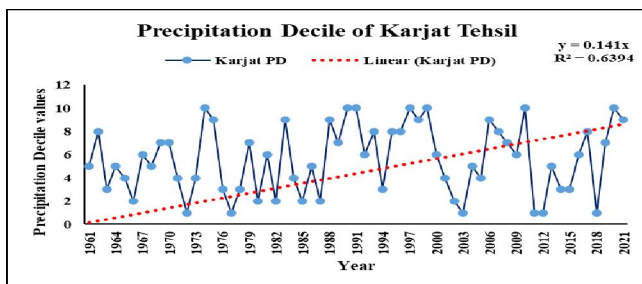

Fig. 5 : PD for the period of 1961-2021 of Karjat station of Ahmednagar district.

(Deciles 9-10) condition was observed for 12 years (1962, 1970, 1979, 1980, 1989, 1993, 1998, 2004, 2006, 2010 and 2020)same was depicted in Fig. 8.

Precipitation Decile (PD) for Pathardi Tehsil

For the calculation of the decile of Pathardi tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under decile 1-2 and 3-4. From Table 4, it was observed that there were 24 drought events in the period of 1961–2021. A much

Table 5 : Precipitation Deciles values of different tehsils of Ahmednagar district (1961-2021).

Years	Sangamner	Shevgaon	Shrigonda	Srirampur
1961	4	NA	3	4
1962	5	NA	7	1
1963	3	NA	4	2
1964	4	NA	10	1
1965	1	NA	3	3
1966	3	NA	2	10
1967	3	NA	5	5
1968	2	NA	2	7
1969	7	NA	5	2
1970	3	NA	2	4
1971	3	NA	4	1
1972	1	NA	1	1
1973	1	NA	9	6
1974	9	NA	10	7
1975	8	NA	6	9
1976	10	NA	3	5
1977	6	NA	7	5
1978	4	NA	4	3
1979	8	NA	9	7
1980	9	NA	6	8
1981	6	NA	7	9
1982	2	NA	3	2
1983	3	NA	9	8
1984	8	NA	5	2
1985	5	NA	2	3
1986	9	NA	4	5
1987	2	NA	6	10
1988	3	NA	9	8
1989	9	NA	8	7
1990	5	NA	8	9
1991	7	NA	5	4
1992	2	NA	2	4
1993	4	NA	6	6
1994	1	NA	1	3
1995	1	NA	10	6
1996	8	NA	7	7
1997	8	NA	5	4
1998	10	10	10	9
1999	6	6	10	4
2000	10	6	3	7
2001	5	4	8	6
2002	6	3	4	1
2003	5	2	1	1
2004	10	9	7	6
2005	7	3	5	6

Table 5 continued....

Table 5 continued....

Years	Sangamner	Shevgaon	Shrigonda	Srirampur
2006	9	9	6	10
2007	7	5	10	9
2008	6	4	4	5
2009	5	8	8	8
2010	10	10	9	10
2011	1	8	1	8
2012	7	1	1	3
2013	6	5	8	5
2014	4	1	2	4
2015	4	2	3	2
2016	7	7	6	8
2017	9	7	7	10
2018	2	1	1	2
2019	10	6	8	9
2020	8	10	10	10
2021	10	10	9	10

below normal (Deciles 1-2) condition was observed for 12 years (1971, 1972, 1978, 1982, 1992,1993, 2005, 2014, 2015 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1962, 1963, 1975, 1983, 1985, 1988, 1996, 1998, 2006, 2009, 2010 and 2020) same was depicted in Fig. 9.

Precipitation Decile (PD) for Rahata Tehsil

For the calculation of the decile of Rahata tehsil, rainfall data for 24 years (1998-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table 4, it was observed that there were 10 drought events in the period of 1998–2021. A much below normal (Deciles 1-2) condition was observed for 5 years (2003, 2008, 2014, 2015 and 2018). and much above normal (Deciles 9-10) condition was observed for 5 years (2006, 2010, 2017, 2019 and 2020)same was depicted in Fig. 10.

Precipitation Decile (PD) for Rahuri Tehsil

For the calculation of the decile of Rahuri tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under decile 1-2 and 3-4. From Table 4, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1962, 1972, 1978, 1985, 1986, 1987, 2002, 2003, 2015 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1969, 1973, 1974, 1979, 1983, 1988, 1990, 1999, 2006, 2007, 2010 and 2020) same was depicted in Fig. 11.

Precipitation Decile (PD) for Sangamner Tehsil

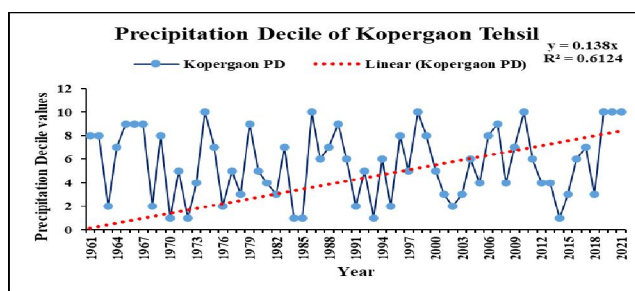For the calculation of the decile of Sangamner tehsil,

Fig. 6 : PD for the period of 1961-2021 of Kopergaon station of Ahmednagar district.
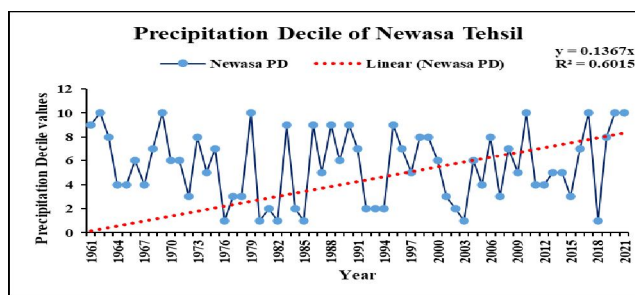

Fig. 7 : PD for the period of 1961-2021 of Newasa station of Ahmednagar district.
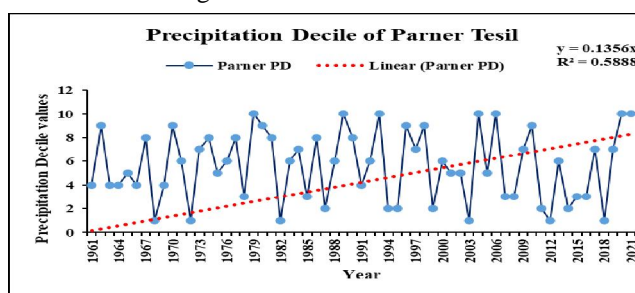

Fig. 8 : PD for the period of 1961-2021 of Parner station of Ahmednagar district.
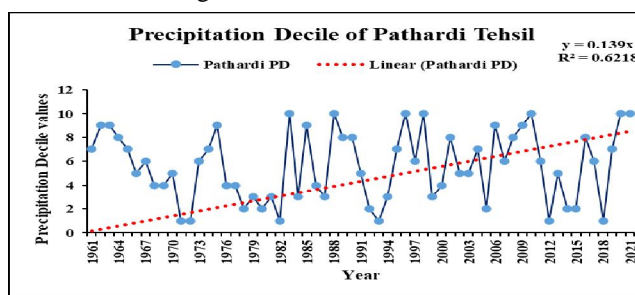

Fig. 9 : PD for the period of 1961-2021 of Pathardi station of Ahmednagar district.

rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table5, it was observed that there were 23 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 11 years (1965, 1968, 1972, 1973, 1982, 1987, 1992, 1994, 1995, 2011 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1974, 1976, 1980, 1986, 1989, 1998, 2000, 2004, 2006, 2010, 2017 and 2019) same was depicted in Fig. 12.
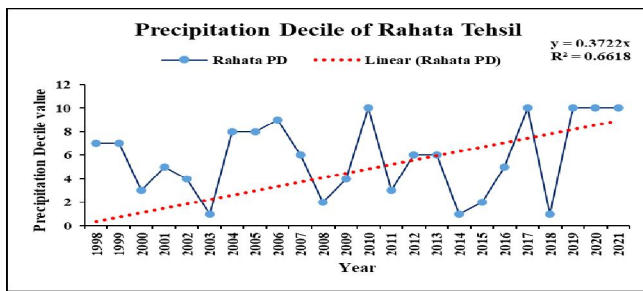
Fig. 10 : PD for the period of 1998-2021 of Rahata station of Ahmednagar district.
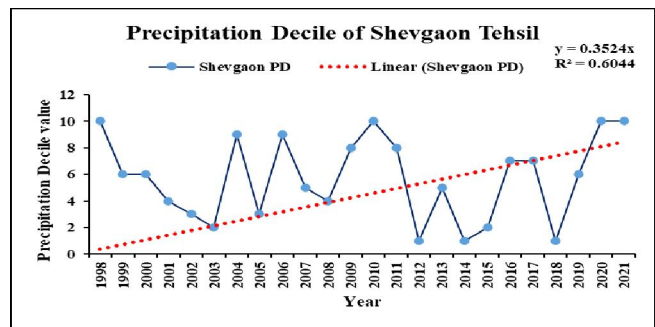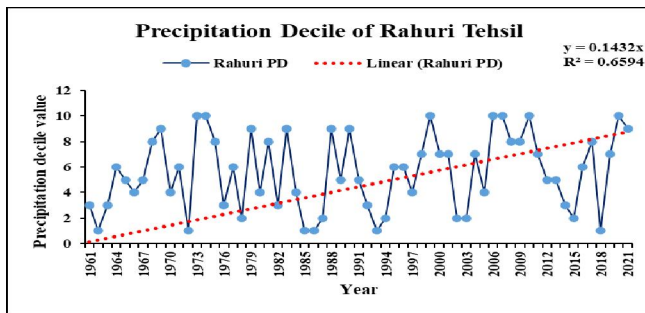

Fig. 11 : PD for the period of 1961-2021 of Rahuri station of Ahmednagar district.
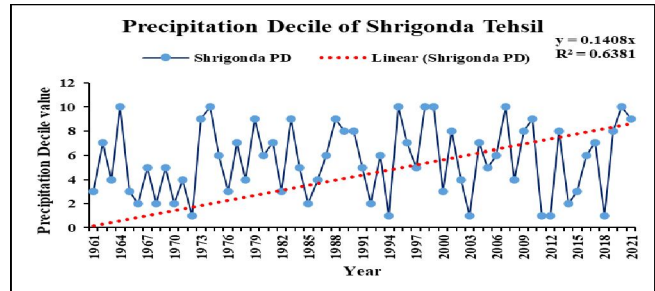

Fig. 12 : PD for the period of 1961-2021 of Sangamner station of Ahmednagar district.
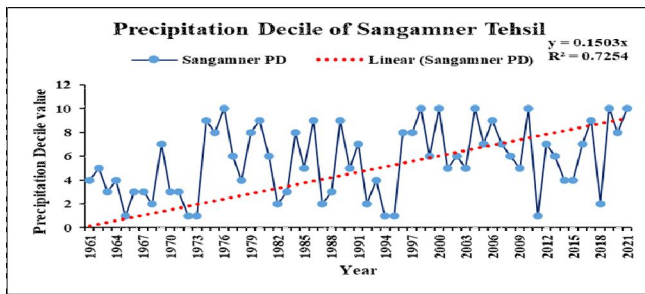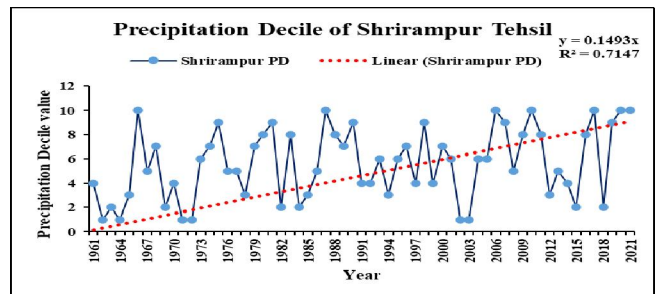
Precipitation Decile (PD) for Shevgaon Tehsil

For the calculation of the decile of Shevgaon tehsil, rainfall data for 24 years (1998-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table 5, it was observed that there were 10 drought events in the period of 1998–2021. A much below normal (Deciles 1-2) condition was observed for 5 years (2003, 2012, 2014, 2015 and 2018). and much above normal (Deciles 9-10) condition was observed for 12 years (1998, 2004, 2006, 2010 and 2020) same was depicted in Fig. 13.

Precipitation Decile (PD) for Shrigonda Tehsil

For the calculation of the decile of Shrigonda tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table 5, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1966, 1968, 1970, 1972, 1985, 1992, 1994, 2003,

Fig. 13 : PD for the period of 1998-2021 of Shevgaon station of Ahmednagar district.

Fig. 14 : PD for the period of 1961-2021 of Shrigonda station of Ahmednagar district.

Fig .15 : PD for the period of 1961-2021 of Shrirampur station of Ahmednagar district.

2011, 2012, 2014 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1964, 1973, 1974, 1979, 1983, 1988, 1995, 1998, 1999, 2007, 2010 and 2020) same was depicted in Fig. 14.

Precipitation Decile (PD) for Shrirampur Tehsil

For the calculation of the decile of Shrirampur tehsil, rainfall data for 61 years (1961-2021) was used. Historical drought events were identified that fall under deciles 1-2 and 3-4. From Table 5, it was observed that there were 24 drought events in the period of 1961–2021. A much below normal (Deciles 1-2) condition was observed for 12 years (1962, 1963, 1964, 1969, 1971, 1972, 1982, 1984, 2002, 2003, 2015 and 2018) and much above normal (Deciles 9-10) condition was observed for 12 years (1966, 1975, 1981, 1987, 1990, 1998, 2006, 2007, 2010, 2017, 2019 and 2020) same was depicted in Fig. 15.

Conclusion

As per the 61 years of rainfall data drought years were observed for 24 years for tehsils like Ahmednagar, Akole, Jamkhed, Karjat, Kopergaon, Newasa, Parner, Pathardi, Rahuri, Shrigonda and Shrirampur, in the case of Sangamner tehsils, out of 61 years, it was observed for 25 years, whereas for tehsils like Rahata and Shevgaon for which only 24 years data was available shows 09 drought years.

In the case of tehsils such as Ahmednagar, Jamkhed, Karjat, Kopergaon, Newasa, Parner, Pathardi, Rahuri and Shrigonda, the frequency of drought events increased as compared to the last decade, whereas in the case of tehsils like Akole, Sangamner, Shevgaon and Shrirampur, the frequency of drought events decreased. Overall, the frequency of drought events has increased since the last two decades, which was a serious concern for crop production in this region, which needs rainwater harvesting and conservation programmes to be implemented.

Acknowledgments

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