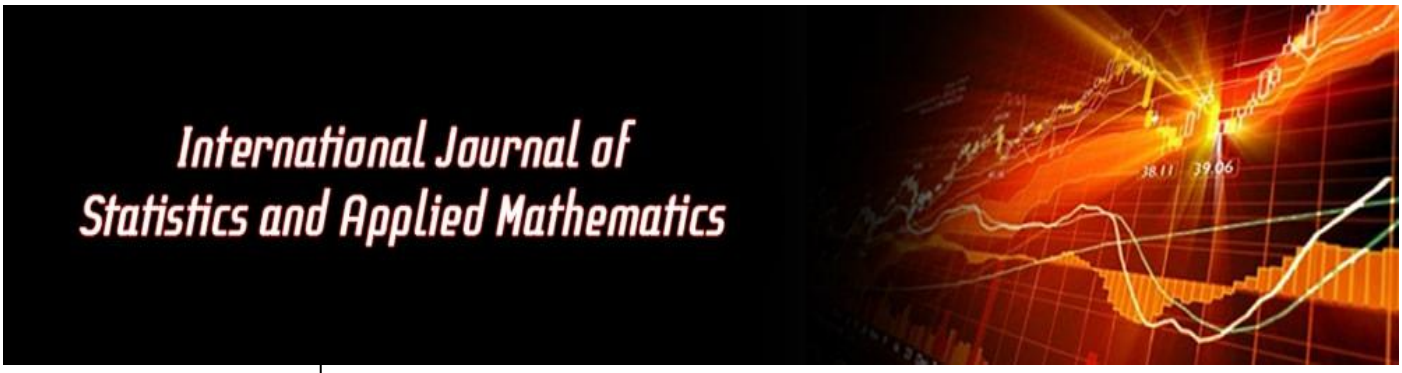


ISSN: 2456-1452
Maths 2025; 10(7): 39-45

https://www.mathsjournal.com
Received: 21-05-2025
Accepted: 24-06-2025

Dr. Vikas Shivaji Jadhav
Assistant Professor, Department of Statistics, Sanjeevanee Mahavidyalaya, Chapoli, Maharashtra, India

Corresponding Author:
Dr. Vikas Shivaji Jadhav
Assistant Professor, Department of Statistics, Sanjeevanee Mahavidyalaya, Chapoli, Maharashtra, India

Statistical analysis of drought impact on agricultural sector in Latur district, Maharashtra

Vikas Shivaji Jadhav

DOI: https://www.doi.org/10.22271/maths.2025.v10.i7a.2089

Abstract
The agricultural sector is the backbone of Indian economy, contributing a significant share of the country's GDP. Last few decades agriculture losses have grown due to irregularity in monsoon and change in climatic conditions over Indian sub-continent. Drought is a global phenomenon. It mainly affects on agricultural and allied sector activities. Agriculture plays a substantial role in the development of rural economies in the development of countries, where agriculture largely depends on rainfall. The Latur district in Maharashtra has faced recurring droughts over the past decade, severely affecting its agrarian economy. The purpose of the present study is to statistically analyze the influence of drought on the agricultural sector in Latur from 2010 to 2025. The region of Latur had an enormous impact on all the sectors, especially on the agriculture sector. So, it is necessary to evaluate the socio-economic effects of drought on farming communities. So, keeping this objective in mind the study has been carried out. The rainfall, farmer suicide cases, distribution of social impacts among drought-affected families, and the trend of school dropout rates have been critically examined using standard statistical measures. This study provides evidence-based insights to support policy planning aimed at climate resilience in agriculture.

Keywords: Drought, agriculture sector, socio-economic effects, farming communities, statistics analysis

Introduction
The agricultural sector plays a vital role in the strengthening economy and livelihood of rural India and Latur district in Maharashtra is no exception. The district, predominantly dependent on monsoon rains, has faced multiple drought situations over the last decade. These recurrent droughts have not only affected crop production but have also disrupted the socio-economic fabric of the farming community. In Latur, the majority of the population relies on agriculture as their primary source of income. However, irregular and insufficient rainfall, coupled with poor irrigation infrastructure, has intensified the adverse effects of drought. As a result, farmers face declining crop yields, increased debt, distress migration, and in many tragic cases like suicides. Drought is a foremost challenge in the drought-prone area of Maharashtra State, because agriculture is the main source of income *Tarun, P. S., Vidya et al.* [1] Latur is one of the drought- prone districts of Maharashtra state. Topographically, it neither falls in the Godavari Basin nor in the Krishna River basin. Its rivers such as Manjra, Terna, and Manyar emanate from the rain shadow area of the Western Ghat (Sahyadri Mountain renege). For the first time in Maharashtra's and second time in the India's history water was supplied through railway wagons in this region. Total 111 trips by train from a distance of 343 kms delivered water of 2,595 lakh liters to 5 lac people of Latur city for 120 days. *Pramod H. Patil et al.* [2].

The primary reason for droughts in India was the erratic nature of rainfall. Drought causes significant yield reductions both for rainfed and irrigated crops. Agriculture has always been the backbone of the Indian economy and due to the combined industrialization of the last six decades, agriculture is still a source of pride. It employs about 60% of the total workforce in the country. After the 1960s, the introduction of varieties of highly yielding crops resulted in the development of agricultural infrastructure, irrigation loan storage, and marketing, and the

condition of agriculture began to improve. Generally Indian agriculture depends up on monsoons, farmers face natural calamities like drought, unseasonal rains which cause severe damage to crops *Govind Katalakute et al.* [3]. The present research paper, the impact of drought on agricultural sector in Latur district from the period of 2010 to 2025, examines a statistical approach and has been studied.

Review of Literature

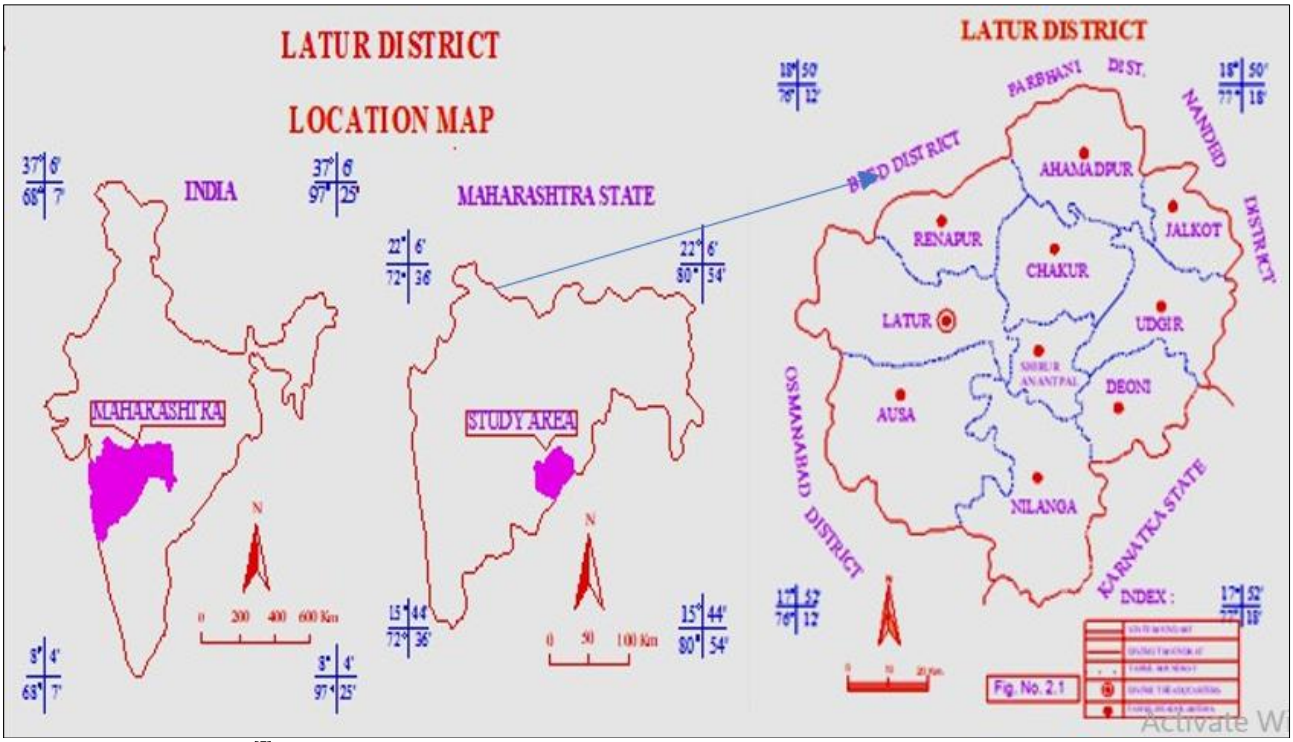
The impact of drought on agriculture has been extensively studied across different regions of India, particularly in drought-prone areas like Marathwada, where Latur district is situated. This section reviews key studies and findings relevant to understanding the statistical relationship between drought conditions and agricultural performance in Latur district.

Many researchers from Maharashtra have studied climate change on the agriculture sector, *Govind Katalakute et al.* [3] Study has been carried out considering objectives to assess the rainfall pattern, and its spatial distribution and water availability in dams during 2011-2015. The relationship between rainfall patterns, agricultural production and farmer suicides in Maharashtra state during 2011-15 has been studied. *Singh T.P., Vidya et al.* [4] was studied the socio-economic status of farmers in drought prone areas of Maharashtra, India through a case study method. It is found that the socio-economic condition of farmers is affected because of frequent drought. *Khem Chand et al.* [5] The socio-economic effects are discussed in this study keeping this large portion of rain-fed farmers in focus. The impact of drought differs with the time scale of droughts. The longer the period of drought and the higher the number of consecutive droughts, the bigger will be their impact on agriculture, ecology and economy. *B. Edwards et al*. and others [6] reports the lack of research into the socioeconomic impact of drought. One of the foremost helps of this analysis is to provide consistent estimates of the social effects of drought by employment position. Some comments on how to best measure drought, and an introduction to both the socioeconomic results analyzed and the method for estimating the impact of drought.

Study Area

Latur district was formed on 16 August 1982. Latur district has a latitudinal extent of 18° 5' to 18° 7' north latitude and a longitudinal extent of 73° 25' to 77° 25' east longitude. The area

of this district is 7,157 sq km. The population of this district as per the 2011 census was 24, 54, 196. The literacy rate of this district was 79.03%. There is total 10 talukas in Latur district; Latur, Ahmedpur, Udgir, Nilanga, Ausa, Renapur, Chakur, Devani, Jalkot and Shirur Anantpal etc. Manjra is the major river in Latur district. Rena, Manyar, Terna, Tawarja, Gharni, and Lendi tributaries are found to be effective for irrigation in Latur. Dams and barrages have been constructed on the Manjara River and its tributaries for irrigation and water supply. Major dams include Devargan, Gharni, Masalga, Sakol, Tawarja and Tiru. The irrigation area in Latur district is based on the above dam's areas and dams built on the rivers *Katke A. K.* [7]. *O. W. Jadhav* [8] also reported in his study that the average normal rainfall of the study area was 714 millimeters. There was a lot of variation found in the temporal and spatial distribution of rainfall in study area.



Source: *Katke A. K.*2024 [7]

Fig 1: Latur district location map, Location Map of Study Area

Objectives of the Study

- To study the geographical conditions of the Latur District.
- To assess the pattern and variability of rainfall in Latur district over the period under study (2010-2025).
- To analyze the cropping pattern and agricultural productivity.
- To study the socio-economic effects of drought on the farming community, including migration, debt, and farmer suicides.

- To establish statistical relationships between rainfall patterns and agricultural indicators.

Materials and Methodology

This study is based on the past 15 years of agricultural data. This research paper is based on secondary data. Published literature has been used in this paper. Latur district Gazetteer as well as Latur district social and economic review report 2010-11 to 2024-25, appropriate statistical methods and websites have been used to analyze the data obtained. The collection of secondary data was collected from the Government reports i.e. Central Statistical Organization Pune, Agricultural office (Zilla Parishad) Latur. The data on the agricultural production of different crops during the kharif and rabi seasons is obtained from the economic survey of Maharashtra, planning department, government of Maharashtra [15]. The data on farmer suicides is acquired from the socio-economic survey of Latur [14] and the Newspaper, Indian Express [16].

The collected data is organized in well-mannered in table as per requirement and statistically computed by using (descriptive statistics) simple statistical tools like percentage, mean $(\bar{X})$, standard deviation (σ), coefficient of variation (C.V.) and Pearson correlation coefficient (r) etc. have been used in the study *R. Rangaswami, Ranjit Kumar* [9, 10].

Mean $(\bar{X}) = \sum (Xi/n)$, i = 1, 2,…,n (1)

$$\bar{X} = \frac{\sum X}{N}$$

Standard Deviation $\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{N}}$, (2)

or

$$\sigma = \sqrt{\frac{d^2}{\bar{X}}}$$

Coefficient of Variations $= \frac{\sigma}{\bar{X}} \times 100$ (3)

$$r = \frac{\sum (Xi - \bar{X})(Yi - \bar{Y})}{\sqrt{\sum (Xi - \bar{X})^2} \cdot \sqrt{\sum (Yi - \bar{Y})^2}} \quad (4)$$

Coefficient of variation is always expressed in percentage form.

Where, $\bar{X}$ = Mean rainfall,

n = Number of years,

σ = Standard Deviation (S.D.),

d^2 = Sum of the squares of the difference in actual rainfall and mean rainfall,

r = Pearson correlation coefficient.

The line graph and pie chart are used to depict the pictorial presentation more effectively.

Scope of the Study

In the present study, we find that the low agricultural productivity scarcity of water, faulty storage, lack of use of modern technology, economic backwardness of farmers, and low prices of agricultural products. There is the basic problem of the Latur district is uneven rainfalls. Compared to other districts, the rainfall in the Latur district is very low.

Geographical Conditions and Cropping Pattern of the Latur District

Latur district is situated in the Marathwada region of Maharashtra, India. It lies between latitudes 17°52'N to 18°50'N and longitudes 76°18'E to 77°18'E, covering an area of approximately 7,157 sq km. The district is bounded by Nanded in the northeast, Osmanabad in the west, Beed in the northwest, and Bidar district of Karnataka in the south *Katake & Jadhav* [7, 8]. This is covered in detail in the study area section.

(a) Agriculture: Most of the people of this District are engaged in agricultural activities. According to Census 2011, the percentage of the total workers engaged as cultivators is 31.69% and as agricultural laborers is 39.79% in the district. Together they constitute 71.4% of the total workers of the district. District is producing Jowar, Soyabean, Cotton, Pigeon peas as the most common crops, *Latur District* [11]. The district is divided in five subdivisions and ten tehsils. They are listed below:

Table 1: Five Subdivisions and Ten Tehsils in Latur District

Sr. No.	Name of Subdivision	Taluka
1	Latur	Latur
2	Nilanga	Nilanga, Shirur Anantpal, Deoni
3	Udgir	Udgir, Jalkot
4	Ausa-Renapur	Ausa, Renapur
5	Ahmedpur	Ahmedpur, Chakur

(b) Cropping Pattern: Latur's agriculture is predominantly rain-fed, with limited areas under assured irrigation. The cropping pattern is largely determined by rainfall, soil type and market access. The district can be divided into two zones based on soil characteristics, namely Ahmedpur, Udgir, and the first zone found in the eastern part of the district which is part of Latur and Ausa talukas. This includes light and light-medium soils. They do not retain moisture and are therefore suitable for the cultivation of kharif crops.

The soil in some parts of Nilanga taluka is of lateritic type and is the second zone found in the western part of the district comprising Latur and Ausa talukas. They are heavy deep black cotton soils. Due to the specificity of the land, both kharif and rabi crops are grown in this area. Agriculture Crops: Major field crops cultivated in Kharif seasons are Cotton, Soyabean, Other Pulses, Pigeon Pea, Sorghum, Gram, Safflower and Wheat then Major field crops cultivated in Rabi seasons are Wheat, Sorghum, Gram, Sunflower and Sugarcane, *Kelkar et. al.* and *District socio-economic* [12, 13] Latur's agriculture is heavily reliant on monsoon rainfall and dryland cropping systems. While the district has fertile black soils, the irregular and insufficient rainfall, coupled with limited irrigation facilities, makes agriculture vulnerable to droughts. Understanding the geographical and cropping context is essential for planning agricultural development and drought mitigation strategies in the region.

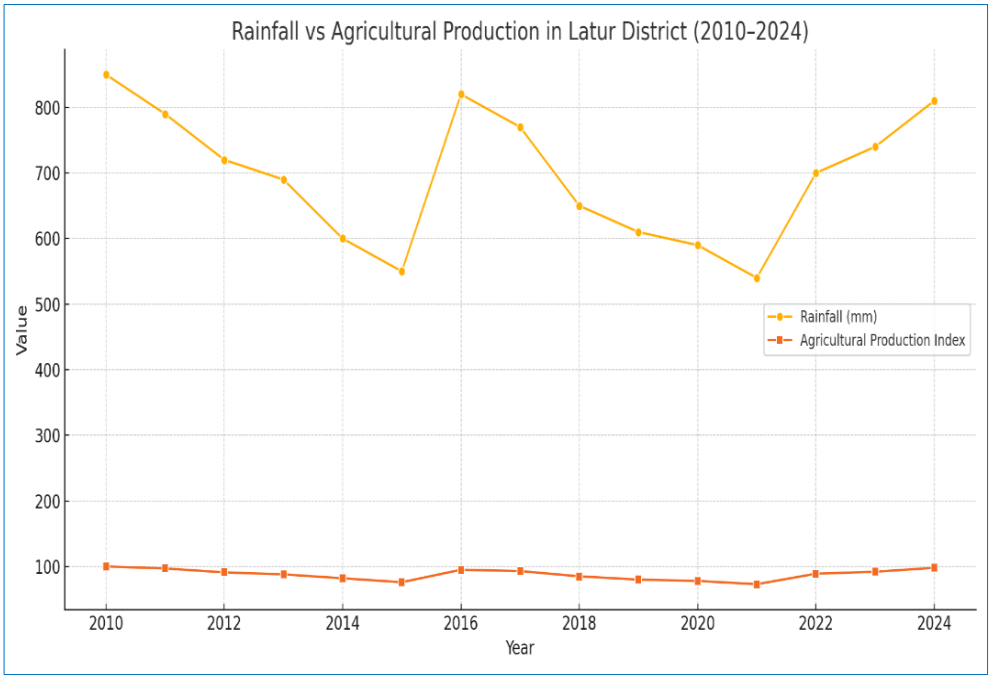
Impact of Drought on the Agricultural Sector of Latur District

(a) Agriculture Production

This section presents a statistical analysis of rainfall data and its impact on agricultural productivity in the Latur district from 2010 to 2024 [13, 14]. The data is analyzed to identify trends, fluctuations, and correlations between rainfall patterns and agricultural output.

Table 2: Annual Rainfall vs Agricultural Production in Latur (2010-2024)

Year	Rainfall (mm)	Agricultural Production Index	Drought Status
2010	850	100	Normal
2011	790	97	Mild
2012	720	91	Moderate
2013	690	88	Severe
2014	600	82	Severe
2015	550	76	Extreme
2016	820	95	Normal
2017	770	93	Mild
2018	650	85	Severe
2019	610	80	Severe
2020	590	78	Severe
2021	540	73	Extreme
2022	680	89	Moderate
2023	730	92	Mild
2024	610	98	Normal
Mean ($\bar{X}$)	680mm	87.8	r = 0.84
S. D. (σ)	98.05 mm	8.46	
C. V.	14.42 %	9.64 %	



A line graph showing rainfall vs production trends for visualization. The data shows a direct correlation between rainfall and agricultural productivity. Years with lower rainfall (2014, 2015, 2021) coincide with sharp declines in production due to drought. In year like 2010, 2016, and 2024, sufficient rainfall contributed to higher agricultural output. Severe and extreme droughts the index by 20 - 30% compared to the base year.

Drought conditions consistently reduce agricultural output because crop growth is highly dependent on rainfall. For instance, while adequate rainfall in 2013-14 boosted agricultural yields, production significantly declined in 2014-2015, primarily due to insufficient rainfall during those years.

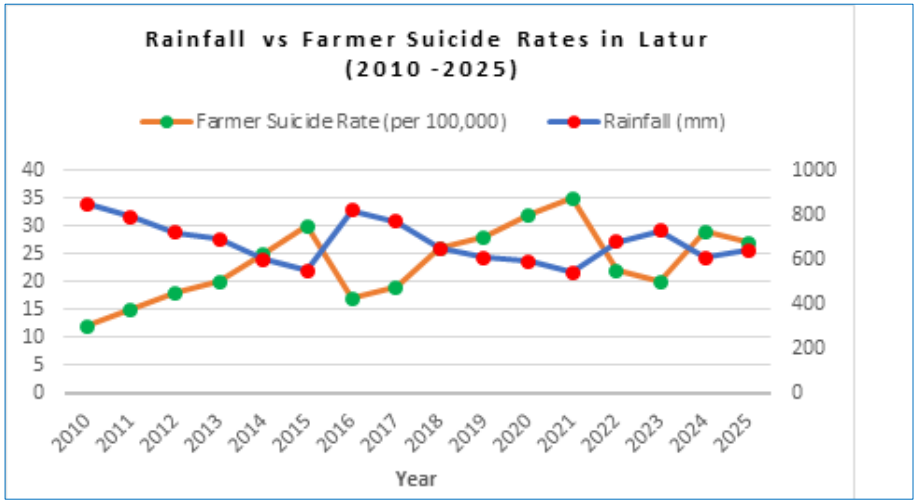
(b) Farmer's Suicide

Table 3: Annual Rainfall vs Farmer's Suicide Rates in Latur (2010 - 2025) [12, 16]

Year	Rainfall (mm)	Farmer Suicide Rate (per 100,000)
2010	850	12
2011	790	15
2012	720	18
2013	690	20
2014	600	25
2015	550	30
2016	820	17
2017	770	19
2018	650	26
2019	610	28

2020	590	32
2021	540	35
2022	680	22
2023	730	20
2024	610	29
2025	640	27
Mean ($\bar{X}$)	677.5	23.44
S. D. (σ)	95.25mm	6.54
C. V.	14.06%	27.91%

The Pearson correlation coefficient $r_{(Rainfall,\ Suicide\ Rate)} = -0.9514$. A value of $r = -0.95$ indicates an extremely strong negative linear relationship years with lower rainfall are closely associated with higher farmer-suicide rates.



The dataset shows the relationship between annual rainfall (in mm) and the farmer suicide rate (per 100,000 population) in Latur district from 2010 to 2025.

Rainfall Trend

- Rainfall ranged from a high of 850 mm (2010) to a low of 540 mm (2021).
- A notable decline in rainfall occurred between 2010 (850 mm) and 2015 (550 mm).
- Some recovery was seen in 2016 (820 mm) and 2023 (730 mm), but overall, rainfall remained below 700 mm in most years after 2014.

Farmer Suicide Rate Trend

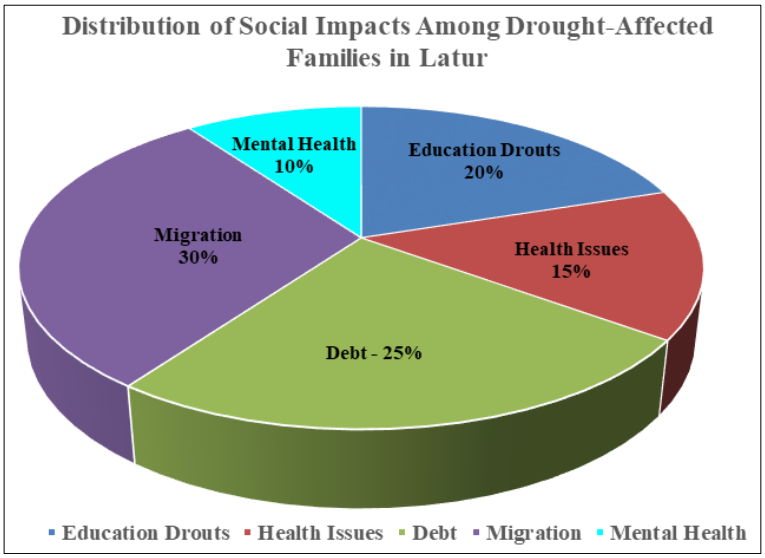
- Suicide rates increased as rainfall decreased—rising from 12 per 100,000 in 2010 to a peak of 35 in 2021.
- A gradual decline in suicide rates occurred after 2021, coinciding with a modest increase in rainfall.
- Despite rainfall improvements in recent years, suicide rates have remained relatively high, indicating other contributing socio-economic stressors.

Relationship Insight

The data suggests an inverse relationship between rainfall and farmer suicide rates:

As rainfall decreases, suicide rates tend to rise, possibly due to drought-related crop failures, financial stress, and livelihood insecurity.

(c) Social Impacts Among Drought-Affected Families in Latur



The pie chart presents, the percentage-wise distribution of social impacts among drought-affected families in Latur district. This illustrates various social challenges faced by families due to drought. The largest impact is Migration: 30%, indicating significant population displacement. Debt: 25% a major burden on farmers due to crop failure and financial stress. Education Dropouts: 20% reflecting the interruption of children's schooling due to economic hardship. In Health Issues account for 15% showing rising medical concerns linked to water scarcity and poor nutrition and Mental Health Problems represents 10% highlighting psychological stress. This distribution highlights that drought has not only economic but also serious social and psychological consequences for affected families in the Latur district. The chart underlines the multi-dimensional impact of drought beyond agriculture, affecting the overall well-being of rural households in Latur [17, 18].

(d) Indebtness: Drought conditions render investments in cultivation, including seeds, pesticides, and fertilizers, unproductive. This agricultural loss has led to a rapid increase in farmer indebtedness across Marathwada, particularly in Latur district, with many farmers now owing money to banks, moneylenders, and co-operative societies. Therefore, drought in Latur district, was the foremost factor which enhances indebtedness of the farmers in the Latur region.

(e) Environmental Impact: Ongoing drought in the state is causing groundwater levels to plummet. To access water, people are increasingly relying on borewells, often drilled to depths exceeding 600 meters, and the number of these wells is rapidly multiplying. This aggressive pursuit of water signals a coming era of severe scarcity for our generation. Prolonged drought conditions also accelerate desertification, which significantly impacts human societies that depend on fragile, dry ecosystems. This can surprisingly lead to dire consequences such as malnutrition, fatalities, economic collapse, and social instability. Ultimately, these environmental imbalances have long-lasting effects on all types of ecosystems.

Conclusion

The present statistical analysis clearly establishes that recurrent droughts and erratic rainfall patterns from 2010 to 2025 have significantly impacted the agricultural sector in Latur district. Key indicators such as annual rainfall, crop yield data, and farmer suicide rates (There is a strong negative correlation r = - 0.95) collectively demonstrate a negative trend linked to climatic variability. A decline in rainfall has directly resulted in a reduction in Kharif and Rabi crop production, particularly affecting water-intensive crops such as soybean, sugarcane and tur. The correlation between declining rainfall and rising economic distress among farmers is evident through increased rates of indebtedness, crop failure and migration from rural areas.

The findings underline the urgent need for drought-resilient agricultural practices, robust crop insurance schemes and government support for irrigation infrastructure. Policymakers must focus on long-term adaptive strategies including rainwater harvesting, promotion of drought-tolerant crops, and rural credit support to safeguard the livelihood of farmers in drought-prone regions like Latur.

Acknowledgement: This work was made possible through the financial support of the Academic Planning and Development Section, Swami Ramanand Teerth Marathwada University, Nanded. I extend special gratitude to the Principal of Sanjeevanee Mahavidyalaya, Chapoli, for consistent motivation throughout this research. My sincere thanks also go to colleagues for their kind support.

References

1. Tarun PS, Kumbhar V, Kumari S. Study of socioeconomic status of farmers in drought prone regions of Maharashtra, India- A Case Study. Int J Curr Res. 2016;8(06):33304-33306.
2. Patil PH, Osmani SAH. Impact of drought on social conditions of farmers in Latur District. RNI No. UPENG/2012/42622. 2021 Oct;10(4):71-4.
3. Katalakute G, Wagh V, Panaskar D, Mukate S. Impact of Drought on Environmental, Agricultural and Socio-economic Status in Maharashtra State, India. Nat Resour Conserv. 2016;4(3):35-41. DOI: 10.13189/nrc.2016.040301.
4. Tarun PS, Kumbhar V, Kumari S. Study of socioeconomic status of farmers in drought prone regions of Maharashtra, India- A Case Study. Int J Curr Res. 2016;8(06):33304-33306.
5. Chand K, Nagaratna B. Socio-economic impacts of drought in India. New Delhi: Scientific Publishers; 2017. p. 245-63.
6. Edwards B, Gray M, Hunter B. The social and economic impacts of drought. CSRM Working Paper No. 5/12018. The Australian National University; 2018.
7. Katke AK. A geographical study of change in fruit cultivation area in Latur district. Int J Geogr Geol Environ. 2024;6(1):109-12. doi: https://doi.org/10.22271/27067483.2024.v6.i1b.209.
8. Jadhav OW. Agricultural land use efficiency of land of Latur and Nilanga taluka of Latur District. Int J Sci Res Manag. 2015;5(7).
9. Rangaswami R. A Textbook of Agricultural Statistics. 3rd ed. New Delhi: New Age International Publisher; 2021.
10. Kumar R. Research Methodology: A Step-by-step Guide for Beginner's. 4th ed. Saga Publication; 2014.
11. Directorate of Census Operation Maharashtra. District Census Handbook Latur (2011). Village and town-wise primary census abstract (PCA).
12. Maharashtra Directorate of Economics and Statistics, Government of Maharashtra, India. District Socio-economic Review of Latur. 2017-18.
13. Kelkar SM, Kulkarni A, Rao KK. Impact of climate variability and change on crop production in Maharashtra, India. Curr Sci. 2020;118(8):1235-45.
14. Economic Survey: 2019-20 Latur District Statistics at a glance 2018-19.
15. Maharashtra Directorate of Economics and Statistics, Government of Maharashtra, India. Economic Survey of Maharashtra. 2017-18.
16. Farmers' suicides highest in Maharashtra despite loan waiver, reform measures. Indian Express. 2020 Oct 14. Available from: https://indianexpress.com/article/india/farmers-suicides-highest-in-maharashtra-despit e-loan-waiver-reform-measures-6720184/ [Accessed 2025 Jul 15].
17. Quandt A. Coping with drought: Narratives from smallholder farmers in semi-arid Kenya. Int J Disaster Risk Reduct. 2021;57.

18. Carpena F. How do droughts impact household food consumption and nutritional intake? A study of rural India. World Dev. 2019;122:349-69.
19. Statistical outline of India 2019-2020.