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Long-Term Climatic Trends in Rainfall and Temperature across Solapur district (Maharashtra): Implications for Climate Change Adaptation in India

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Abstract

Climate change has emerged as a critical concern worldwide, with significant implications for natural and social systems at local, regional, and national levels. The study was conducted at Department of Environmental Science, PAH Solapur University, Solapur for period 1982 to 2023. By using 42 years annual rainfall and temperature data of different tehsils of Solapur calculated trend analysis of mentioned weather parameters by using linear regression analysis method. The required climatic data is collected from IMD, Pune, Agro-meteorology Department, College of Agriculture, Pune and Agriculture Department, Govt. of Maharashtra. This study analyzes the long-term climatic trends (1982–2023) in rainfall and temperature across 11 tehsils in the Solapur district of Maharashtra, India. Using linear regression analysis, the study investigates the variations in annual rainfall, maximum, and minimum temperatures. The results reveal both significant and non-significant trends across the region. Akkalkot and Malshiras tehsils demonstrated significant increases in annual rainfall, with rates of 0.820 and 6.4588, respectively. On the other hand, significant decreases in rainfall were observed in Mohol, North Solapur, and Pandharpur tehsils. Temperature analysis showed a general non-significant increase in annual minimum temperatures, with slight decreases in maximum temperatures in some tehsils. These findings suggest complex regional patterns in climatic trends, with varying impacts on water resources, agriculture, and the environment. The study highlights the need for district-specific strategies to address climate change impacts, particularly in the context of water scarcity and agricultural productivity in India. Further research is required to understand the underlying causes of these trends and their long-term implications.

Keywords: *Rainfall and Temperature trends, Solapur District, climate change, drought risk, water resource management, agriculture, monsoon variability, Maharashtra, statistical analysis.*

Introduction:

The study of climate change over the previous and current centuries has drawn significant attention due to its profound effects on ecosystems and human societies at local, regional, and national levels. Climate change presents a substantial challenge to scientists as it threatens to disrupt these systems. Global temperatures have risen by approximately 0.5 to 0.6°C, with projections indicating further increases of 0.3 to 0.7°C by 2035 (Jaswal et al., 2015). In South Asia, including India, the Intergovernmental Panel on Climate Change (IPCC) predicts temperature increases ranging from 0.5 to 1.2°C up to 2020, 0.88 to 3.16°C till 2050, and 1.56 to 5.44°C till 2080 (IPCC, 2018; IPCC, 2021). The warming trend in India over the past century, at a rate of 0.57°C per century, aligns closely with global trends (Dash et al., 2007). Atmospheric surface temperatures in India have risen by approximately 1°C during winter and by 1.1°C during post-monsoon months in the last century (Jain and Kumar, 2012). Seasonal studies across eight sites in Central Northeast India reveal that maximum temperatures have increased annually by 0.008°C during the monsoon season, by 0.014°C during post-monsoon periods, and by 0.008°C overall between 1914 and 2003. Meanwhile, minimum temperatures have shown an annual rise of 0.012°C during post-monsoon periods but a slight decline of 0.002°C during the monsoon season (Subash et al., 2011).

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Long-term climatic trends can be analyzed using non-parametric statistical methods like those developed by Mann and Kendall. Variations in temperature and rainfall caused by climate change could adversely impact water resources, posing challenges for agriculture-dependent nations like India.

Methodology: Trend analysis for selected variables can be effectively estimated using a linear equation, which is typically, fitted through the application of regression analysis techniques.

Linear model:

$$Y = a + bx$$

Where,

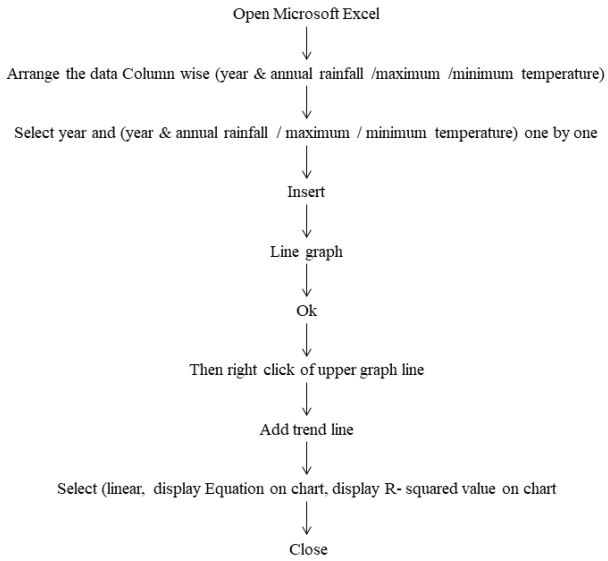
Y = weather data (rainfall/ maximum & minimum temperature)

a = intercept

b = slope

x = year/time

For trend analysis of gridded annual rainfall, maximum and minimum temperature in 11 tehsils. The long period data (1982-2023) were used for trend analysis. The steps-by -steps procedure are given below:



Result & Discussion:

Table 1: Summary of Result and Discussion

Tehsil	Annual Rainfall Trend	Annual Max Temp Trend	Annual Min Temp Trend
Akkalkot	**Significant ↑ (0.820)**	Non-significant ↓ (-0.0061)	Non-significant ↑ (0.0154)
Barshi	Non-significant ↓ (-0.243)	Non-significant ↓ (-0.0047)	Non-significant ↑ (0.0195)
Karmala	Non-significant ↑ (0.0703)	Non-significant ↓ (-0.0021)	Non-significant ↑ (0.0226)
Madha	Non-significant ↑ (0.2443)	Non-significant ↓ (-0.0062)	Non-significant ↑ (0.0195)
Malshiras	**Significant ↑ (6.4588)**	Non-significant ↓ (-0.0034)	Non-significant ↑ (0.0204)
Mangalwedha	Non-significant ↓ (-0.1199)	Non-significant ↑ (0.0103)	Non-significant ↑ (0.0264)
Mohol	**Significant ↓ (-0.0123)**	Non-significant ↑ (0.0023)	Non-significant ↑ (0.0185)
North Solapur	**Significant ↓ (-0.0143)**	**Significant ↓ (-0.0005)**	Non-significant ↑ (0.0197)
Pandharpur	**Significant ↓ (-0.1080)**	Non-significant ↑ (0.0021)	Non-significant ↑ (0.0211)
Sangola	**Significant ↓ (-0.1238)**	**Significant ↓ (-0.0003)**	Non-significant ↑ (0.0229)
South Solapur	**Significant ↓ (-0.0094)**	Non-significant ↓ (-0.0054)	Non-significant ↑ (0.0155)

1. **Akkalkottehsil**

   The trend analysis for Akkalkottehsil over the period from 1982 to 2023, as indicated in Figure 4.1.1.1 (a), reveals a substantial raisein annual rainfall at a rate of 0.820. Over this period, the annual maximum temperature experienced a slight decrease of -0.0061, whereas the annual minimum temperature saw a modest increase of 0.0154.

2. **Barshitehsil**

   The results for rainfall depicted indicate that weather parameters exhibit non-significant decreases at rates of -0.243and maximum temperature trend decreases non-significantly at a rate -0.0047, over the last 42 years. Furthermore, the long-term data for Barshi tehsil indicate a moderate upward trend in the annual minimum temperature, with an increase rate of 0.0195 over the same period.

3. **Karmala tehsil**

   A close examination indicates that the trend of annual rainfall in Karmala tehsil shows a non-significant increase at a rate of 0.0703. In contrast, annual maximum temperature exhibit non-substantialfall in driftat rate -0.0021 and minimum temperature shows non-substantialraise in drift at a rate 0.0226, during the period from 1982 to 2023.

4. **Madhatehsil**

   The analysis of long-term data for Madha tehsil indicates a moderate upward trend in both annual rainfall and annual minimum temperature, with rates of 0.2443 and 0.0195, respectively, from 1982 to 2023. Conversely, the annual maximum temperature shows a slight downward trend of -0.0062 over the same period. These observations contribute to a deeper understanding of regional climate patterns.

5. **Malshiras tehsil**

   The results of the trend analysis for the period from 1982 to 2023 indicate a significant increase in annual rainfall for Malshiras tehsil, recorded at a rate of 6.4588. Over the last 42 years, the trends for annual maximum and minimum temperatures show non-significant decreases and increases at a rate of -0.0034 and 0.0204, respectively. These findings contribute to the understanding of climatic changes in the region.

6. **Mangalwedha tehsil**

   The trend analysis of long-term data from 1982 to 2023 indicates that annual rainfall in Mangalwedha tehsil has non-significantly decreased at a rate of -0.1199. In contrast, both annual maximum and minimum temperatures show non-significant increases of 0.0103 and 0.0264, respectively.

7. **Mohol tehsil**

   Significant decreasing trend in annual rainfall for Mohol tehsil, with a rate of -0.0123 has been observed. In contrast, the trends for both annual maximum and minimum temperatures exhibit non-significant increases of 0.0023 and 0.0185, respectively, during the period from 1982 to 2023.

8. **North Solapur tehsil**

   The trend analysis based on long-term rainfall and temperature data for North Solapur tehsil from 1982 to 2023. The findings reveal a notable decline in annual rainfall and maximum temperature, with rates of -0.0143 and -0.0005, respectively. Meanwhile, the annual minimum temperature exhibits a modest upward trend of 0.0197.

9. **Pandharpur tehsil**

   The trend analysis for Pandharpur tehsil reveals a notable decline in annual rainfall at a rate of -0.1080 from 1982 to 2023. Conversely, both the annual maximum and minimum temperatures show slight upward trends of 0.0021 and 0.0211, respectively. These findings highlight the contrasting patterns in rainfall and temperature changes in the region.

10. **Sangola tehsil**

    It has been observed that the significant fall trend in annual rainfall and maximum temperature for Sangola tehsil at a rate of -0.1238 and -0.0003, respectively. Conversely, the trends for annual minimum temperatures show non-significant increases of 0.0229, over the last 42 years.

11. **South Solapur tehsil**

    The findings for South Solapur tehsil reveal a notable decline in annual rainfall at a rate of -0.0094. Meanwhile, the annual maximum temperature exhibits a slight downward trend of -0.0054, although this change is not pronounced. Conversely, the annual minimum temperature shows a modest upward trend of 0.0155 over the period from 1982 to 2023.

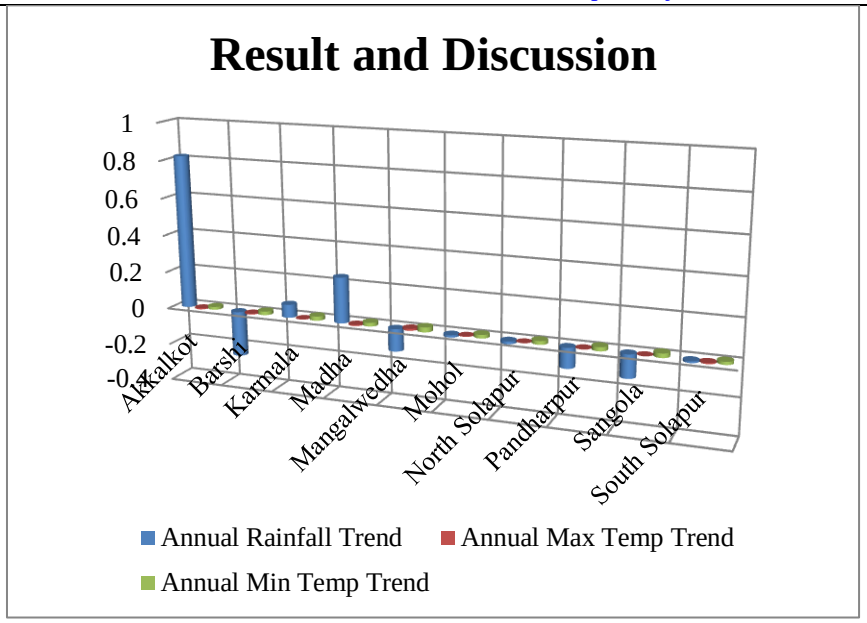


Figure 1: Summary of Result and discussion

Conclusion and recommendations:

The climatic trend analysis across various tehsils from 1982 to 2023 reveals important variations in rainfall and temperature patterns. Significant changes were observed in both annual rainfall and temperature, which indicate regional climate shifts. Akkalkot and Malshiras tehsils experienced a notable increase in annual rainfall, with rates of 0.820 and 6.4588, respectively, highlighting potential shifts in precipitation patterns. On the other hand, tehsils such as Mohol, North Solapur, and Pandharpur saw significant decreases in rainfall over the study period, with the rates ranging from -0.0123 to -0.1080. These declining trends in rainfall could impact agricultural and water resources in these regions.

Regarding temperature trends, most tehsils experienced non-significant increases in minimum temperatures, with only minor fluctuations in maximum temperatures. This increase in minimum temperatures, although non-significant, points to regional warming, which may have implications for local ecosystems and agriculture. In contrast, the maximum temperature showed slight, non-significant decreases in several tehsils, such as North Solapur, Sangola, and South Solapur. In conclusion, the results demonstrate a mixed trend of increasing minimum temperatures across most tehsils and fluctuating rainfall patterns. These trends, particularly in rainfall, suggest that some regions may face challenges due to water scarcity, while rising minimum temperatures could affect local agricultural practices. Further investigation is necessary to uncover the underlying factors driving these trends and to evaluate their long-term effects on the region's capacity to withstand climate-related challenges.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References:

1. Dash, S.K., Jenamani, R.K., Kalsi, S.R. and Panda, S.K. (2007). Some evidence of climate change in twentieth century India. Clim. Chang., 85: 299– 321.
2. Dash, S. K. and Hund, J. C. R. (2007). Variability of climate change in India. Current Science, 93(6): 782-788.
3. Intergovernmental Panel on Climate Change (2021). Climate Change: The Physical Science Basis; Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Pp. 134-136.
4. IPCC (2018). Summary for Policy makers. In: Global Warming of 1.5°C. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. MoufoumaOkia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (Eds.)], World Meteorological Organization, Geneva, Switzerland, 32 pp.
5. Jain, S.K. and Kumar, V. (2012). Trend analysis of rainfall and temperature data for India. Curr. Sci., 102 (1):37-49.
6. Jaswal, A.K., Rao, P.C.S and Singh, V. (2015). Climatology and trends of summer high temperature days in India during 1969-2013. J. Earth Sys. Sci., 124: 1-15.
7. Kendall, M.G. (1975). Rank Correlation Methods, 4th edition. Charles Griffin, London, U. K.

8. Mann, H.B. (1945). Nonparametric tests against trend. Econometrica, 13: 245–259.
9. Subash, N., Sikka, A.K. and Mohan, H.R. (2011). An investigation into observational characteristics of rainfall and temperature in Central Northeast India – a historical perspective 1889–2008. Theor. Appl. Climatol., 103(3):305-319.