Spatiotemporal Variation Characteristics of Precipitation in the Tomur Peak National Nature Reserve from 1967 to 2018: Postprint

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Abstract

This study utilized precipitation data from six meteorological stations surrounding the Tomur Peak National Nature Reserve during 1967–2018, conducting linear regression analysis and significance testing on precipitation amount, number of precipitation days, and precipitation intensity. The Mann-Kendall abrupt change test was applied to perform change-point analysis on precipitation amount to identify years when precipitation changes occurred. The results show: 1 The multi-year precipitation amount, number of precipitation days, and precipitation intensity in the Tomur Peak National Nature Reserve all exhibit a fluctuating increasing trend. Annual precipitation amount, number of precipitation days, and precipitation intensity all pass the significance level (=0.05) test. The seasonal variation of precipitation in the Tomur Peak National Nature Reserve is pronounced, with precipitation mainly concentrated in summer and the increase in precipitation mainly concentrated in summer and autumn. Precipitation in each season shows a fluctuating increasing trend. Through significance testing of the increasing trends of seasonal precipitation amount and precipitation intensity, it was found that at the 0.05 level, the increasing trend of precipitation amount in spring, summer, and autumn is significant, while the increasing trend of precipitation intensity in winter is significant. Through abrupt change analysis of annual precipitation amount, the change point was identified as 1997, which passed the significance level (=0.05) test.

Full Text

1. Precipitation Trend Analysis

The annual precipitation, precipitation days, and precipitation intensity in Tomur Peak Nature Reserve all exhibit fluctuating trends. The annual precipitation trend is 7.79 mm · (10a) ^{1}, which passes the significance test at =0.05. Precipitation is predominantly concentrated in summer, and the humidification trend is mainly concentrated in summer and autumn. Seasonal precipitation shows an increasing trend with fluctuations.

Summer Season: Precipitation days average 32.43 days, with a maximum of 44.50 days (in 2005) and a minimum of 17.67 days (in 1984), and an average intensity of 26.83 days. Precipitation intensity averages 3.37 mm · d ^{1}, with a maximum of 4.38 mm · d ^{1} (in 1998), a minimum of 2.21 mm · d ^{1} (in 1990), and an overall average of 2.17 mm · d ^{1}. The decadal trend of precipitation intensity is 0.08 mm · d ^{1} · (10a) ^{1}, which is significant at the =0.05 level.

[FIGURE 6] Change trend of summer precipitation in Tomur Peak Nature Reserve
[FIGURE 8] Change trend of autumn precipitation in Tomur Peak Nature Reserve

Autumn Season: The precipitation trend is 4.30 mm · (10a) ^{1}, significant at =0.05. Precipitation days average 14.63 days, with a maximum of 21.67 days (in 2010), a minimum of 8.50 days (in 1997), and an average intensity of 13.17 days. Precipitation intensity averages 2.78 mm · d ^{1}, with a maximum of 4.59 mm · d ^{1} (in 2001), a minimum of 1.71 mm · d ^{1} (in 1969), and an overall average of 2.88 mm · d ^{1}. The decadal trend is 0.08 mm · d ^{1} · (10a) ^{1}, significant at =0.05.

[FIGURE 9] Change trend of autumn precipitation intensity in Tomur Peak Nature Reserve

Winter Season: Precipitation averages 11.85 mm, with a coefficient of variation of 5.33%. The maximum is 22.82 mm (in 1994), the minimum is 3.60 mm (in 1996), and the range is 19.22 mm.

[FIGURE 10] Change trend of winter precipitation in Tomur Peak Nature Reserve
[FIGURE 11] Change trend of winter precipitation intensity in Tomur Peak Nature Reserve

Spring Season: The precipitation trend is 0.77 mm · (10a) ^{1}, which is not significant at =0.05. Precipitation days average 12.12 days, with a maximum of 22.00 days (in 2005), a minimum of 5.00 days (in 1996), and an average of 17.00 days. Precipitation intensity averages 0.98 mm · d ^{1}, with a maximum of 1.84 mm · d ^{1} (in 2015), a minimum of 0.56 mm · d ^{1} (in 1967), and an overall average of 1.28 mm · d ^{1}. The decadal trend is 0.07 mm · d ^{1} · (10a) ^{1}, which is not significant.

The decadal trends are: precipitation 2.37 mm · (10a) ^{1}, 7.79 mm · (10a) ^{1}, 4.30 mm · (10a) ^{1}, and 0.77 mm · (10a) ^{1} for spring, summer, autumn, and winter respectively. The precipitation intensity trends are 0.09 mm · d ^{1} · (10a) ^{1}, 0.08 mm · d ^{1} · (10a) ^{1}, and 0.07 mm · d ^{1} · (10a) ^{1} for summer, autumn, and winter respectively. Significance tests show that spring, summer, and autumn precipitation trends are significant at the 0.05 level, while the winter precipitation intensity trend is also significant.

3.3 Mann-Kendall Abrupt Change Analysis

The Mann-Kendall test reveals that an abrupt change in annual precipitation occurred in 1997. The UF and UB statistics ([FIGURE 12]) show that before 1997, UF < 0, indicating a decreasing trend; after 1997, UF > 0, indicating an increasing trend. The intersection point in 2002 exceeds the critical value of 1.96 (=0.05), indicating a significant upward mutation.

[FIGURE 12] Abrupt change of annual precipitation in Tomur Peak Nature Reserve

4. Discussion

Over the 52-year study period (1967–2018), precipitation, precipitation days, and precipitation intensity all show increasing trends. The decadal rates are 15.29 mm · (10a) ^{1} for precipitation, 2.91 d · (10a) ^{1} for precipitation days, and 0.09 mm · d ^{1} · (10a) ^{1} for precipitation intensity, all statistically significant at =0.05.

The seasonal contributions to the annual precipitation increase are: summer 26.64%, autumn 49.34%, spring 18.69%, and winter 5.33%. Summer shows the highest contribution, followed by autumn, indicating that precipitation increases are primarily driven by summer and autumn seasons.

5. Conclusions

(1) From 1967 to 2018, the annual precipitation, precipitation days, and precipitation intensity in Tomur Peak Nature Reserve show fluctuating but statistically significant increasing trends at the =0.05 level, with decadal rates of 15.29 mm · (10a) ^{1}, 2.91 d · (10a) ^{1}, and 0.09 mm · d ^{1} · (10a) ^{1}, respectively.

(2) Seasonal variation is pronounced, with precipitation concentrated in summer and humidification effects mainly in summer and autumn. All seasonal precipitation shows increasing trends, with spring, summer, and autumn precipitation increases being statistically significant at =0.05, and winter precipitation intensity also showing a significant increase.

(3) An abrupt change in annual precipitation occurred in 1997, as confirmed by Mann-Kendall mutation analysis at the =0.05 significance level.

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Note: Figure translations are in progress. See original paper for figures.