Regular Article
pISSN: 2288-9744, eISSN: 2288-9752
Journal of Forest and Environmental Science
Vol. 38, No. 4, pp. 219-228, December, 2022
https://doi.org/10.7747/JFES.2022.38.4.219

JFES
Journal of Forest and Environmental Science

Analysis of the Relationship between the Number of Forest Fires and Non-Rainfall Days during the 30-year in South Korea

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Abstract

This study examined the relationship between the number of forest fires and days with no rainfall based on the national forest fire statistics data of the Korea Forest Service and meteorological data from the Open MET Data Portal of the Korea Meteorological Administration (KMA; data.kma.go.kr) for the last 30 years (1991-2021). As for the trend in precipitation amount and non-rainfall days, the rainfall and the days with rainfall decreased in 2010 compared to those in 1990s. In terms of the number of forest fires that occurred in February－May accounted for 75% of the total number of forest fires, followed by 29% in April and 25% in March. In 2000s, the total number of forest fires was 5,226, indicating the highest forest fire activity. To analyze the relationship between regional distribution of non-rainfall periods (days) and number of forest fires, the non-rainfall period was categorized into five groups (0 days, 1-10 days, 11-20 days, 21-30 days, and 31 days or longer). During the spring fire danger season, the number of forest fires was the largest when the non-rainfall period was 11-20 days; during the autumn fire precaution period, the number of forest fires was the largest when the non-rainfall period was 1-10 days, 11-20 days, and 21-30 days, showing differences in the duration of forest fire occurrence by region. The 30-year trend indicated that large forest fires occurred only between February and May, and in terms of the relationship with the non-rainfall period groups, large fires occurred when the non-rainfall period was 1-10 days. This signifies that in spring season, the dry period continued throughout the country, indicating that even a short duration of consecutive non-rainfall days poses a high risk of large forest fires.

Key Words: forest fire statistics, precipitation, non-rainfall, forest fire danger season, large forest fire

Introduction

In recent years, Europe has been continuously afflicted by severe drought, heatwaves, and persistent dry spells, and the entire continent is affected by a series of extreme weather events. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2021), a 1.5°C increase in global temperature will increase the occurrence of natural disasters, such as extreme high temperatures, heavy rainfall, and drought, and the effects of climate change will only worsen according to the rate and scale of global warming. Furthermore, a temperature rise of 2°C or more will lead to an increased frequency and severity of agricultural and vegetation droughts in many regions of Africa, South America, and Europe, and it is predicted that these regions will suffer from a decrease in average precip-

Received: October 11, 2022. Revised: October 18, 2022. Accepted: October 19, 2022.

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itation, increasing dry climate, as well as an increase in regions prone to wildfires (IPCC 2021). Climate change caused by global warming affects all areas of humanity and the global environment, and this impact is expected to be widespread in various fields in the future (Chae et al. 2012a). It affects meteorological drought as a precipitation decreases or the evapotranspiration amount increases with climate change, and the continuation of meteorological drought decreases a soil water content that ends up affecting the growth of animals and plants such as the reduction in crop production, thereby causing an agricultural drought (Chae et al. 2012b). Over the last three decades, global temperatures have risen by approximately 0.2°C per decade, and climate change induced phenomena, such as more severe and extensive droughts and sea surface temperature variations caused by regional droughts, are expected to influence global wildfire variations and increase forest fire danger season severity over the coming decades (Jolly et al. 2015). In the case of the 2019/2020 Australian bushfires, the massive geographic scale of Australia and the anomalous drought coupled with strong, hot, and dry westerly winds in the region helped prolong the devastating fire weather throughout the forest fire danger season (Bowman et al. 2021). To predict global warming-induced forest fires in the future, research investigating the effects of temperature and precipitation on forest fire activity is required. With the increasing severity of droughts in some areas of the western US forests, annual fluctuations in temperature and precipitation showed strong relationships with the area burned. Droughts have been associated with years having anomalously high burned area (Keeley et al. 2016). A previous study that explored the relationship between forest fires and precipitation variability in temperate forests of the eastern United States confirmed that precipitation variability greatly influenced forestfire activity throughout the eastern United States other than that in the forest region. Another study reported that with increasing precipitation, fire occurrence showed a significant decrease in Serbia, Europe (Lafon et al. 2012; Živanović et al. 2020). In the recent, Forest fires occur frequently by climate change as continuing drought, drying weather condition (Jeon et al. 2016). An analysis of the meteorological data of the Gangwon Province, South Korea from 2002 to 2006 revealed that 68% of all forest fires in the province occurred during the spring forest fire danger season. High temperatures and little precipitation in spring served as weather conditions with a high risk of forest fire occurrence (Park et al. 2009). Annual precipitation showed a significant correlation with the frequency of forest fires and fire-burnt land area. In addition, surface dryness increased due to an overall decrease in the number of days with rainfall and an increase in the interval between rainfall events, which leads to an increase in the probability of forest fire occurrence (Choi et al. 2020). Another study reported that a decrease in winter snowfall and an increase in spring drought, caused by global warming, increased the risk of forest fires (Sung et al. 2010). In previous studies, there were many analyses of weather factors and forest fire statistics, but research on non-rainfall and forest fire statistics was not conducted. In the previous research, there were studies on weather factors and forest fire statistics, but there were no studies on the number of days without non-rainfall and forest fire statistics. Therefore, in this study, based on the meteorological data of South Korea over a period of 30 years from 1991 to 2021, the non-rainfall period (days) was derived in order to: 1) analyze the relationship between forest fire statistics and non-rainfall periods, and 2) understand the patterns of regional forest fire occurrence and the range of non-rainfall periods. Based on the findings of this study, we aim to provide useful data for the prevention and management of forest fires in South Korea.

Materials and Methods

In this study, the effect of the non-rainfall period on forest fires was examined using the forest fire statistics of the Korea Forest Service and KMA's precipitation data. Data from January 1, 1991 to December 31, 2021 were used, and based on the KMA data, regional patterns were comparatively analyzed by dividing the study area into the following 10 regions: Seoul/Gyeonggi, Gangwon (Yeongdong/Yeongseo), Chungbuk, Chungnam, Gyeongbuk, Gyeongnam, Jeonbuk, Jeonnam, and Jeju.

Regional precipitation data from 66 weather stations for the period from 1991 to 2021 were used; data were obtained from the Open MET Data Portal of the Korea Meteorological Administration (KMA) (data.kma.go.kr). The mean and total daily precipitation data were used as the

rainfall data in this study.

To calculate the non-rainfall period (days) using the weather data obtained through KMA, days with daily total precipitation less than 1.00 mm were set as non-rainfall days (The Climate Atlas of Korea 2021). Based on daily records of non-rainfall days, consecutive non-rainfall days were counted for calculation, and the length of the non-rainfall period was classified into groups.

The non-rainfall period was categorized into five groups as follows: 0 days, 1-10 days, 11-20 days, 21-30 days, and 31 days or longer. In setting the classification of drought severity according to the drought level category in South Korea, as the drought level is divided for every 10 days of the non-rainfall period, the classification of the non-rainfall period was determined by dividing into the data into five groups (Park 2005).

With respect to the national forest fire statistics, the data analysis was performed by classifying the data into: 1) the entire period from 1991 to 2021, 2) spring forest fire danger season (from February 1st to May 15th) during the study period, and 3) autumn forest fire precaution period (from November 1st to December 15th) during the study

Table 1. Yearly trend in the number of forest fires, mean non-rainfall period (days), and total rainfall for the last 30 years

Year	No. of forest fires	Non-rainfall period (days)	Total rainfall (mm)
1991	139	2.52	1,297.70
1992	180	1.81	1,069.60
1993	278	2.60	1,363.80
1994	433	2.72	900.10
1995	630	2.79	1,037.50
1996	527	2.51	1,049.70
1997	524	3.73	1,328.30
1998	265	2.12	1,722.20
1999	315	2.56	1,610.20
2000	729	2.67	1,271.10
2001	785	2.90	977.60
2002	599	1.89	1,454.40
2003	271	2.23	1,848.30
2004	544	2.84	1,444.20
2005	516	3.01	1,268.30
2006	405	3.14	1,410.70
2007	418	2.39	1,432.40
2008	389	3.21	972.10
2009	570	3.07	1,182.80
2010	282	1.94	1,429.70
2011	277	3.06	1,609.30
2012	197	2.12	1,461.90
2013	296	2.47	1,145.80
2014	492	1.91	1,161.00
2015	623	2.37	932.70
2016	391	2.06	1,257.30
2017	692	2.27	954.50
2018	496	2.81	1,374.50
2019	649	3.42	1,159.40
2020	620	3.35	1,612.30
2021	347	2.44	1,230.30
Standard error	31.02	0.09	43.85
Mean	448	2.61	1,289.35

period. The KMA precipitation data corresponding to the same period as that of the national forest fire statistics data were collected, and the days with precipitation and days with no rainfall were divided to analyze the number of forest fires and non-rainfall period.

The non-rainfall period (days) was divided into five groups and a one-way analysis of variance (ANOVA) was performed using the data on the number of forest fires in each region using SPSS (SPSS Statistics ver. 26) to determine whether the difference between the 10 regions was statistically significant. Subsequently, the Scheffe test was performed as a post-hoc test to determine the significance of the difference by region for the five groups.

Results and Discussion

Analyzing the trend in the non-rainfall period (days) in South Korea

Based on the precipitation data from 1991 to 2021, the 30-year average rainfall was 3.53 mm, and the mean non-rainfall period was 2.61 days. In 1990s, the mean rainfall was 3.46 mm, and the mean non-rainfall period was 2.60 days; in 2000s, the mean rainfall was 3.63 mm, and the mean non-rainfall period was 2.73 days; in 2010s, the mean rainfall was 3.42 mm, and the mean non-rainfall period was 2.44 days. Among the annual mean values of the non-rainfall period, the mean non-rainfall period was the longest in 1997, 2019, and 2020 at 3.73 days, 3.42 days, and 3.35 days, respectively. The total non-rainfall period was the longest in 2008, 1997, and 2009 at 32 days, 26 days, and 26 days, respectively (Table 1). With respect to the forest fire season, the longest mean non-rainfall period occurred during the spring forest fire precaution period (2/1-5/15) in 2000 at 9.42 days and 39 consecutive non-rainfall days were recorded in 2000, which was the longest period recorded. With respect to the autumn forest fire precaution period (11/1-12/15), 2020 had the longest mean non-rainfall period at 7.82 days and, and a total of 20 consecutive non-rainfall days in 1999 and in 2020s (Fig. 1). In early spring, because the climate of South Korea tends to show an increase in temperature, decrease in relative humidity, and decrease in rainfall and number of days with rainfall, the mean non-rainfall period and the maximum non-rainfall period tend to be longer in spring forest fire danger season compared to that on other seasons of the year (Sung et al. 2010)

Analyzing the trend in the number of forest fires in South Korea

The total number of forest fires over 30 years from 1991 to 2021 was 13,879, and the total number of forest fires was 3,291 in the 1990s, 5,226 in the 2000s, and 4,395 in the 2010s. The highest number of forest fires recorded was 785 in 2001, followed by 729 in 2000, and 692 in 2017, accounting for 15.9% of the total forest fire events. The mean number of forest fires by decade was 366 fires in the 1990s, 523 in the 2000s, and 440 in the 2010s (Fig. 2).

In the spring forest fire danger season (forest fire precaution period), the total number of forest fires from February to May for the analysis period of 1991-2021 was 10,409, accounting for 75% of the total number of forest fires. During this period, the number of forest fires in April was the highest with 4,004 fires, accounting for 29% of the total, followed by 3,484 fires (25%) in March. The forest fires mostly occurred in March and April of the spring sea-

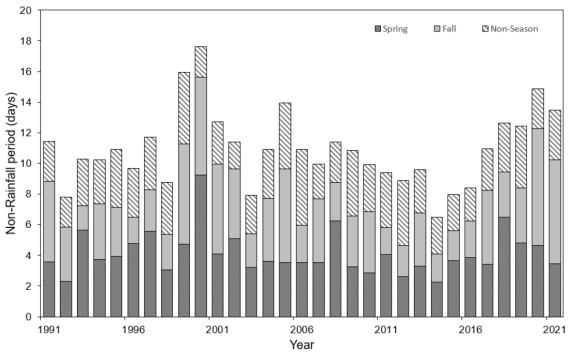

Fig. 1. Seasonal trend in the variation in the mean non-rainfall period (days) over the last 30 years.

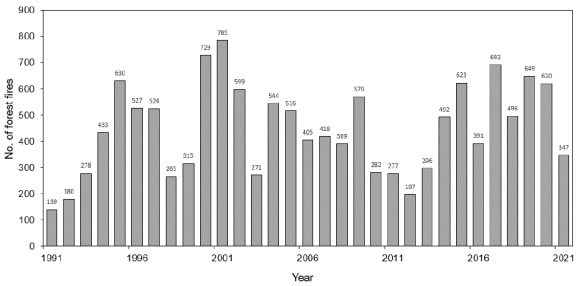

Fig. 2. Trend in the number of forest fires over the last 30 years in South Korea.

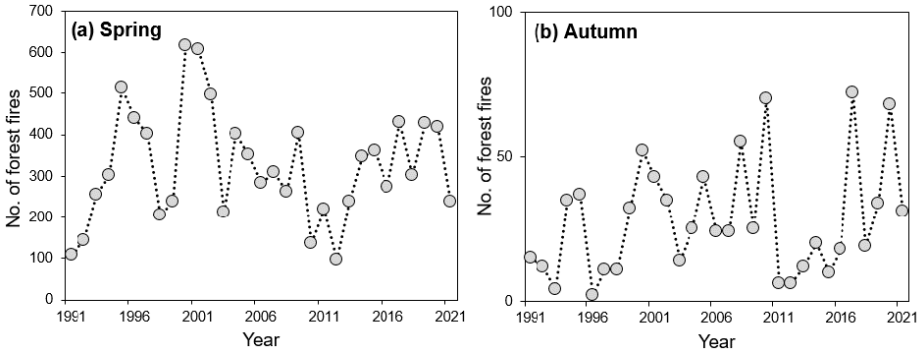

Fig. 3. Comparison of patterns in the number of forest fires in the spring & autumn fire seasons (fire precaution period) over the last 30 years

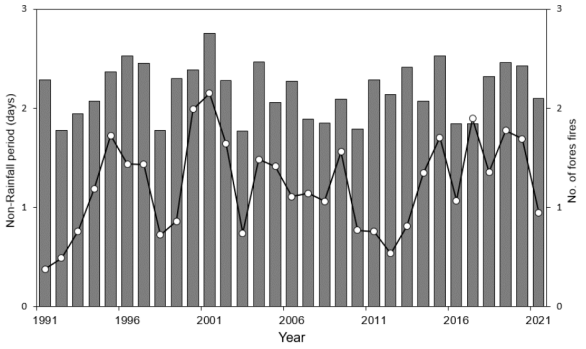

Fig. 4. The 30-year trend in the non-rainfall period (days) and number of forest fires.

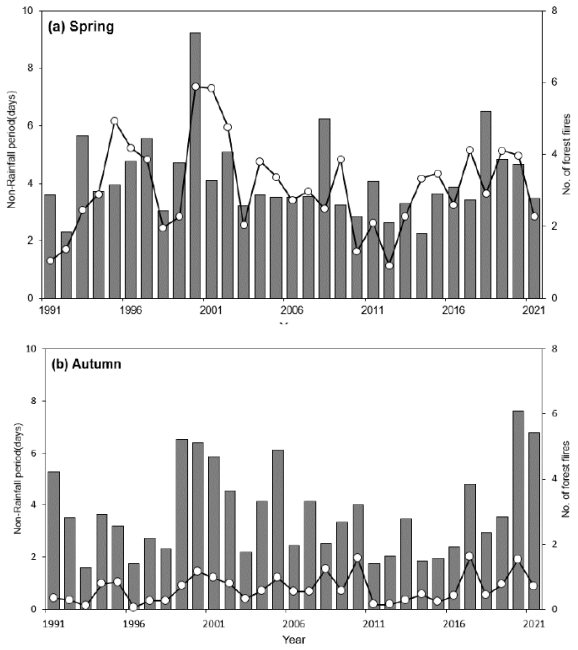

Fig. 5. The 30-year trend in the number of forest fires and non-rainfall period (days) for the spring and autumn forest fire danger seasons (fire precaution period).

son; for the autumn forest fire season, fires in November and December accounted for 9% of the total, indicating the most frequent occurrence of forest fires after the spring season. The number of forest fires in November was 589, accounting for 4.2% of the total, and that in December was 654 (4.7%) (Fig. 3). In the spring season, the temperature rise causes dry atmospheric conditions and during this period, a forest floor with dry leaf litter is formed; combined with low daily mean relative humidity and deficiency in daily mean precipitation, forest fires occur most frequently in spring (Jeon et al. 2017; Forest Disasters Report 2021).

Analyzing the trend in the non-rainfall period and number of forest fires in South Korea

Based on the 30-year trend of the mean number of forest fires and the mean non-rainfall period, the mean number of forest fires was 1.23 and the mean non-rainfall period was 2.61 days. In the 1990s, the mean number of forest fires was 0.96, and the mean non-rainfall period was 1.83 days; in the 2000s, the mean number of forest fires was 1.09 with a mean non-rainfall period of 2.17 days; in the 2010s, the mean number of forest fires was 1.49 with a mean non-rainfall period of 2.41 days. In 2001, the number of forest fires and the non-rainfall period were the highest, with 2.15 fires and 2.76 days without rainfall. Based on the yearly trend, the years with decreased rainfall showed long non-rainfall period (Fig. 4). Comparing the number of forest fires and non-rainfall period in spring and autumn revealed that, for the spring forest fire danger season (forest fire precaution period), year 2000 had the longest non-rainfall period and

the largest number of forest fires with the mean non-rainfall period of 9.24 days and the mean number of forest fires at 5.90. For the autumn forest fire danger season, the mean non-rainfall period was longest in 2020 with 7.62 days, followed by 6.78 days in 2021, and 6.53 days in 1999. The mean number of forest fires was the highest in 2017 with 1.60 fires, followed by 1.56 fires in 2010 and 1.51 fires in 2020 (Fig. 5). A decrease in rainfall and the number of days with rainfall is also increases the risk of forestfires; however, the analysis of meteorological data show that the number of days with rainfall and amount of precipitation exhibit a decreasing trend (White Paper on the East Coast forestfires in Gangwon-do 2019). In addition, a longer non-rainfall period indicates an increasing risk of large forest fires (Kong et al. 2017).

Non-rainfall period class

To examine the relationship between the non-rainfall period and the number of forest fires by group in individual regions, the non-rainfall period was divided into 5 groups of 0 days, 1-10 days, 11-20 days, 21-30 days, and ≥31 days. To define the drought severity level in South Korea, the levels are divided for every 10 days of the non-rainfall period; the non-rainfall period groups were also divided by 10 days in line with the drought severity classification criteria (Park 2005). Based on the KMA data, 10 regional divisions were classified follows: (a) Seoul/Gyeonggi, (b) Gangwon (Yeongdong), (c) Gangwon (Yeongseo), (d) Chungbuk, (e) Chungnam, (f) Gyeongbuk, (g) Gyeongnam, (h) Jeonbuk, (i) Jeonnam, and (j) Jeju. The regions (a) Seoul/Gyeonggi and (e) Chungnam showed a correlation in three groups, 11-20 days, 21-30 days, and ≥31 days. In particular, the number of forest fires was the highest in the group with a non-rainfall period of 21-30 days. (No correlation was observed for the (c) Gangwon (Yeongseo) and (g) Gyeongnam regions for each group of the non-rainfall period; However, an overall trend was observed wherein the number of forest fires increased with the length of the non-rainfall period.

In (f) Gyeongbuk, the number of forest fires gradually increased from the non-rainfall period group of 11-20 days and the forest fires occurred most frequently when the non-rainfall period continued for 31 days or longer.

In (h) Jeonbuk, the number of forest fires was high in the non-rainfall period groups of 11-20 days and 21-30 days.

In (i) Jeonnam, forest fires occurred the most in the non-rainfall period group of 21-30 days. In (d) Chungbuk, no correlation was observed for each group of non-rainfall

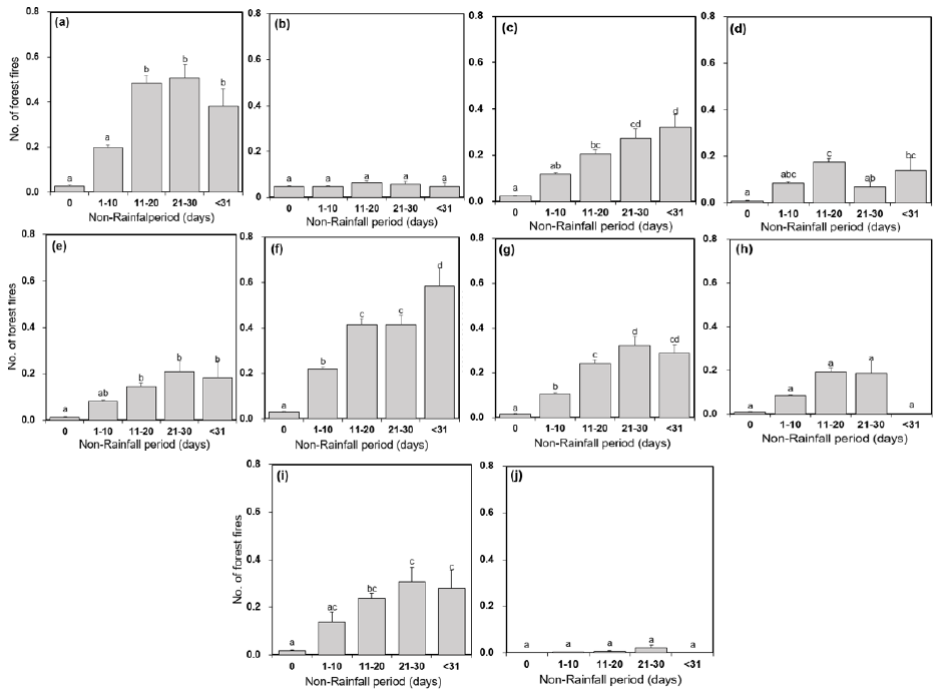

Fig. 6. Comparative analysis of the number of forest fires by region with respect to the non-rainfall period class over the last 30 years (Total study period) Regions: (a) Seoul/Gyeonggi, (b) Gangwon (Yeongdong), (c) Gangwon (Yeongseo), (d) Chungbuk, (e) Chungnam, (f) Gyeongbuk, (g) Gyeongnam, (h) Jeonbuk, (i) Jeonnam, and (j) Jeju

period; however, the number of forest fires was the highest in the non-rainfall period group of 11-20 days. Both (b) Gangwon (Yeongdong) and (j) Jeju showed a correlation between the non-rainfall period and the number of forest fires in all five groups (Fig. 6).

Analyzing the relationship with the number of forest fires by the non-rainfall period group for each region during the spring and autumn spring forest fire danger season (forest fire precaution period) revealed that, for the spring forest fire danger season, the number of forest fires was high in the non-rainfall period group of 11-20 days in the regions (a) Seoul/Gyeonggi, (b) Gangwon Yeongdong, (d) Chungbuk, (e) Gyeongbuk, (h) Jeonbuk, (i) Jeonnam, and (j) Jeju. In (c) Gangwon Yeongseo and (f) Gyeongnam, forest fires occurred the most in the non-rainfall period group of 21-30 days; in (g) Chungnam, the number of forest fires was high in the non-rainfall period group of 1-10 days. As for the autumn forest fire danger season, the number of forest fires was high in the non-rainfall period group of 1-10 days in the regions of (b) Gangwon Yeongdong, (h) Jeonbuk; 11-20 days in the regions of (d) Chungbuk, (e) Gyeongbuk, (f) Gyeongnam, and (g) Chungnam; 21-30 days in the regions of (a) Seoul/Gyeonggi (c) Gangwon Yeongseo. In (j) Jeju, the mean number of forest fires was 0. For each region, during the spring forest fire dnager season, the number of forest fires was large from the non-rainfall period group of 11-20 days, indicating that when days with no rainfall continued for 10 days or longer, it affected the occurrence of forest fires. As for the autumn forest fire danger season, the days of risk of forest fire occurrence differed by region in three groups of non-rainfall period: 1-10 days, 11-20 days and 21-30 days (Fig. 7).

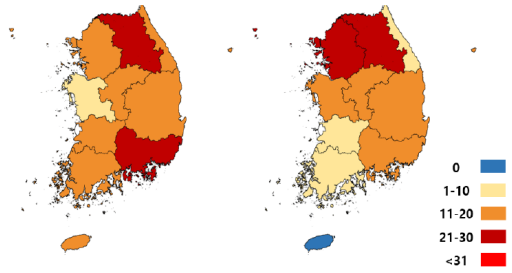

Fig. 7. Illustration of number of forest fires and non-rainfall period classes by region over the last 30 years (for forest fire danger period in spring (left) and autumn (right)).

Large forest fires and non-rainfall period class

In Article 25 of the Enforcement Decree of the Forest Protection Act, which was implemented on January 15, 2012, large forest fires are defined as those spreading to an area of at least 100 ha or forest fires that persists for at least 24 hours, and forest fires not classified into this category are defined as small-or medium-scale forest fires (Enforcement Decree of the Forest Protection Act 2012). Analyzing the relationship between large forest fires affecting over 100 ha and the non-rainfall period from 1991 to 2021 showed that the months with occurrence of large forest fires during the 30-year period were February, March, April, and May, indicating that large forest fires only occurred in the spring forest fire danger season (Table 2). The total number of forest fires was 55 and the total affected area was 45,758.54 ha.

The total number of large forest fires and the affected area by decade were as follows: 11 fires over 5,868.89 ha in the 1990s, 26 fires over 31320.73 ha in the 2000s, and 13 fires over 5,563.72 ha in the 2010s. The Gangwon Yeongdong had 27 fires over 3,5325.2 ha, and the mean non-rainfall period was 3.63 days, and Gangwon Yeongseo had 6 fires over 1,311.39 ha, and the mean non-rainfall period was 4.33 days. In Gyeongbuk, the total number of forest fires was 13 with the total affected area of 4,365.3 ha and the mean non-rainfall period of 5.08 days; in Jeonbuk, there

Table 2. Analysis of the number of large forest fires, mean non-rainfall period and affected area for the last 30 years

Month	No. of forest fires	Non-rainfall period (days)	Affected area (ha)
February	3	3.33	580
March	13	2.38	3,400
April	36	3.94	40,638
May	3	12.00	1,140
Mean	14	5.42	11,440

were 3 fires over 382.70 ha and 3.67 days of mean non-rainfall period; in Ulsan, there were 3 fires over 919 ha and 2.67 days of mean non-rainfall period; in Gyeongnam, there were 2 fires over 360 ha and 4.5 days of mean non-rainfall period; in Chungnam, there was 1 fire over 3095 ha and 1 day of mean non-rainfall period.

The number of forest fires by region was in the order of Gangwon Yeongdong > Gyeongbuk > Gangwon Yeongseo > Ulsan > Jeonbuk > Gyeongnam > Chungnam and the size of the affected area was in the order of Gangwon Yeongdong > Gyeongbuk > Chungnam > Gangwon Yeongseo > Ulsan > Jeonbuk > Gyeongnam. The mean non-rainfall period by region was 1-10 days. The most frequent occurrence of forest fires and the largest affected area in March and April was because of the forest fire weather index in the spring season. Since 1973, the southern regions of the Korean Peninsula showed a strong trend of hot and dry climate and the regions of Honam, Yeongnam, and Chungcheong showed little precipitation (Jeong et al. 2018). It is thought that the forest fires in the 2000s showed an increasing trend compared to that in the 1990s because of the decrease in humidity, rainfall, and the number of days with rainfall following the increase in the average temperature caused by global warming, and the carelessness in the agricultural activities in the Yeongnam and Honam regions and of the people visiting the mountains contributed to the increasing trend of forest fire occurrence (Won et al. 2011).

Conclusion

In this study, 30-year (1991-2021) data for the number of forest fires in South Korea and the non-rainfall period were obtained to analyze the effect of the non-rainfall period on the number of forest fire occurrences. The non-rainfall period was categorized into five groups and the number of forest fires was compared by region.

The 30-year average non-rainfall period was 2.61 days and the mean total rainfall was 129.31 mm. In 1990s, the mean rainfall was 3.46 mm, and the mean non-rainfall period was 2.60 days; in 2000s, the mean rainfall was 3.63mm, and the mean non-rainfall period was 2.73 days; in 2010s, the mean rainfall was 3.42 mm, and the mean non-rainfall period was 2.44 days. As for the spring forest fire danger season (forest fire precaution period) (2/1-5/15), year 200 was the year with the longest mean non-rainfall period at 9.42 days and there was a total of 39 consecutive rain-free days, recording the longest non-rainfall period in 2000. As for the autumn forest fire danger season (11/1-12/15), year 2020 was the year with the longest mean non-rainfall period at 7.82 days and there was a total of 20 consecutive rain-free days, recording the longest persistence of non-rainfall period in 2020, the same year as the year with the longest mean non-rainfall period. It is considered that since the climate of South Korea in spring is characterized by little rainfall in terms of frequency and amount, large evaporation and dry wind, the mean non-rainfall period and the days of maximum non-rainfall period were longer in the spring season compared to the autumn forest fire danger season (Lee 2006).

Analyzing the number of forest fires and the trend of changes over the last 30 years revealed that the total number of forest fires was 13,879 for the analysis period, and the year with the most occurrences of forest fires was 2001 with 785 fires. Forest fires that occurred during the spring forest fire danger season accounted for 75% of the total number of forest fires, those that occurred in April accounted for 29%, and those in March accounted for 25%. It is reasoned that the temperature rise and dry atmosphere in spring with little rainfall led to frequent occurrence of forest fires. As for the autumn forest fire danger season, forest fires occurred in November accounted for 4.2% and those in December accounted for 4.7%, showing that autumn forest fire danger season showed the most frequent occurrence of forest fires after the spring season.

The non-rainfall period was classified into 5 groups: 0 days, 1-10 days, 11-20 days, 21-30 days, and ≥31 days; analyzing the relationship between the number of forest fires and non-rainfall period by region indicated that, with respect to the total analysis period, the number of forest fires was large in groups of 11-20 days (4 regions), 21-30 days (7 regions), and ≥31 days (3 regions). As for the spring forest fire season, the number of forest fires was large in the non-rainfall period group of 11-20 days (7 regions) and for the autumn season, the number of forest fires was large in the non-rainfall period group of 11-20 days (4 regions).

Comparing different non-rainfall period groups, the months with occurrences of large forest fires were February,

March, April, and May, showing forest fire occurrences only in the spring forest fire danger season, and the mean non-rainfall period was 3.63 days. Analyzing the number of large forest fires according to the non-rainfall period class by region showed that the non-rainfall period group of 1-10 days showed a frequent occurrence of large forest fires in all regions. This indicates that in spring, the risk of forest fires is high even if the non-rainfall period is not long owing to meteorological conditions in spring, such as low humidity, dry weather, and wind. Through this research, it is expected that it will help to build forest fire hazard data for forest fire and the number of days without rain that match the characteristics of each region.

In this study, the correlation between days of non-rainfall period and number of forest fires, and the relationship between the non-rainfall period and number of forest fires by non-rainfall period group were analyzed in 10 regions of South Korea. Although the analysis was conducted only using the number of forest fires, rainfall, population, regional economic activity and non-rainfall period in this study, future studies should account for the regional causes of forest fire occurrence as well as rainfall and the non-rainfall period using meteorological factors of the affected area to achieve an in-depth understanding of the accurate relationship between the non-rainfall period and the occurrence of forest fires.

Acknowledgements

Development of Urban Forest Fire Response Techniques Caused by Strong Wind based on Big data. This research was supported by a grant (20010162) of Regional Customized Disaster-Safety R&D Program funded by Ministry of Interior and Safety (MOIS, Korea).

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