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EFFECT OF METEOROLOGICAL VARIABLES ON THE OCCURRENCE OF WILDFIRES IN JIPIJAPA, MANABÍ, ECUADOR

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Resumo

Efeito de variáveis meteorológicas na ocorrência de incêndios florestais em Jipijapa, Manabí, Equador. Variáveis meteorológicas são um dos fatores que afetam a ocorrência de incêndios florestais, portanto, compreender seu comportamento em nível local é de grande importância para o planejamento adequado das atividades de manejo do fogo. Este estudo teve como objetivo analisar o efeito de variáveis meteorológicas na ocorrência de incêndios florestais no cantão de Jipijapa, Manabí, Equador, durante o período de 2014 a 2023. A pesquisa utilizou um delineamento longitudinal, não experimental, com dados sobre a ocorrência de incêndios e variáveis meteorológicas de 2014 a 2023. Os dados de ocorrência de incêndios foram fornecidos pelo Corpo de Bombeiros de Jipijapa, e as variáveis climáticas foram obtidas do projeto POWER-NASA. Análises estatísticas não paramétricas (Kruskal-Wallis, Dunn e Spearman) foram aplicadas com o SPSS devido à não normalidade dos dados. A maioria dos incêndios florestais em Jipijapa concentrou-se entre agosto e dezembro, coincidindo com baixas temperaturas, umidade, precipitação e altas velocidades do vento. Durante esse período, exceto em dezembro, não houve precipitação diária superior a 10 mm. As diferenças mensais nas variáveis meteorológicas e na ocorrência de incêndios foram significativas. Houve correlações muito baixas entre incêndios e essas variáveis, sendo apenas a umidade relativa e a precipitação (negativas) significativas. No entanto, padrões sazonais relevantes foram identificados, como o fato de a baixa precipitação estar significativamente relacionada aos incêndios. Essas informações são essenciais para a implementação da Estratégia Nacional de Gestão Integrada do Fogo no Equador.
Palavras-chave: Estatísticas de incêndios, gestão do fogo, variáveis meteorológicas.

Abstract

Meteorological variables are among the factors that influence the occurrence of wildfires; therefore, understanding their local behavior is crucial for effective fire management planning. This study aimed to analyze the effect of meteorological variables on wildfire occurrence in the Jipijapa canton, Manabí, Ecuador, during the 2014–2023 period. The research employed a non-experimental longitudinal design using wildfire occurrence records and meteorological data from 2014 to 2023. Wildfire data were provided by the Jipijapa Fire Department, and climate variables were obtained from the POWER-NASA project. Non-parametric statistical analyses (Kruskal-Wallis, Dunn, and Spearman tests) were conducted using SPSS due to the non-normal data distribution. Most wildfires in Jipijapa occurred between August and December, coinciding with low temperature, humidity, and precipitation, and high wind speed. During this period—except for December—no daily precipitation events exceeded 10 mm. Monthly differences in meteorological variables and wildfire occurrence were statistically significant. Although correlations between wildfires and meteorological variables were generally very low, only relative humidity and precipitation showed significant (negative) relationships. Nonetheless, relevant seasonal patterns were identified, such as the significant association between low precipitation and wildfire occurrence. These findings are essential for implementing Ecuador's National Integrated Fire Management Strategy.
Keywords: Fire statistics, fire management, meteorological variables.

INTRODUCTION

Climate change is increasing drought and fire activity in many parts of the world (SPARKS *et al*., 2018), thereby altering wildfire patterns (WU *et al*., 2020). Future fire projections are likely to degrade key ecosystem services unless climate change is aggressively mitigated (SAYEDI *et al*., 2024).

Wildfires—uncontrolled fires that spread through various types of vegetation—arise and propagate due to factors such as a sufficient ignition source, the presence of fuel, topography, and weather conditions, the latter being the most variable. According to Sharples (2022), the influence of meteorological conditions on wildfire behavior and spread has been recognized through the development of various fire weather indices that combine information on air temperature, atmospheric humidity, wind speed, and other factors. Similarly, Soares *et al*. (2017) affirm that wildfire behavior is region-specific, as fire probability and frequency are closely linked to atmospheric conditions.

Wildfires have caused substantial environmental, social, and economic damage over the years (KOSSOSKI *et al*., 2024), leading to widespread vegetation mortality (OLIVO NETO; CARNIELLO, 2024), and adversely impacting the biological, chemical, and physical properties of forest soils (AGBESHIE *et al*., 2022), and increased input of pyrogenically modified components to the soil organic matter (DYMOV *et al*., 2023). Climate and fire are the primary drivers of plant species distribution (STROH *et al*., 2018).

Wildfires lead to forest degradation and increase greenhouse gas emissions, thereby disrupting climate systems, affecting ecosystems, and posing risks to human health. The recent surge in wildfire activity has drawn considerable public attention due to its profound impact on air quality and public health. Understanding the physical drivers of wildfires is essential not only for forecasting and managing wildfires but also for advancing climate science and assessing the socioeconomic impacts of fire (DONG *et al*., 2021).

To address this issue, various studies have established links between wildfire ignition and spread and meteorological variables. For instance, Torres *et al*. (2019) found strong correlations between certain fire behavior variables and environmental conditions. Likewise, Ramos *et al*. (2017) argue that understanding the relationship between meteorological variables and wildfires is vital for managing fire use, prevention, and suppression within economically viable, socially acceptable, and ecologically sound limits. Along these lines, Alves *et al*. (2021) emphasize that knowing the weather conditions most conducive to fire outbreaks and how to prevent them is as important as knowing how to extinguish them. Often, a small fire can escalate into a disaster.

Considering the above, this study aimed to analyze the effect of meteorological variables on the occurrence of forest fires in the canton of Jipijapa, Manabí, Ecuador, during the period 2014–2023. The investigation was based on the hypothesis that, similar to other regions, there is a significant relationship between the occurrence of forest fires and the seasonal distribution of meteorological variables in this locality.

MATERIALS AND METHODS

Study area characterization

The Jipijapa canton covers an area of 1,420 km² and is located in the southern part of the Manabí province, along Ecuador's coastal strip, between coordinates 80°24'24" and 80°51'10" W longitude and 1°11'45" and 1°44'42" S latitude. According to the political-administrative division, the area borders Montecristi and part of Santa Ana to the north, Puerto López to the south, 24 de Mayo and Paján to the east, and the Pacific Ocean to the west. Jipijapa has three urban parishes (San Lorenzo de Jipijapa, Manuel Inocencio Parrales y Guale, and Dr. Miguel Morán Lucio) and seven rural parishes (La América, El Anegado, Julcuy, Pedro Pablo Gómez, Puerto Cayo, Membrillal, and La Unión). The canton has three altitudinal levels. The first, ranging from 0 to 300 m, corresponds to the coastal strip; the second, from 300 to 500 m, with a very rugged topography of steep hills and steep slopes, corresponds to the coastal mountain range; and the third, where the altitude varies from 500 to 800 m, with reliefs of mesas and (steep) cornices, corresponding to a subhumid zone. In this last level, both elements of the natural landscape and human settlements coexist, the latter undergoing constant growth and economic development. In Jipijapa, the native diversity of flora and fauna is currently threatened and in danger of extinction, mainly due to the continuous and increasing deforestation (Gobierno Autónomo Descentralizado Municipal de Jipijapa, 2020).

During the 1981–2022 period, the mean values in Jipijapa for air temperature, relative humidity, wind speed, and annual precipitation were 24.22 °C, 76.12%, 3.95 m.s^{-1}, and 775.61 mm, respectively. The driest months were August, September, and October (NASA, 2024).

Methodological process

A non-experimental longitudinal research design was employed. The variables considered included: wildfire occurrence, air temperature, relative humidity, precipitation, wind speed, number of days without precipitation or with ≤10 mm, and days with precipitation >10 mm. All data corresponds to the period from January 1, 2014, to December 31, 2023, totaling 10 years of observations.

Wildfire occurrence data were obtained from the Jipijapa Fire Department. Meteorological variables were sourced from the POWER (Prediction Of Worldwide Energy Resources) Project developed by NASA through its

Earth Science Research Program. These model- and satellite-based products have proven accurate enough to provide reliable solar and meteorological data in regions with limited or no ground-based measurements (https://power.larc.nasa.gov/). The meteorological information used in this study was taken from the "Renewable Energy" community with a "Daily" temporal resolution, downloaded in CSV format and imported into Excel, where it was organized into columns for easier processing. Air temperature and relative humidity were taken at 2 meters above ground level, precipitation data were corrected, and wind speed values (originally at 10 m) were converted to 2 m using Equation 1 (FERNÁNDEZ-LONG *et al*., 2012). All data for meteorological variables correspond to the central area of the Jipijapa canton, with coordinates -1.45138 (latitude) and -80.58249 (longitude).

$$U_2 = U_{10} \frac{4.87}{\ln(67.8 * 10 - 5.42)} \qquad (1)$$

U_2 is wind speed at 2 m (m·s^{-1}); U_{10} is wind speed at 10 m (m·s^{-1}).

Data analysis and processing

For the variable fire occurrence, the monthly distribution of its total value was analyzed; while for the meteorological variables, the minimum, maximum, and median monthly values were utilized. The relationship between fire occurrence and meteorological variables was also examined. In the case of precipitation, since it is an important factor in the occurrence and spread of fires, an additional analysis was performed to identify the months with less precipitation, making them more dangerous. For this purpose, daily precipitation was taken into account, using as an indicator of days with little precipitation when precipitation was less than or equal to 10 mm. According to Soares *et al*. (2017), the calculation of the Nesterov hazard index is interrupted, restarting the following day or when the rain stops.

Using data on the occurrence of forest fires, meteorological variables, and daily rainfall, databases were created using Microsoft Excel, a software application for Windows, while the analysis was performed using IBM SPSS Statistics for Windows (version 22.0).

The comparison between groups for the variable fire occurrence was made with observations corresponding to the monthly value reported in each of the 10 years of the research period. For meteorological variables and days with and without rain, daily observations corresponding to the period 2014–2023 were used. Accordingly, the conformity of each variable within the factors to a normal distribution was assessed using the Shapiro-Wilk test for fire occurrence and days with or without rainfall, and the Kolmogorov-Smirnov test for meteorological variables. The results indicated that none of the variables conformed to a normal distribution ($p > 0.05$) across all factors and throughout the 12 months of the year. Consequently, comparisons of monthly values were conducted using the nonparametric Kruskal-Wallis H test. When this test revealed significant differences, Dunn's post hoc test was applied to identify the specific groups that differed from each other. In the case of correlations, since the variables did not meet the assumption of normality, Spearman's rank correlation coefficient was used, considering a probability of significance of 5%.

RESULTS

Wildfire occurrence and meteorological variables

The distribution of 252 forest fire occurrences across the months in the Jipijapa canton from 2014 to 2023 revealed that, although fires were reported throughout the entire year, a defined fire season can be established from August to December, during which 84.52% of the total fires recorded in the period occurred. The number of occurrences during these five months exceeded the monthly average of 21.00 fires per month for the entire period. The Kruskal-Wallis test demonstrated significant differences among the median values of fire occurrence for each month of the year ($\chi^2 = 67.252$; $p < 0.05$). However, some pairs of medians were statistically similar, including those corresponding to months within the fire season as well as those below the monthly average (Figure 1).

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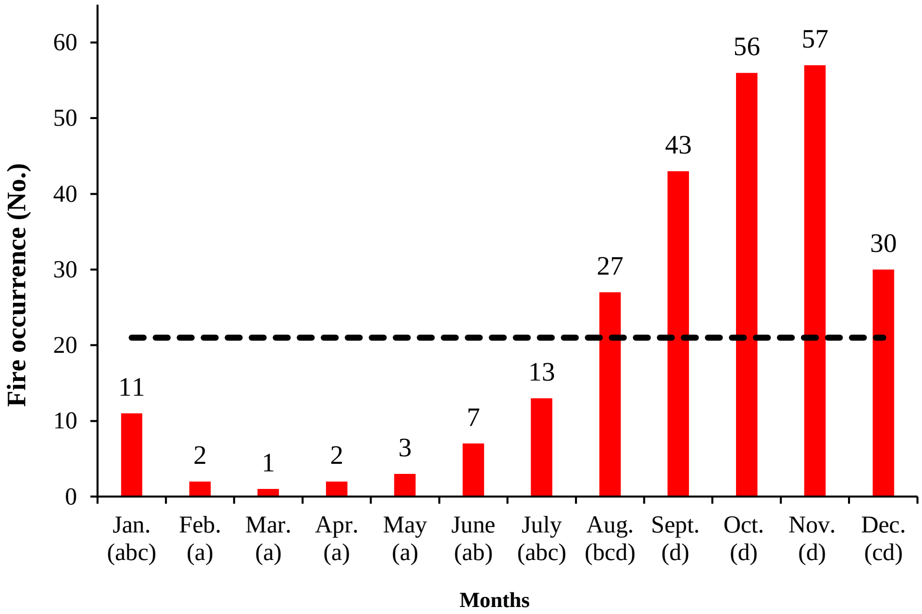

Figure 1. Monthly distribution of the total number of forest fires in the Jipijapa canton along with their monthly average and comparison of median values (2014-2023).

Figura 1. Distribuição mensal do número total de incêndios florestais no cantão de Jipijapa juntamente com sua média mensal e comparação de valores medianos (2014-2023).

Note: The dashed line indicates the monthly average wildfire occurrence (21.00 fires/month) for the period. Identical letters in parentheses indicate statistically similar medians according to Dunn's post hoc test ($p < 0.05$).

Regarding the monthly distribution of the meteorological variables considered in this study, the Kruskal-Wallis test identified significant differences among the monthly medians for air temperature ($\chi^2 = 992.971$; $p < 0.05$), relative humidity ($\chi^2 = 1830.791$; $p < 0.05$), precipitation ($\chi^2 = 1838.403$; $p < 0.05$), and wind speed ($\chi^2 = 1959.406$; $p < 0.05$). It is noteworthy that the median values for the months within fire season (August–December) consistently differed from those of other months, except for air temperature in December, which was statistically similar to that of June. December and July also had similar medians for relative humidity, and October and July showed comparable medians for wind speed (Table 1).

Table 1. Monthly distribution of meteorological variables in Jipijapa (2014-2023).

Tabela 1. Distribuição mensal de variáveis meteorológicas em Jipijapa (2014-2023).

Months	Air temperature (ºC)			Relative humidity (%)			Precipitation (mm.día^{-1})			Wind speed (m.s^{-1})		
	Min	Max	Medians	Min	Max	Medians	Min	Max	Medians	Min	Max	Medians
Jan.	23.53	27.15	25.35 ^{e}	65.00	88.62	76.28 ^{e}	0.00	49.73	1.12 ^{h}	1.30	4.43	2.82 ^{c}
Feb.	23.76	27.28	25.45 ^{e}	70.00	88.50	81.28 ^{g}	0.01	26.12	2.94 ^{i}	1.05	3.84	2.23 ^{b}
Mar.	23.21	27.47	25.44 ^{e}	63.62	93.94	83.06 ^{h}	0.00	33.03	2.74 ^{i}	0.95	3.34	1.94 ^{a}
Apr.	22.81	27.38	25.43 ^{e}	67.94	95.25	81.03 ^{g}	0.00	74.46	1.14 ^{h}	1.01	3.44	2.20 ^{b}
May	22.70	26.96	25.22 ^{d}	68.06	91.06	78.62 ^{f}	0.00	34.90	0.38 ^{g}	1.35	4.11	2.79 ^{c}
June	21.98	27.03	24.64 ^{c}	67.12	89.31	75.65 ^{e}	0.00	12.25	0.04 ^{e}	1.88	4.40	3.19 ^{d}
July	22.54	26.90	24.26 ^{b}	67.69	84.69	72.84 ^{d}	0.00	13.22	0.01 ^{c}	2.28	4.05	3.29 ^{ef}
Aug.	21.63	26.59	24.08 ^{a}	66.69	78.19	71.62 ^{bc}	0.00	1.18	0.00 ^{a}	2.59	4.45	3.36 ^{f}
Sept.	22.14	26.48	24.06 ^{a}	66.69	76.81	71.28 ^{a}	0.00	4.56	0.01 ^{b}	2.39	4.26	3.43 ^{g}
Oct.	22.23	26.67	24.06 ^{a}	65.56	78.19	71.41 ^{ab}	0.00	3.10	0.02 ^{d}	2.33	4.38	3.31 ^{ef}
Nov.	21.68	26.94	24.04 ^{a}	66.06	77.69	71.81 ^{c}	0.00	8.23	0.02 ^{d}	2.34	4.98	3.25 ^{e}
Dec.	22.18	27.62	24.72 ^{c}	65.25	86.50	73.53 ^{d}	0.00	26.91	0.13 ^{f}	1.82	4.75	3.28 ^{e}

Legend: Min: Minimum; Max: Maximum. Medians of each variable with the same letter in the columns are statistically equal according to Dunn's post hoc tests ($p < 0.05$).

When plotting the monthly values for total wildfires and the medians of the meteorological variables, it becomes evident that during the fire season (August–December), air temperature, relative humidity, and precipitation were at their lowest, while wind speed was at its highest (Figure 2).

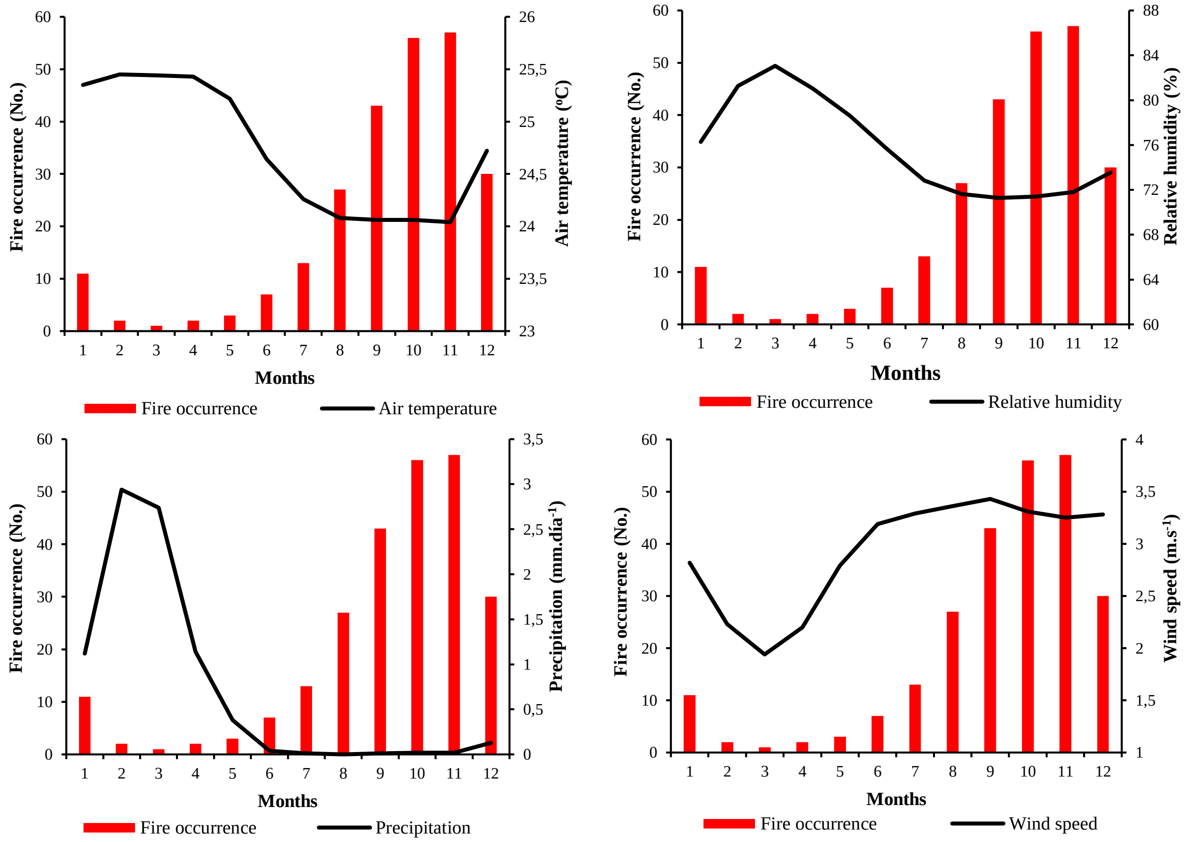

Figure 2. Monthly distribution of the total number of fires occurrence and medians of air temperature, relative humidity, precipitation, and wind speed in Jipijapa (2014–2023).

Figura 2. Distribuição mensal do número total de ocorrências de incêndios e medianas de temperatura do ar, umidade relativa, precipitação e velocidade do vento em Jipijapa (2014–2023).

Regarding the number of days with no precipitation or with ≤10 mm, and days with >10 mm rainfall, it is worth noting that during the fire season (August–December), there were no days with rainfall exceeding 10 mm, except in December, which had a maximum of 3 such days. A similar pattern was observed in the three months preceding the fire season (May–July). The Kruskal-Wallis test indicated significant differences among the monthly medians of days without or with light rainfall ($\chi^2 = 84.463$; $p < 0.05$) and days with rainfall over 10 mm ($\chi^2 = 66.521$; $p < 0.05$) (Table 2). These findings suggest that, based on the Nesterov index, the fire danger level from May to December in the study area is likely to be high or extreme.

Table 2. Monthly distribution of the number of days without and with precipitation in the Jipijapa canton (2014-2023).

Tabela 2. Distribuição mensal do número de dias sem e com precipitação no cantão de Jipijapa (2014-2023).

Months	Days without precipitation or with ≤10 mm			Days with precipitation>10 mm		
	Minimum	Maximum	Medians	Minimum	Maximum	Medians
Jan.	21	31	29.00 bcd	0	10	2.00 de
Feb.	17	28	26.00 a	0	11	2.50 de
Mar.	20	31	26.00 ab	0	11	5.00 e
Apr.	21	30	28.50 bc	0	9	1.50 cde
May	28	31	31.00 e	0	3	0.00 bcd
June	27	30	30.00 cd	0	3	0.00 ab

Months	Days without precipitation or with ≤10 mm			Days with precipitation>10 mm		
	Minimum	Maximum	Medians	Minimum	Maximum	Medians
July	30	31	31.00 [e]	0	1	0.00 [ab]
Aug.	31	31	31.00 [e]	0	0	0.00 [a]
Sept.	30	30	30.00 [d]	0	0	0.00 [ab]
Oct.	31	31	31.00 [e]	0	0	0.00 [ab]
Nov.	30	30	30.00 [d]	0	0	0.00 [ab]
Dec.	28	31	31.00 [e]	0	3	0.00 [abc]

Legend: Medians of each variable with the same letter in the columns are statistically equal according to Dunn's post hoc tests ($p < 0.05$).

Correlation analysis

The correlation analysis between wildfire occurrence and meteorological variables in Jipijapa showed that, in all cases, correlations were very low. A positive linear relationship was observed only between fire occurrence and wind speed. Significant correlations with fire occurrence ($p < 0.05$) were found exclusively for relative humidity and precipitation (Table 3)

Table 3. Correlation between forest fires occurrence and meteorological variables.
Tabela 3. Correlação entre ocorrência de incêndios florestais e variáveis meteorológicas.

Variables	r	p
Wildfire occurrence – Air temperature	-0.045	0.511
Wildfire occurrence – Relative humidity	-0.144	0.032
Wildfire occurrence – Precipitation	-0.157	0.020
Wildfire occurrence – Wind speed	0.055	0.416

DISCUSSION

The development of this research allowed for the testing of the hypothesis that, based on data from the 2014–2023 period in the Jipijapa canton, Manabí, Ecuador, there is a relationship between forest fire occurrence and meteorological variables. This relationship is evidenced by the fact that, during the fire season (August–December) and in the two months preceding it, the lowest monthly median values of precipitation and relative humidity, and the highest wind speed values were recorded. However, the Spearman rank correlation coefficients between fire occurrence and the meteorological variables used in the study were very low, even when the relationships—such as that between relative humidity and precipitation with fire occurrence—was statistically significant. Nevertheless, these results may serve as a basis for the formulation of fire management policies in the region, including fire use regulation, prevention, and suppression.

If farmers ultimately do not adopt alternatives to using fire for land clearing, it is advisable to encourage early burning, i.e., conducting burns before meteorological conditions become critical for fire spread. Additionally, issuing burn notices and permits could be regulated based on the area to be burned. When many farmers notify their intent to burn on the same day, arrangements could be made to distribute burns over multiple days. A burn permit calendar should be established, with restrictions during critical months when permits are not valid. Furthermore, prevention measures should be developed in response to prevailing meteorological conditions, and firefighting brigades should be maintained on alert. Implementing a local meteorological fire danger index would be a beneficial tool for the area.

It is important to note that this study utilized daily meteorological data spanning a 10-year period; however, analyzing meteorological data over a longer time frame and specifically recorded at 1:00 PM might yield stronger correlations between fire occurrence and meteorological variables. Similar results were reported by Ramos *et al.* (2017) for Pinar del Río, Cuba, who also found low or very low correlations between meteorological variables and forest fire occurrence. Unlike this study, however, the relationships between the considered meteorological variables and fire occurrence in their research were statistically significant. According to Ganteaume *et al*. (2013), it is well established that the climatic conditions characteristic of the Mediterranean summer—namely high temperatures, prolonged drought periods, and strong winds—play a key role in shaping fire regimes across Europe. Similarly, in the case of California, Dong *et al*. (2021), when examining the association between weather conditions and forest fires in that region, found that the majority (60.5%) of wildfires occurred under warm and dry conditions. They also reported a significant relationship between such meteorological anomalies and fire size.

The distribution of wildfires throughout the months of the year is crucial for planning fire prevention, as it indicates the periods of highest wildfire occurrence risk (SOARES *et al*., 2017). In this study, it was found that the highest number of wildfires occurred during the period from August to December, the months in which the lowest median values were recorded for air temperature, relative humidity, and precipitation, while the highest wind speed values were observed. It was also found that, during the fire season, with the exception of December, no precipitation greater than 10 mm was recorded. It may be worthwhile to explore future research focusing on periods with even lower rainfall. It is important to note that August, in addition to having the lowest median value for daily precipitation, is preceded by three months characterized by similarly low precipitation levels. This contributes to the reduced relative humidity observed during these months, which in turn promotes moisture loss in combustible materials, thereby facilitating their ignition when a fire source is present. These findings are consistent with those reported by Ramos *et al*. (2017) for the Pinar del Río province, Cuba, during the 2010–2014 period, where the highest number of wildfires occurred in months with the lowest average values of relative humidity and precipitation, as well as the highest wind speeds. In a similar context, Tošić *et al*. (2019) examined the potential influence of meteorological variables on the wildfire risk in Serbia, with results indicating that forest fires interact with climatic dynamics, with the most favorable conditions for wildfire occurrence being high air temperatures, low relative humidity, and the absence of precipitation. Also, in Loja city, Loja province, Ecuador, Ramos-Rodríguez *et al.* (2024) defined the fire season from August to November, preceded by three months of low precipitation, with the lowest value for this variable recorded in August. When evaluating wildfire occurrences in Paraná State, Brazil, from 2005 to 2010, Tetto *et al*. (2012) found a significant correlation between wildfire occurrence and precipitation.

It is noteworthy that Carrión-Paladines *et al*. (2024), in their exploration of ethnobiological fire practices across three natural regions of Ecuador—through the integration of traditional knowledge and scientific research—found a significant correlation between traditional ecological knowledge, climatic data, and the occurrence of numerous low-severity fires. These findings, according to the authors, not only support the identification of optimal techniques and appropriate timing for traditional burning practices but also contribute to human well-being by promoting a harmonious balance between communities and their environment. However, according to surveys conducted by Manrique-Toala *et al.* (2022) in the communities of Sancán and Membrillal, farmers in the canton of Jipijapa primarily use fire for land clearing in November, which coincides with the month of highest fire occurrence in the study area. Nevertheless, although only a few respondents reported using fire in October, a number of fires similar to that of November was recorded for that month. This suggests that the survey question regarding the months in which fire is used may not have been sufficiently precise, as it was asked in general terms rather than specifically about land clearing activities.

Indeed, despite the assertion that agricultural burning is a major cause of fire occurrence, the cited study reveals that there is not always a direct correspondence between the months in which farmers report using fire and the months with the highest number of fires according to records from the Jipijapa Fire Department. What is evident is that both fire occurrence and the months in which farmers report using fire are related to the monthly distribution of precipitation, relative humidity, and wind speed.

In this context, Tetto *et al*. (2012) argued that wildfire occurrence is directly related to both the amount and distribution of precipitation, likely because ignition sources—mainly human activity and lightning—are sensitive to weather conditions. These authors found that the greatest wildfire danger in Paranavaí, Paraná, Brazil, occurred during months of low precipitation. In areas with fewer rainy days, wildfire incidence was higher—findings that are consistent with those observed in Jipijapa.

Ramos-Rodríguez *et al*. (2013), in their comparison of the historical behavior of wildfires in Pinar del Río, Cuba, and Monte Alegre, Brazil, found that fire occurrence was strongly related to the annual distribution of precipitation. Similarly, Labres Dos Santos *et al.* (2019), in a comparative study of forest fires in Londrina, Brazil, and Pisa, Italy, concluded that precipitation was the predominant factor influencing fire occurrence in Londrina. However, in Pisa, a stronger correlation was observed when the dry season coincided with elevated temperatures. This may explain why, in this research, the correlation between fire occurrence and air temperature was negative.

CONCLUSIONS

- This research has demonstrated that in Jipijapa canton, the correlation between forest fire occurrence and meteorological variables is very low. However, it was observed that during the fire season (August–December), the monthly median values of air temperature, precipitation, and relative humidity were lower, while wind speed values were higher. These results may serve as a basis for the development of policies related to fire use regulation, as well as forest fire prevention and suppression efforts—constituting a significant contribution to the implementation of Ecuador's National Integrated Fire Management Strategy.
- Another key finding of this research is that, during the fire season—except for December—no precipitation events exceeding 10 mm were recorded. A statistically significant relationship was found between this meteorological variable and fire occurrence, despite the correlation coefficient being very low. It may be worthwhile to conduct similar studies using data spanning a longer time period as well as meteorological data collected at 13:00 hours.

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REFERENCES

AGBESHIE, A. A. *et al*. A review of the effects of forest fire on soil properties. **Journal of Forestry Research**, Heidelberg, v. 33, n. 5, p. 1419–1441, 2022.

ALVES, J. M. B. *et al.* Um Estudo de Focos de Calor no Bioma Caatinga e suas Relações com Variáveis Meteorológicas. **Revista Brasileira de Meteorologia**, São José dos Campos, v. 36, n. 3, p. 513–527, 2021.

CARRIÓN-PALADINES, V. *et al*. Exploring the ethnobiological practices of fire in three natural regions of Ecuador, through the integration of traditional knowledge and scientific approaches. **Journal of Ethnobiology and Ethnomedicine**, London, v. 20, n. 1, p. 60, 2024.

DONG, L. *et al*. Meteorological Environments Associated With California Wildfires and Their Potential Roles in Wildfire Changes During 1984–2017. **Journal of Geophysical Research: Atmospheres**, Washington, v. 126, n. 5, p. 1–20, 2021.

DYMOV, A. A. *et al*. Fire-Induced Alterations of Soil Properties in Albic Podzols Developed under Pine Forests (Middle Taiga , Krasnoyarsky Kray). **Fire**, Basel, v. 6, n. 67, 2023.

FERNÁNDEZ-LONG, M. E. *et al*. Modelo de Balance Hidrológico Operativo para el Agro (BHOA). **Agronomía & Ambiente**, Buenos Aires, v. 32, n. 1–2, p. 31–47, 2012.

GANTEAUME, A. *et al*. A review of the main driving factors of forest fire ignition over Europe. **Environmental Management**, London, v. 51, n. 3, p. 651–662, 2013.

GOBIERNO AUTÓNOMO DESCENTRALIZADO MUNICIPAL DE JIPIJAPA. **Plan de Desarrollo y Ordenamiento Territorial 2019-2023 - Cantón Jipijapa**. 2020.

KOSSOSKI, M. C. *et al*. Climate elements and fire hazard indexes in Santa Catarina. **Floresta**, Curitiba, v. 54, n. 1, 2024.

LABRES DOS SANTOS, J. F. *et al*. Comparison of Forest Fire Profiles in Londrina, Brazil and Pisa, Italy. **Floresta e Ambiente**, Seropédia, v. 26, n. 2, p. 1–10, 2019.

MANRIQUE-TOALA, T. O. *et al*. Uso del fuego en tierras de vocación forestal del cantón Jipijapa, Manabí, Ecuador. **Bosques Latitud Cero**, Loja, v. 12, n. 2, p. 40–51, 2022.

NASA. **The Prediction Of Worldwide Energy Resources (POWER)**. Disponível em: <https://power.larc.nasa.gov/>. 2024. Acesso em 18 set 2024.

OLIVO NETO, A. M. O.; CARNIELLO, M. A. Vegetation Mortality Caused By Forest Fire in a Fragment in the Amazonia-Cerrado-Pantanal Ecotone: Use of Drones in the Assessment. **Floresta**, Curitiba, v. 54, n. 1, p. 1–9, 2024.

RAMOS-RODRÍGUEZ, M. P. *et al*. Comparação entre o perfil dos incêndios florestais de Monte Alegre, Brasil, e de Pinar del Río, Cuba. **Floresta**, Curitiba, v. 43, n. 2, p. 231–240, 2013.

RAMOS-RODRÍGUEZ, M.; POMA-CABRERA, E.; REYES-CHANCAY, J. Estadísticas de incendios forestales en el cantón Loja , provincia Loja , Ecuador , en el periodo 2011 – 2020. **Bosques Latitud Cero**, Loja, v. 14, n. 1, p. 64–76, 2024.

RAMOS RODRÍGUEZ, M. P. *et al*. Relación entre variables meteorológicas e incendios forestales en la provincia Pinar del Río, Cuba. **Floresta**, Curitiba, v. 47, n. 3, p. 343–352, 2017.

SAYEDI, S. S. *et al*. Assessing changes in global fire regimes. **Fire Ecology**, Fayetteville, v. 20, n. 18, 2024.

SHARPLES, J. J. A note on fire weather indices. **International Journal of Wildland Fire**, Clayton, v. 31, n. 7, p. 728–734, 2022.

SOARES, R. V.; BATISTA, A. C.; TETTO, A. F. **Incêndios florestais: controle, efeito e uso do fogo**. Segunda Ed ed. Curitiba: Gráfica Capital, 2017.

SPARKS, A. M. *et al*. An experimental assessment of the impact of drought and fire on western larch injury, mortality and recovery. **International Journal of Wildland Fire,** Clayton, v. 27, n. 7, p. 490–497, 2018.

STROH, E. D. *et al*. Fire and Climate Suitability for Woody Vegetation Communities in the South Central United States. **Fire Ecology**, Fayetteville, v. 14, n. 1, p. 106–124, 2018.

TETTO, A. F.; BATISTA, A. C.; SOARES, R. V. Ocorrência de incêndios florestais no estado do Paraná, no período de 2005 a 2010. **Floresta**, Curitiba, v. 42, n. 2, p. 391, 2012.

TORRES, F. T. P.; SILVA JÚNIOR, M. R. DA; LIMA, G. S. Influência dos Elementos Meteorológicos Sobre o Comportamento do Fogo. **Revista Brasileira de Meteorologia**, São José dos Campos, v. 34, n. 1, p. 33–41, 2019.

TOŠIĆ, I. *et al*. Potential influence of meteorological variables on forest fire risk in Serbia during the period 2000-2017. **Open Geosciences**, Varsovia, v. 11, p. 414–425, 2019.

WU, Z. *et al*. Current and future patterns of forest fire occurrence in China. **International Journal of Wildland Fire,** Clayton, v. 29, n. 2, p. 104–119, 2020.