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USE FIRE, WILDFIRES, AND CRITICAL METEOROLOGICAL CONDITIONS IN EL ANEGADO, ECUADOR

Marcos Pedro Ramos-Rodríguez[1*], Karla Valentina Corral-Cedeño[2], Lidia Eliana Flores-Anchundia[3], Alberto Peñalver-Romeo[4], Ignacio Estévez-Valdés[5], Franklin Ignacio Macías-Bailón[6]

[1*]Universidad Estatal del Sur de Manabí, Facultad de Ciencias Naturales y de la Agricultura, Carrera de Ingeniería Forestal, Jipijapa, Manabí, Ecuador - marcos.ramos@unesum.edu.ec
[2]Independent researcher, Manabí, Ecuador - corralkarla2002@gmail.com
[3]Independent researcher, Manabí, Ecuador - eliana.anchundia.30@gmail.com
[4]Universidad Católica de Santiago de Guayaquil, Facultad Técnica para el Desarrollo, Carrera Agropecuaria, Guayaquil, Guayas, Ecuador - ekoforest@hotmail.com
[5]Universidad Estatal del Sur de Manabí, Facultad de Ciencias Naturales y de la Agricultura, Carrera de Ingeniería Forestal, Jipijapa, Manabí, Ecuador - ignacio.estevez@unesum.edu.ec
[6]Universidad Estatal del Sur de Manabí, Centro de Idiomas, Jipijapa, Manabí, Ecuador - franklin.macias@unesum.edu.ec

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Resumo

Uso do fogo, incêndios florestais e condições meteorológicas críticas em El Anegado, Equador. O uso do fogo, amplamente empregado como prática agrícola tradicional e de baixo custo, assim como os incêndios florestais, tende a se concentrar em períodos específicos do ano. O objetivo deste estudo foi analisar a distribuição temporal do uso do fogo na agricultura, a ocorrência de incêndios florestais e as condições meteorológicas críticas em El Anegado, Manabí, Equador. O uso do fogo foi caracterizado por meio de um questionário semiestruturado aplicado a 210 produtores. Para a análise, foram calculados o nível de fidelidade da informação (LIF) e o fator de consenso entre informantes (FIC). Os dados meteorológicos foram obtidos do Projeto POWER-NASA, enquanto as informações sobre a ocorrência de incêndios foram fornecidas pelo Corpo de Bombeiros de Jipijapa. As análises estatísticas foram realizadas com o software IBM SPSS Statistics. A principal finalidade do uso do fogo na localidade foi a limpeza de terrenos para o estabelecimento de cultivos (LIF 73,17%; FIC 0,00), sendo novembro o mês preferido para a realização de queimadas (LIF 63,49%; FIC 0,24). Durante os últimos meses do ano, foram registrados os menores valores médios de umidade relativa e precipitação, bem como os maiores valores de velocidade do vento, sendo também esses os meses com maior ocorrência de incêndios. Concluiu-se que, em El Anegado, tanto o uso do fogo quanto a temporada de incêndios florestais estão estreitamente relacionados às condições meteorológicas críticas. Os resultados devem ser considerados pelos tomadores de decisão no âmbito do manejo integrado do fogo.
Palavras-chave: Agricultura tradicional, sazonalidade climática, manejo do fogo, queimadas agrícolas, temporada de incêndios, variáveis meteorológicas.

Abstract

Fire use and wildfire occurrence tend to be concentrated in specific periods of the year; fire is widely employed as a traditional and low-cost agricultural practice. The objective of this study was to analyze the temporal distribution of fire use in agriculture, wildfire occurrence, and critical meteorological conditions in El Anegado, Manabí, Ecuador. Fire use was characterized using a semi-structured questionnaire administered to 210 farmers. For the analysis, the level of information fidelity (LIF) and the informant consensus factor (ICF) were calculated. Meteorological data were obtained from the POWER-NASA Project, while information on fire occurrence was provided by the Jipijapa Fire Department. Statistical analyses were performed using IBM SPSS Statistics software. The main purpose of fire use in the area was land clearing for crop establishment (LIF 73.17%; ICF 0.00), with November being the preferred month for burning (LIF 63.49%; ICF 0.24). During the last months of the year, the lowest average values for relative humidity and precipitation were reported, as well as the highest wind speeds. These months also saw the highest number of fires. It was concluded that in El Anegado, both the use of fire and the wildfire season are closely related to critical meteorological conditions. These results should be taken into account by decision-makers in the field of integrated fire management.
Keywords: Traditional agriculture, climate seasonality, fire management, agricultural burning, fire season, meteorological variables.

INTRODUCTION

The use of fire as a tool for landscape and agricultural management is an ancestral practice that has shaped ecosystems and sociocultural dynamics in numerous regions worldwide. Traditionally, fire has been used for land preparation, pest control, pasture renewal, and agricultural residue management (CARROLL *et al*., 2021; RAMOS; MOLINA, 2023). In Ecuador, several studies have documented the persistence of these traditional uses and their importance in shaping rural landscapes, as well as in the intergenerational transmission of knowledge (RAMOS RODRÍGUEZ *et al*., 2018; RAMOS; MOLINA, 2023; DÍAZ *et al*., 2023; CARRIÓN-PALADINES *et*

al., 2024; QUIJIJE BRIONES *et al*., 2025). However, the intensification of extreme climate events and the expansion of the agricultural frontier have increased the vulnerability of these landscapes to wildfires, with significant ecological, economic, and social consequences (SARANGO-COBOS *et al*., 2019; GIL MORA, 2020).

The relationship between traditional fire use and wildfire occurrence has become increasingly complex due to the interaction among climate change, weather variability, and land-use changes (SARANGO-COBOS *et al*., 2019; GIL MORA, 2020; RAMOS RODRÍGUEZ *et al*., 2024; ABBAS *et al*., 2025). Variables such as air temperature, relative humidity, precipitation, and wind speed influence fuel flammability and fire spread (TOŠIĆ *et al*., 2019; ABBAS *et al*., 2025; IPIÑA *et al*., 2025; RAMOS-RODRÍGUEZ *et al*., 2025). In the province of Manabí, the pronounced seasonality of precipitation influences the planning of agricultural burning, which is typically scheduled during the dry season based on farmers' experience and prevailing environmental conditions (RAMOS RODRÍGUEZ *et al*., 2018; RAMOS; MOLINA, 2023; QUIJIJE BRIONES *et al*., 2025). However, increasing pressure on natural resources and the intensification of agricultural and livestock activities have increased the frequency of uncontrolled fires, highlighting the need for a better understanding of the factors that determine their occurrence and spread (GIL MORA, 2020).

In this context, several studies highlight the importance of integrating traditional knowledge of fire use with scientific evidence to strengthen wildfire management and prevention strategies through participatory and adaptive approaches (RAMOS RODRÍGUEZ *et al*., 2018; CARROLL *et al*., 2021; DÍAZ *et al*., 2023). However, further research is still needed to jointly analyze the temporal patterns of agricultural fire use, wildfire occurrence, and critical meteorological conditions in rural areas of Manabí, where these practices remain widespread.

Accordingly, this study aimed to analyze the temporal distribution of fire use in agriculture, wildfire occurrence, and critical meteorological conditions in El Anegado, Manabí, Ecuador. It was hypothesized that the temporal distribution of agricultural fire use, wildfire occurrence, and critical meteorological conditions in El Anegado exhibits marked seasonality.

MATERIALS AND METHODS

Characterization of the study area

The study was conducted in El Anegado, one of the rural parishes of Jipijapa Canton, Manabí Province, Ecuador. The parish covers an area of 117.05 km² and borders other rural parishes of Jipijapa and neighboring cantons: La América to the north; Pedro Pablo Gómez and Paján Canton to the south; La Unión and Paján Canton to the east; and Julcuy to the west. In El Anegado, the local economy is primarily based on agriculture, with smallholdings and family labor on farms predominating, particularly during the rainy season. The soils of the parish have good agricultural potential and are distributed across three river basins: 56.90% lies within the Guayas River basin, 36.50% within the Buenavista River basin, and the remaining 6.60% within the Ayampe River basin. The climate of the area is influenced by the Humboldt and El Niño ocean currents, with mean temperatures ranging from 22.00 °C to 24.00 °C. Annual precipitation ranges from 1,200.00 to 1,500.00 mm in the southern part of the parish and is below 1,200.00 mm in the northern part.

Methodological process and data analysis

A descriptive cross-sectional non-experimental design was used to characterize both the respondents and the use of fire in agriculture, whereas a trend-type longitudinal non-experimental design was used to analyze wildfire occurrence and weather conditions, considering the temporal distribution (months) of these variables. For the analysis of fire use, the sampling units were agricultural producers. The study population comprised individuals over 18 years of age who lived or worked the land in the communities where the research was conducted. Given the small population size, a census was conducted, surveying a total of 210 individuals from the communities of El Retiro (30), El Secal (30), La Quinta Unión (34), La Fuente (30), El Carmen (40), and Los Pocitos (46). Data were collected using a semi-structured questionnaire consisting of open- and closed-ended questions, designed similarly to those used in previous studies conducted in Brazil (BONFIM *et al*., 2003; ASSUNÇÃO *et al*., 2017) and in localities of Manabí, Ecuador (RAMOS-RODRÍGUEZ *et al*., 2021, 2022; MANRIQUE-TOALA *et al*., 2022; QUIJIJE BRIONES *et al*., 2025). To analyze the characteristics of fire use, the level of information fidelity (LIF) and the informant consensus factor (ICF) were calculated using Equations 1 and 2, which have previously been applied in similar studies (DÍAZ *et al*., 2023; CARRIÓN-PALADINES *et al*., 2024; QUIJIJE BRIONES *et al*., 2025).

$$LIF = \frac{Ip}{Iu} * 100 \qquad (1)$$

LIF is the degree of preference for a particular characteristic of fire use over the others (high LIF values indicate that a characteristic is used more frequently); Ip is the number of informants who reported a particular characteristic; and Iu is the number of informants who mentioned all characteristics related to fire use.

$$ICF = \frac{Nt - Nur}{Nt - 1} \qquad (2)$$

ICF is the informant consensus factor (values close to 0 indicate that a fire-use characteristic was common and that there was consensus among informants); *Nt* is the total number of informants surveyed; and *Nur* is the number of informants who reported the same characteristic.

Given the absence of surface weather stations in the study area, meteorological data were obtained from the POWER (Prediction Of Worldwide Energy Resources) Project of the NASA Langley Research Center, through the Data Access Viewer. Hourly data ("Hourly") on air temperature, relative humidity (2 m), and wind speed (10 m), recorded at 13:00, as well as daily data ("Daily") on 24-h accumulated precipitation, were used. For the analysis, wind speed was adjusted to a height of 2 m using Equation 3 (FERNÁNDEZ-LONG et al., 2012). The data correspond to the central point of the study area, located in the El Carmen community (Lat. -1.516623; Long. -80.555655; UTM 17S 549427 9832362).

$$U_2 = U_{10} * \frac{4{,}87}{\ln(678 - 5.42)} \qquad (3)$$

U_2 is the wind speed at a height of 2 m (m s^{-1}); U_{10} is the wind speed at a height of 10 m (m s^{-1}).

Data on wildfire occurrence were provided by the Jipijapa Fire Department. Both wildfire occurrence data and meteorological variable data covered a 10-year period (2015–2024).

The normality of the meteorological variables was assessed using the Kolmogorov–Smirnov test, whereas the normality of wildfire occurrence was evaluated using the Shapiro–Wilk test. None of the variables followed a normal distribution ($p < 0.05$); therefore, minimum, maximum, and median values were calculated, and the nonparametric Kruskal–Wallis H test followed by Dunn's *post hoc* test was applied to compare medians. The correlation between wildfire occurrence and the meteorological variables was determined using Spearman's rank correlation coefficient. A significance level of 5.00% was adopted for all analyses.

Data from the surveys, wildfire occurrence records, and meteorological variables were organized in Microsoft Excel, which was also used to create Figure 2. Statistical analyses and Figure 1 were performed using IBM SPSS Statistics (version 22.0). Figure 3 was generated in Python 3.11 using Jupyter and the pandas, scikit-learn, and seaborn/matplotlib libraries.

RESULTS

Profile of respondents and their agricultural activities

A total of 210 individuals participated in the study: 148 men (70.48%) and 62 women (29.52%). The mean age of the respondents was 45 years, ranging from 18 to 93 years. Regarding educational attainment, primary education predominated (45.24%), followed by secondary education (38.57%) and university education (2.38%). In addition, 29 respondents (13.81%) reported having no formal education. In terms of income, 99.52% of the participants reported a monthly household income below USD 450.00. Furthermore, in 74.29% of households, families consisted of five or fewer members.

It is noteworthy that 67.62% of the respondents learned how to use fire from their grandparents, while the remainder acquired this knowledge from their parents, demonstrating the intergenerational transmission of this knowledge within the community. However, 95.71% of the farmers reported being unaware of alternatives to fire use, reflecting a strong dependence on traditional practices and limited adoption of alternative methods.

Regarding agricultural and livestock activities, most study participants (95.71%) performed agricultural work manually. With respect to fertilizer use, 176 respondents (83.81%) used chemical fertilizers, whereas 19 (9.05%) used organic fertilizers. These findings indicate a strong dependence on manual methods and chemical inputs in local agricultural production, with limited adoption of organic alternatives. All participants reported growing maize (*Zea mays* L.). In addition, 72 respondents also cultivated plantain (*Musa paradisiaca* L.), 57 cassava (*Manihot esculenta* Crantz), and 31 common bean (*Phaseolus vulgaris* L.). Regarding livestock activities, 98 respondents (46.67%) were engaged in animal husbandry. Furthermore, 97 participants (46.19%) reported no activities other than agriculture, while 12 (5.71%) identified themselves as merchants.

Characteristics of fire use in agriculture

The main purpose of fire use in the study area was land clearing for crop establishment, with very high consensus among informants (LIF 73.17%; ICF 0.00). November was the most frequently mentioned month for conducting agricultural burns, with high consensus among respondents (LIF 63.49%; ICF 0.24). Regarding the preferred time of day for burning, the highest frequencies were reported at 09:00, 10:00, and 12:00, with LIF values of 33.96%, 24.06%, and 16.51%, respectively, with no consensus among informants. Regarding the frequency of agricultural burning, most respondents reported conducting burns every year in the same locations, although the level of consensus was moderate (LIF 59.24%; ICF 0.41). Regarding the burning method, burning residues piled in rows predominated (LIF 62.83%; ICF 0.37). The predominant burning direction was against the wind (LIF

45.00%; ICF 0.55). Among the preventive measures taken before burning, the most common was assessing weather conditions, although consensus was moderate (LIF 57.80%; ICF 0.42) (Table 1).

In the event of an emergency during agricultural burning, most farmers preferred to contact family members first, although consensus regarding this practice was moderate (LIF 52.88%; ICF 0.47). The most commonly used fire suppression technique was the application of water (LIF 47.26%; ICF 0.53). Regarding tools and equipment, machetes were the most commonly used, with moderate consensus among informants (LIF 61.58%; ICF 0.39). The use of personal protective equipment during agricultural burning was limited, with boots (LIF 40.00%; ICF 0.60) and long-sleeved shirts (LIF 39.81%; ICF 0.60) being the most frequently reported items, although consensus was low in both cases (Table 1).

Table 1. Characteristics of Fire Use in El Anegado Parish, Jipijapa, Manabí, Ecuador.
Tabela 1. Características do uso do fogo na paróquia El Anegado, Jipijapa, Manabí, Equador.

Characteristics of fire use		LIF (%)	ICF
Purposes of fire use	Land clearing for crop establishment	73.17	0.00
	Burning household waste	19.86	0.73
	Charcoal production	3.14	0.96
	Pest and disease control	2.44	0.97
	Burning dry leaves	1.39	0.99
Preferred months for burning for land clearing	November	63.49	0.24
	October	30.16	0.64
	December	5.56	0.94
	September	0.79	1.00
Preferred times for burning for land clearing	09:00	33.96	0.66
	10:00	24.06	0.76
	12:00	16.51	0.83
	13:00	8.96	0.91
	14:00	6.13	0.94
	15:00	3.77	0.96
	11:00	3.30	0.97
	08:00	1.42	0.99
	07:00	0.94	0.99
	06:00	0.47	1.00
	16:00	0.47	1.00
Frequency of agricultural burning	Every year – Always in the same locations	59.24	0.41
	Every year – Always in different locations	29.38	0.71
	Every year – Sometimes in the same locations	11.37	0.89
Conducting burns alone	Never	80.48	0.20
	Always	17.62	0.83
	Sometimes	1.90	0.99
Method of burning crop residues and weeds	Piled in rows	62.83	0.37
	Scattered throughout the area	35.40	0.65
	Piled in heaps scattered throughout the area	1.77	0.99
Direction of burning	Against the wind	45.00	0.55
	With the wind	44.09	0.56
	Upslope	5.91	0.95
	Downslope	5.00	0.95
Preventive measures adopted before burning	Assesses the weather	57.80	0.42
	Observes weather conditions	28.44	0.72
	Assesses the slope	4.89	0.95
	Creates 2-m-wide cleared strips	3.67	0.97
	Clears vegetation around the area (firebreak)	2.45	0.98
	Creates cleared strips	2.45	0.98
	Constructs firebreaks	0.31	1.00

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Characteristics of fire use		LIF (%)	ICF
People or organizations contacted for fire suppression	Family members	52.88	0.47
	Friends	24.10	0.76
	Neighbors	12.95	0.87
	Fire Department	3.96	0.96
	Let the fire burn out on its own	3.96	0.96
	Authorities	1.08	0.99
	ECU 911	1.08	0.99
Techniques used for fire suppression	Use of water	47.26	0.53
	Use of soil	38.82	0.61
	Use of green branches	13.92	0.86
Tools and equipment used for fire suppression	Machetes	61.58	0.39
	Rake	14.08	0.86
	Brush hook	8.50	0.92
	Pick-head axe	6.45	0.94
	Shovel	5.28	0.95
	Hooks	1.76	0.99
	Brush cutter	1.17	0.99
	Hoe	0.59	1.00
	Buckets	0.59	1.00
Personal protective equipment	Boots	40.00	0.60
	Long-sleeved shirts	39.81	0.60
	Caps	14.29	0.86
	Face masks	4.76	0.95
	Safety glasses	1.14	0.99

Legend: LIF: level of information fidelity; ICF: informant consensus factor.

Wildfire occurrence

The monthly distribution of wildfire occurrence made it possible to identify a fire season extending from August to December, with 79.76% of the 252 wildfires reported by the Jipijapa Fire Department during the 2015–2024 period occurring in these months. During this period, the number of wildfires recorded each month exceeded the monthly mean of 21.00 fires month^{-1} (Figure 1). The Kruskal–Wallis test showed significant differences among the monthly median values of wildfire occurrence ($\chi^2 = 53.120$; $p < 0.05$).

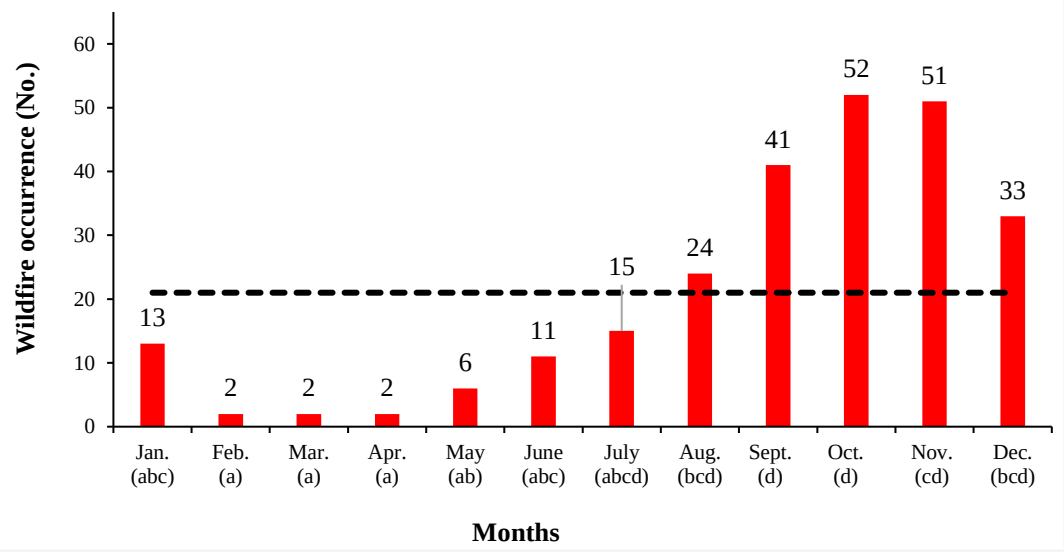


Figure 1. Monthly distribution of the total number of wildfire occurrences in Jipijapa canton (2015–2024).
Figura 1. Distribuição mensal do número total de ocorrências de incêndios florestais no cantão Jipijapa (2015–2024).

Note: The dashed line indicates the mean monthly wildfire occurrence (21.00 fires month^{-1}) for the study period. Identical letters in parentheses indicate that the median values are not statistically different according to Dunn's *post hoc* test.

Meteorological variables

In the study area, air temperature remained warm throughout the 2015–2024 period, with monthly median values ranging from 29.16 °C (March) to 30.90 °C (September). The lowest median relative humidity was 45.94% (September), while the highest was 66.82% (March). Median precipitation values ranged from 0.00 mm day^{-1} (August) to 3.35 mm day^{-1} (February). Median wind speed values ranged from 2.52 m s^{-1} (March) to 3.80 m s^{-1} (September) (Table 2). The Kruskal–Wallis test identified significant differences among monthly median values for air temperature (χ^2 = 311.669; $p < 0.05$), relative humidity (χ^2 = 1807.281; $p < 0.05$), precipitation (χ^2 = 1936.498; $p < 0.05$), and wind speed (χ^2 = 1030.132; $p < 0.05$).

Table 2. Description of the monthly values of meteorological variables in El Anegado, Jipijapa, Manabí, Ecuador (2015–2024).
Tabela 2. Descrição dos valores mensais das variáveis meteorológicas em El Anegado, Jipijapa, Manabí, Equador (2015–2024).

Months	Air temperature (°C)			Relative humidity (%)			Precipitation (mm día^{-1})			Wind speed (m s^{-1})		
	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Jan.	25.57	33.45	30.64^{efg}	39.66	78.23	53.08^{f}	0.00	49.73	1.12^{g}	1.22	5.19	3.34^{e}
Feb.	26.61	32.99	29.69^{b}	40.50	87.89	62.19^{h}	0.01	55.78	3.35^{i}	0.28	5.02	2.88^{c}
Mar.	25.35	33.52	29.16^{a}	42.56	87.16	66.82^{i}	0.00	33.03	2.84^{h}	0.87	4.82	2.52^{a}
Apr.	25.33	33.88	29.84^{bc}	36.15	92.07	60.32^{h}	0.00	74.46	1.28^{g}	0.49	4.27	2.61^{b}
May	25.61	34.40	30.52^{def}	41.03	81.94	55.28^{g}	0.00	34.90	0.32^{f}	0.91	5.79	3.06^{d}
June	25.97	33.84	30.07^{bcd}	40.15	78.61	51.48^{e}	0.00	12.25	0.04^{d}	1.74	5.01	3.28^{e}
July	27.18	33.81	30.57^{fg}	38.11	66.40	48.44^{c}	0.00	13.22	0.01^{c}	1.56	5.10	3.45^{f}
Aug.	26.88	33.98	30.77^{gh}	35.05	58.79	46.07^{a}	0.00	1.18	0.00^{a}	2.28	5.35	3.64^{hi}
Sept.	27.56	34.33	30.90^{h}	35.65	55.44	45.94^{a}	0.00	4.56	0.01^{b}	2.33	5.36	3.80^{j}
Oct.	25.65	33.90	30.76^{fg}	34.88	66.13	47.44^{b}	0.00	3.10	0.01^{c}	1.64	5.74	3.74^{ij}
Nov.	24.98	33.89	30.29^{cde}	35.35	64.84	47.98^{b}	0.00	8.23	0.01^{c}	1.79	5.89	3.49^{fg}
Dec.	25.65	34.13	30.51^{fg}	39.43	66.84	50.28^{d}	0.00	18.65	0.12^{e}	1.29	5.65	3.59^{gh}

Legend: Min: Minimum; Max: Maximum. Median values for each variable with the same superscript letter are not statistically different according to Dunn's *post hoc* test.

The monthly distribution of the main climatic variables recorded in the study area showed little variation in air temperature throughout the year. The highest monthly median air temperature was recorded in September (30.90 °C), whereas the lowest was recorded in March (29.16 °C). Relative humidity and precipitation showed a progressive decrease throughout the year, with higher values during the January–May period and marked declines during the remaining months. Wind speed also exhibited a clear seasonal pattern, with increases during the dry months (Figure 2).

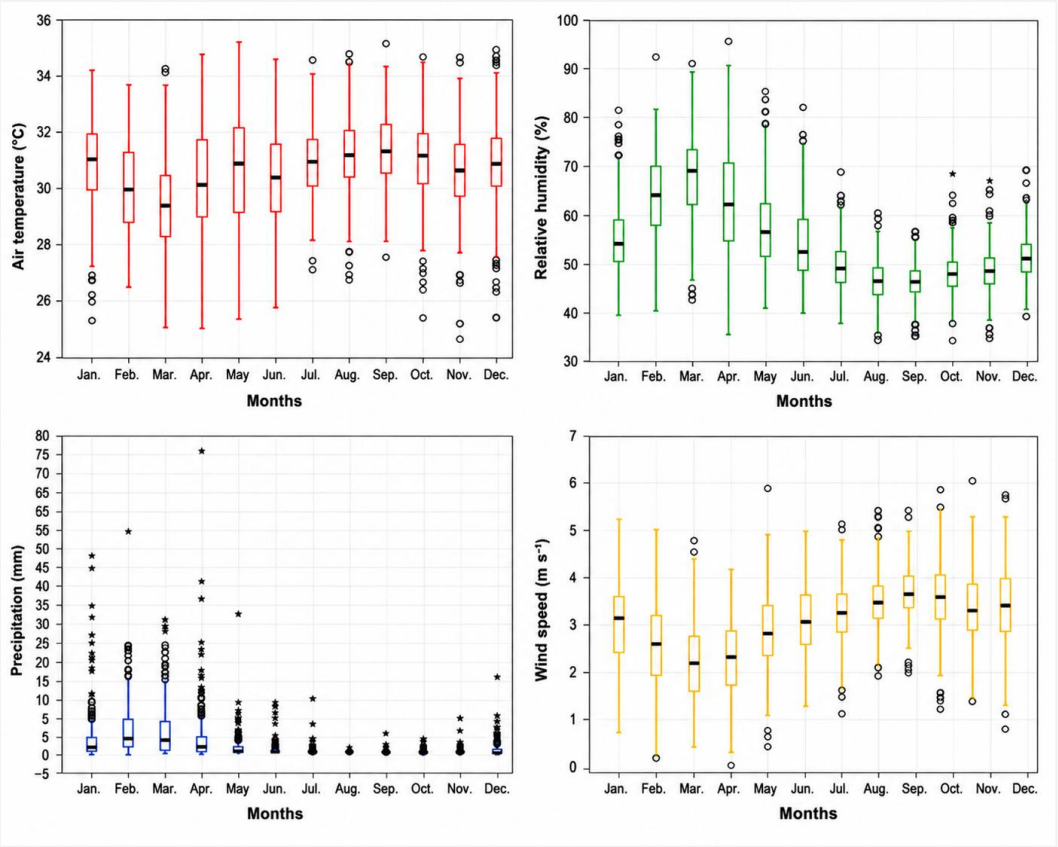


Figure 2. Monthly distribution of meteorological variables in El Anegado, Jipijapa, Manabí, Ecuador (2015–2024).

Figura 2. Distribuição mensal das variáveis meteorológicas em El Anegado, Jipijapa, Manabí, Equador (2015–2024).

Note: Air temperature in °C, Relative humidity in %, Precipitation in mm, Wind speed in m s^{-1}.

Correlation analysis

The correlations between wildfire occurrence and the meteorological variables were statistically significant. Air temperature, relative humidity, and precipitation showed negative correlations, with relative humidity exhibiting the strongest negative correlation (r = -0.220). In contrast, wind speed was positively correlated with wildfire occurrence. However, all correlations were weak, indicating weak associations between the meteorological variables and wildfire occurrence (Table 3).

Table 3. Correlation between wildfire occurrence and meteorological variables.
Tabela 3. Correlação entre a ocorrência de incêndios florestais e as variáveis meteorológicas.

Variables	r	p
Wildfire occurrence – air temperature	-0.152	$2.5718x10^{-20}$
Wildfire occurrence – relative humidity	-0.220	$4.2165x10^{-41}$
Wildfire occurrence – precipitation	-0.191	$1.6774x10^{-31}$
Wildfire occurrence – wind speed	0.165	$7.6157x10^{-24}$

Fire use, wildfires, and critical meteorological conditions

Figure 3 presents a heatmap of the normalized values (0–1) of the variables analyzed. The highest values of air temperature, wind speed, wildfire occurrence, and preference for conducting agricultural burns were concentrated between August and November, coinciding with the lowest relative humidity and precipitation values. In contrast, February and March recorded the highest precipitation levels and the lowest values of wildfire occurrence and preference for conducting agricultural burns. Overall, the results indicate a relationship among traditional agricultural burning practices, wildfire occurrence, and critical meteorological conditions.

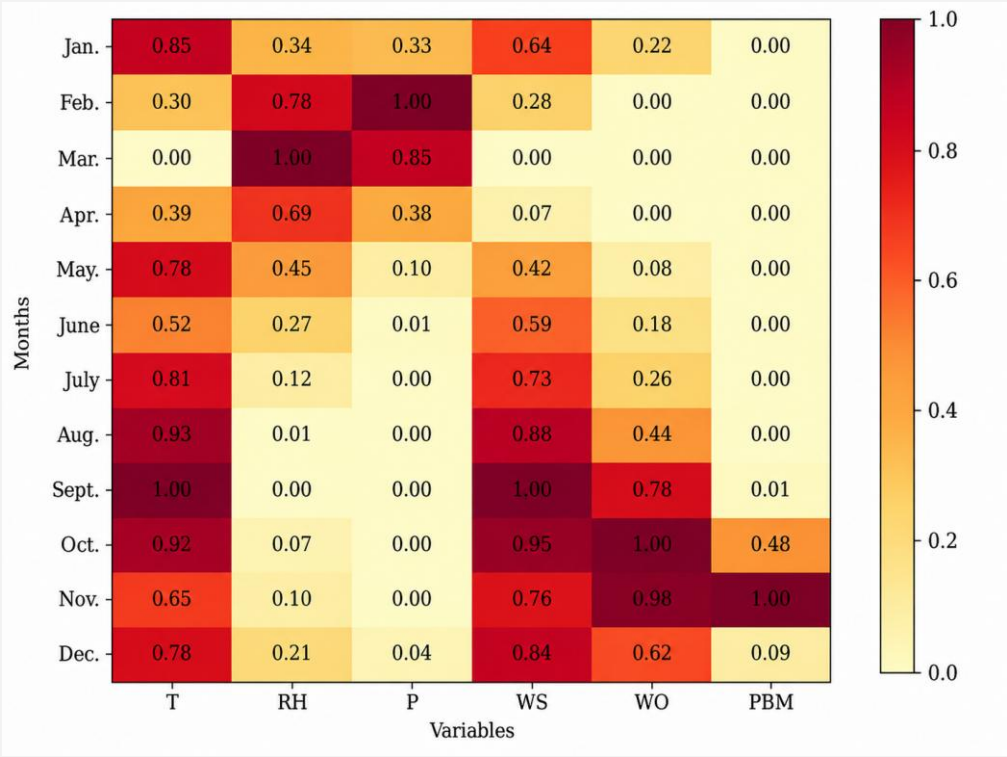


Figure 3. Heat map with normalized values of the variables used in the research.
Figura 3. Mapa de calor com valores normalizados das variáveis utilizadas na pesquisa.
Legend: T: air temperature; RH: relative humidity; P: precipitation; WS: wind speed; WO: wildfire occurrence; PBM: preferred burning months.

DISCUSSION

The results confirm that fire use in El Anegado Parish is a deeply rooted practice in local agricultural and cultural dynamics, primarily used for land preparation for crop cultivation. This pattern is consistent with the findings reported by Manrique-Toala *et al*. (2022) in the communities of Sancán and Membrillal and by Quijije Briones et al. (2025) in Estancia Vieja, Portoviejo Canton, Manabí. Likewise, Ramos and Molina (2023) and Carrión-Paladines *et al*. (2024) emphasize that these practices are based on knowledge transmitted across generations and adapted to environmental conditions and the productive rationale of smallholder farming.

The widespread use of fire for land preparation, together with the limited knowledge of alternatives, indicates a strong dependence on this practice. A similar pattern was described by Bonfim *et al*. (2003) in Brazil, where fire continues to be used despite regulatory restrictions due to the lack of technological alternatives and its perceived effectiveness. In El Anegado, 95.71% of farmers reported being unaware of alternatives to fire use, a finding consistent with that reported by Ramos-Rodríguez *et al*. (2021) for Ayacucho Parish, Manabí, confirming the influence of tradition and the limited dissemination of alternative practices.

The concentration of agricultural burning during October and November coincides with periods of lower relative humidity, limited precipitation, and higher wind speeds. This seasonality is consistent with the findings reported by Ramos Rodríguez *et al*. (2017) in Cuba and by Ramos-Rodríguez *et al*. (2025) in Jipijapa, who identified a close relationship between dry conditions and increased wildfire occurrence. Farmers in El Anegado take advantage of these conditions to conduct agricultural burns, demonstrating empirical knowledge of the most favorable climatic windows.

The preference for conducting agricultural burns between 09:00 and 11:00 also reflects traditional strategies aimed at reducing the influence of extreme heat and wind, a pattern also described by Ramos-Rodríguez *et al*. (2021). However, Kariuki *et al*. (2025) warn that climate change may alter these daily patterns, increasing fire risk even during times traditionally considered safe, which reinforces the need to incorporate up-to-date meteorological information into burn planning.

The growing recognition of the effects of fire on soil fertility and biodiversity provides opportunities to promote interventions that integrate scientific knowledge with local knowledge (ARAYA BRAVO *et al*., 2009; SANTÍN; DOERR, 2016). In this context, the collective nature of agricultural burning is particularly important.

Carrión-Paladines *et al*. (2024) point out that these practices strengthen community ties and foster cooperation, although they may also increase wildfire risk when adequate preventive protocols are lacking.

The limited adoption of preventive measures, such as firebreaks, slope assessment, or fuel moisture evaluation, represents a risk factor under scenarios of increasing climate variability. This situation is consistent with the findings reported by Ramos-Rodríguez *et al*. (2022). In this regard, Abbas *et al*. (2025) propose complementing traditional knowledge with accessible technologies and agroforestry practices, particularly during periods of increased fire risk.

The motivations for fire use in El Anegado are essentially related to agricultural production, with land preparation for cultivation predominating over ritual or symbolic purposes. This pattern differs from that observed in the Colombian Llanos, where the fire regime is influenced by flooding cycles and responds to specific cultural practices (HUERTAS HERRERA *et al*., 2019). In the study area, climate seasonality determines both the timing of agricultural burning and the perception of the associated risk.

Farmers' responses to emergencies during agricultural burning reveal limited coordination with institutions responsible for fire management. The priority given to assistance from family members over fire departments and other authorities is consistent with the findings of Quijije Briones *et al*. (2025) and reflects limited institutional capacity for wildfire response. In this regard, Ríos Hervas (2023) highlights that significant gaps in integrated fire management persist in Ecuador, ranging from prevention to post-fire restoration.

Local fire suppression capacity is also limited due to the low use of specialized tools and personal protective equipment, a situation also described by Quijije Briones *et al*. (2025). This condition increases the risk to farmers and reduces the effectiveness of initial fire control, increasing the likelihood that agricultural burns will develop into wildfires. In this regard, Flores Garnica *et al*. (2025) indicate that most wildfires in Colima, Mexico, occur in the western region of the state, where various productive activities (livestock farming, agriculture, agroindustry, and tourism) are carried out in areas dominated by secondary vegetation of tropical dry deciduous forest.

The intergenerational transmission of knowledge ensures the continuity of traditional fire use but also poses the challenge of transitioning toward more sustainable practices. Smith *et al*. (2024) indicate that the most effective public policies are those that recognize the cultural value of these practices and promote gradual changes through participatory processes, an approach that is particularly relevant to the context of El Anegado.

The correlations obtained indicate weak but statistically significant associations between meteorological variables and wildfire occurrence. The negative correlation between relative humidity and wildfire occurrence, as well as the positive correlation between wildfire occurrence and wind speed, reinforces the findings of Gil Mora (2020) and Ramos-Rodríguez *et al*. (2025). Similarly, Villar-Hernández *et al*. (2024) found that environmental factors such as precipitation and temperature significantly influenced wildfire occurrence across different Brazilian biomes.

The overlap between the preferred months for agricultural burning and the period of highest wildfire occurrence indicates that, under critical meteorological conditions, these practices may contribute to the ignition of uncontrolled fires. This finding is consistent with Kariuki *et al*. (2025), who highlight the importance of identifying periods of greatest fire risk to strengthen fire prevention and management strategies.

The absence of local early warning systems limits the safe planning of agricultural burning. Abbas *et al*. (2025) propose integrating community-based weather stations with real-time climate information, combining traditional knowledge with scientific tools to reduce the occurrence of accidental fires and improve the planning of agricultural activities that still depend on fire use.

In El Anegado, decisions regarding fire use are primarily based on empirical experience, without specialized technical support. Factors such as slope and fuel arrangement, recognized by Ramos-Rodríguez *et al*. (2024) for their influence on fire behavior and its effects on soil, are not yet systematically incorporated into burning practices. Therefore, technical assistance, incentives for adopting alternatives to fire use, and community participation could contribute to more resilient agriculture and more sustainable integrated fire management.

CONCLUSIONS

- Fire use is the main practice for clearing agricultural land in El Anegado and persists due to the intergenerational transmission of knowledge and the limited availability of technical alternatives.
- Agricultural burning exhibits marked seasonality, occurring mainly between October and November, when low relative humidity, limited precipitation, and higher wind speeds prevail.
- The period of greatest fire use coincides with the period of highest wildfire occurrence, suggesting an association between meteorological conditions and fire dynamics.
- The results support the proposed hypothesis and indicate a temporal association among fire use, wildfire occurrence, and critical meteorological conditions.

- It is recommended that integrated fire management strategies be strengthened through training programs and the promotion of alternatives to traditional fire use, while incorporating additional social and environmental factors into future research.

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