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Economic Impact on Micro, Small and Medium Enterprises (MSMEs) Due to Forest and Land Fires in Kutai Kartanegara Regency

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ABSTRACT

Forest and land fires (karhutla) are recurring disasters that cause serious economic impacts on Micro, Small, and Medium Enterprises (MSMEs). This study aims to analyze the direct and indirect economic impacts of karhutla on MSMEs in Kutai Kartanegara Regency. A quantitative approach was applied through a survey of 150 respondents across five districts, analyzed using descriptive statistics, the Wilcoxon Signed-Rank comparative test, and multiple linear regression. The results prove a highly significant difference in net income before and after the disaster (Z = -7.126; p = 0.000). The heaviest losses were borne by smallholder oil palm farmers in rural areas, while urban areas remained relatively stable. Indirect impacts were transmitted through a health crisis (acute respiratory infection) that triggered treatment costs and loss of productive working days. The regression model (R^2 = 0.524) shows that disaster exposure has a dominant negative effect, while business adaptation and the institutional role of local government (the Kredit Kukar Idaman program) have a significant positive effect on income recovery.

INTRODUCTION

Indonesia, as an agricultural and maritime country rich in natural resources, frequently faces various environmental challenges, one of which is forest and land fires (Karhutla). Forest and land fires not only threaten the sustainability of ecosystems and biodiversity but also cause serious multidimensional impacts, including social, health, and economic impacts (Novita & Vonnisa, 2021). East Kalimantan Province, particularly Kutai Kartanegara Regency, is one of the areas vulnerable to forest and land fires due to biophysical and anthropogenic factors. Forest and land fires in this region are often exacerbated by climatic conditions, the presence of peatlands, and human activities such as land clearing by burning.

Kutai Kartanegara Regency has experienced an alarming escalation in forest and land fires between 2021 and 2024. Data shows a drastic spike in both incidents and the area of land affected. In aggregate, the total area burned reached 32,334.97 hectares during this four-year

period. This peaked in 2023, with 19,730.34 hectares burned, followed by 12,084.63 hectares in 2024. This surge in land loss, which coincided with a significant increase in the number of hotspots (5,246 in 2023 and 4,462 in 2024), indicates that Kutai Kartanegara Regency is facing an acute environmental vulnerability crisis.

Table 1. Comprehensive trends of forest and land fires in Kutai Kartanegara (2021-2025)

Year	Number of Incidents (BPBD)	Area of Burned Land (Ha)	Number of Hotspots (SIPONGI)	Intensity
2021	0	466.00	64	Low
2022	2	54.00	848	Currently
2023	58	19,730.34	5,246	Very high
2024 (YTD)	23	12,084.63	4,462	Tall
2025	25	105.00	1,541	-
Total Accumulation	118	32,334.97	10,620	-

Source: SiPongi and BPBD of Kutai Kartanegara Regency

The economic impact of forest and land fires is extensive and often overlooked in policy analysis, particularly on the informal sector and micro, small, and medium enterprises (MSMEs). MSMEs play a strategic role in the national economy, contributing a significant portion of gross domestic product (GDP) and providing employment to millions. In Kutai Kartanegara Regency, the MSME sector is the backbone of the local economy, encompassing a wide range of businesses, from agriculture and fisheries to handicrafts and tourism. Therefore, even the slightest disruption to MSME operations can have significant implications for community welfare and regional economic stability.

Forest and land fires cause various direct and indirect losses for MSMEs. Direct losses include physical damage to business assets, such as agricultural land, plantations, livestock pens, or burned business premises. Indirect losses are more complex and long-term, such as decreased productivity due to worker health problems, decreased market demand, supply chain disruptions, and changes in consumption patterns among affected communities (Utoro, 2024). The local tourism sector, which relies on natural beauty and clean air, is also hit hard (Cahyono et al., 2019). et al., 2020).

Previous studies have extensively discussed the causes and efforts to control forest and land fires (Utoro, 2024; Novita & Vonnisa, 2021), but specific focus on the economic impact of forest and land fires on MSMEs in Kutai Kartanegara is still limited. Cassandra et et al. (2020) highlighted the impact of forest and land fires on public health and the general economy in Kalimantan and Sumatra, but did not specifically examine the impact on the MSME segment. The lack of comprehensive data and analysis on this impact may hamper the

formulation of effective recovery policies and programs for MSMEs post- forest and land fires.

Based on this background, this study aims to: (1) map the temporal trends and spatial distribution of forest and land fires in Kutai Kartanegara; (2) quantitatively measure the magnitude of economic losses of MSMEs due to exposure to forest and land fires; (3) analyze the transmission mechanisms of microeconomic losses and determinants of post-disaster resilience; and (4) develop evidence-based policy recommendations to improve risk mitigation and resilience of small economies to the threat of forest and land fires in the future.

RESEARCH METHODS

This research uses a quantitative approach focused on causal inference, which is most appropriate for development planning theses because it allows for statistically rigorous impact testing. The data used combines a temporal dimension (2021-2025) and cross-dimensions of business units in various sub-districts, comparing pre -disaster (2021-2022) and post-disaster (2023-2025) conditions.

Historical secondary data on forest and land fires (hotspots per village, incidents per sub-district, burned area) were collected from the Kutai Kartanegara Regional Disaster Management Agency (BPBD) and SIPONGI, while supporting macroeconomic data (GRDP) were taken from the Kutai Kartanegara Statistics Agency (BPS). Primary data were collected through surveys of micro-business actors and farmer/fisher households in the treatment area (high exposure) and control (low exposure). The survey included pre- and post- shock data to measure key variables such as income, turnover, health costs, and capital losses. Data collection techniques were supplemented with in-depth interviews, observation, and documentation to ensure triangulation (Denzin, 1978).

This study determined the treatment group (high exposure) namely Muara Kaman, Samboja, and Kembang Janggut Districts, as well as the control group (low exposure) namely Tenggarong and Sanga-Sanga, to isolate the pure effects of forest and land fires from normal regional economic trends.

Table 2. Research variables and operational definitions

Variables	Type	Operational Definition	Data source
Forest and Land Fire Exposure (X)	Independent	Hotspot density per village/sub-district (cumulative 2023-2024) or burned land area (Ha)	SIPONGI Satellite, BPBD
Economic Impact (Y)	Dependent	Decrease in average monthly income/turnover and working capital loss per business unit	Primary Data (Survey)
Indirect Loss (Z)	Intermediary	Cost of treatment for smoke-related ISPA (Cost of Illness) and estimated	Primary Data (Survey)

Variables	Type	Operational Definition	Data source
		lost productive work hours	
Resilience (R)	Control	Kukar's Ideal Credit Access /capital assistance, livelihood diversification, asset ownership	Primary Data (Survey)

Analysis Techniques

Data analysis using a combination of descriptive statistics, non- parametric comparative tests Wilcoxon Signed Rank Test , and multiple linear regression. The Wilcoxon test was used because the income difference data were not normally distributed . The multiple linear regression model used is formulated as follows:

$$Yi = \beta 0 + \beta 1Xi + \beta 2Zi + \beta 3Ri + \epsilon i$$

RESULTS AND DISCUSSION

Overview of Location and Respondent Characteristics

Kutai Kartanegara Regency has unique geographical characteristics, encompassing land and water areas as well as extensive forests and peatlands, making it highly vulnerable to forest and land fires (Novita & Vonnisa , 2021). Based on field data collection, a sample of 150 respondents was obtained spread across five affected sub-districts: Muara Kaman (42 respondents), Kembang Janggut (23 respondents), Samboja (35 respondents), Tenggarong (25 respondents), and Sanga-Sanga (25 respondents).

The demographic profile and operational characteristics of respondents are presented in Table 3 to provide a comprehensive picture of the socio-economic conditions of business actors in the research area.

Table 3. Demographic and business characteristics of respondents (N = 150)

Parameter	Category	Frequency (N)	Percentage (%)
Subdistrict Area	Muara Kaman	42	28.0
	Beard Flower	23	15.3
	Samboja	35	23.3
	Tenggarong	25	16.7
	Sanga-Sanga	25	16.7
Gender	Man	82	54.7
	Woman	68	45.3
Education	Elementary School / Equivalent	18	12.0

Parameter	Category	Frequency (N)	Percentage (%)
	Junior High School / Equivalent	52	34.7
	High School / Equivalent	60	40.0
	College	20	13.3
Business Sector	Trade & Services	102	68.0
	Agriculture & Plantation	32	21.3
	Fisheries & Processing	16	10.7
Land Ownership	One's own	138	92.0
	Rent / Not Own	12	8.0

Source: Processed primary data, 2025

The geographic distribution of the sample shows a representation of rural areas close to forest areas (Muara Kaman and Kembang Janggut) and semi-urban areas (Samboja, Tenggarong , and Sanga-Sanga). In terms of education, the majority of respondents were junior high school graduates (34.7%) and high school graduates (40.0%), with only 13.3% having pursued higher education. This limited formal education indicates that business actors' managerial capacity and financial literacy in anticipating disaster risks are still relatively limited.

The business sector structure is dominated by Trade & Services (68.0%), followed by Agriculture & Plantations (21.3%), dominated by independent oil palm farmers, and Fisheries & Processing (10.7%). The dominance of private land ownership at 92.0% indicates that if a physical fire occurs on business premises, MSMEs will directly experience the degradation of their privately owned productive assets.

Direct Economic Loss Analysis

The direct economic impact is measured through monthly financial performance fluctuations (turnover, operating costs, and net income). Average financial indicators before (pre) and after (post) the forest and land fire disaster are presented in Table 4.

Table 4. Comparison of monthly finances before and after the disaster by sub-district (Rp)

Subdistrict	Pre-sale Turnover	Post-Turnover	Net Pra	Post Net
Muara Kaman	68,321,429	59,845,238	31,904,762	21,904,762
Kembang Janggut	136,217,391	114,652,174	87,086,957	64,913,043
Samboja	22,828,571	21,600,000	8,857,143	6,842,857
Tenggarong	18,000,000	17,800,000	7,420,000	7,180,000
Sanga-Sanga	18,300,000	18,160,000	7,940,000	7,820,000

Source: Processed primary data, 2025

Financial data shows that Kembang Janggut and Muara Kaman sub-districts experienced the steepest net income shocks. In Kembang Janggut, average net income dropped from Rp 87,086,957 to Rp 64,913,043 per month (a 25.5% decrease), triggered by physical damage to smallholder oil palm plantations. For example, respondent K043 suffered the destruction of 5 hectares of oil palm plantations, resulting in a drop in harvest quantity from 150 to 100 units, resulting in a harvest loss of Rp 100,000,000 and the destruction of fixed assets worth Rp 400,000,000.

In Muara Kaman District , peatland fires severely damaged independent smallholder oil palm plantations; respondent K035 reported damage to 7 hectares of oil palm plantations, with estimated asset damage of Rp 125,000,000 and loss of harvest value of Rp 65,000,000. The damage to these oil palm plantations is long-term, requiring 3 to 4 years of rehabilitation and replanting to reach the productive stage. In contrast, urban areas such as Tenggarong and Sanga-Sanga recorded minimal direct physical losses due to the remoteness of their businesses from direct fire exposure.

Analysis of Indirect Losses and Health Impacts

Indirect economic impacts are transmitted through regional air quality degradation (haze), which triggers a public health crisis. Exposure to dense smoke increases the incidence of Acute Respiratory Infections (ARI), triggering self-medication costs and lost productive workdays. Details of the impacts are presented in Table 5.

Table 5. Distribution of health impacts and productivity losses per sub-district

Subdistrict	ISPA Respondents	ISPA Ratio (%)	Health Cost (Rp)	Lost Work Day	Production Loss (Rp)
Muara Kaman	27	64.3	510,714	3.36	1,139,524
Kembang Janggut	21	91.3	610,870	4.96	667,391
Samboja	22	62.9	234,286	2.09	592,857
Tenggarong	7	28.0	120,000	0.24	192,000
Sanga-Sanga	0	0.0	0	0.12	20,000

Source: Processed primary data, 2025

The tabulation results demonstrate a significant spatial gradient in health impacts. In Kembang Janggut District, the incidence rate of acute respiratory infections (ARI) reached an extreme 91.3%, with 21 of 23 respondents falling ill due to the dense haze, with an average additional health care cost of Rp 610,870 and a loss of 4.96 productive workdays per month. In a subsample of cage fish farmers in Muara Kaman, the loss of productive days automatically halted regular cage maintenance, disrupted the biological condition of the fish,

caused the death of fry, and triggered indirect productivity losses of up to Rp 5,000,000 per respondent.

On the other hand, Sanga-Sanga District serves as a natural spatial control group. Its relatively remote distance from the fire hotspots and favorable wind patterns keep the area free from haze, resulting in a 0% incidence of acute respiratory infections (ARI). This spatial comparison empirically demonstrates that the indirect impact transmission pathway of forest and land fires operates locally and regionally through exposure to air pollutants.

Comparative Hypothesis Testing: Pre- and Post-Disaster Financial Conditions

To test whether forest and land fires significantly degrade MSMEs' net income, a pairwise comparative analysis was conducted, beginning with a normality test . Given the sample size of N = 150, the Kolmogorov-Smirnov test was used as the primary reference.

Table 6. Results of the normality test for the difference in net income

Test Method	Statistics	df	Sig .	Conclusion
Kolmogorov-Smirnov	0.284	150	0,000	Abnormal
Shapiro-Wilk	0.412	150	0,000	Abnormal

A significance value of 0.000 < 0.05 causes H0 to be rejected; the income difference data is not normally distributed . Because the normality assumption is not met, comparative testing uses a non- parametric test. Wilcoxon Signed Rank A more robust test for paired data.

Table 7. Rank analysis and Wilcoxon test results Signed Rank Test

Shift Category	N	Mean Rank	Sum of Ranks
Negative Ranks (Down)	64	32.50	2,080.00
Positive Ranks (Up)	1	1.00	1.00
Ties (Fixed)	85	-	-
Total	150	-	-

Statistical Parameters	Mark
Z- Statistic	-7,126
Asymp . Sig . (2-tailed)	0,000

Source: Processed primary data, 2025

The test results show a Z-value of -7.126 with a significance level of 0.000 < 0.05, thus rejecting H0 and accepting H1. Thus, empirically, there is a very significant difference in net income for MSMEs in Kutai Kartanegara Regency between the periods before and after the forest and land fires. This result is in line with the findings of Suryani et al. (2020) which shows that MSMEs have low mitigation capacity against disaster shocks.

Multiple Linear Regression Modeling: Determinants of Post-Disaster Income

To analyze the determinants of post-disaster net income variability, a multiple linear regression model was constructed that tested the influence of business adaptation (X1), the

role of government institutions (X2), disaster exposure (X3), and psychological concerns (X4).

Table 8. Summary of the feasibility of the regression model (Model Summary) and F-test

Parameter	Mark
Correlation Coefficient (R)	0.724
Coefficient of Determination (R^2)	0.524
Adjusted R^2	0.511
F- Statistic	39,913
Sig . (F-Test)	0,000

The R^2 value of 0.524 indicates that the independent variables simultaneously explain 52.4% of the variance in post-disaster net income. The F-test yields a calculated F of 39.913 with a significance level of 0.000 < 0.05, proving that the four variables together significantly influence the net income of MSMEs.

Table 9. Results of partial regression coefficient estimation (t-test)

Variables	Coefficient	Beta	t	Sig .	VIF
(Constant)	45,321,400	-	5,319	0,000	-
Adaptation (X1)	12,150,000	0.214	2,949	0.004	1,171
Role of Government (X2)	8,420,000	0.311	3,991	0,000	1,348
Disaster Exposure (X3)	-11,950,000	-0.412	-3,970	0,000	1,451
Worry (X4)	-3,120,000	-0.122	-2,026	0.045	1,096

Source: Processed primary data, 2025

Based on the computational results, the regression equation is structured as follows:

$$Y = 45{,}321{,}400 + 12{,}150{,}000X1 + 8{,}420{,}000X2 - 11{,}950{,}000X3 - 3{,}120{,}000X4$$

Adaptation (X1) has a positive and significant effect (p = 0.004): MSMEs who implement operational adaptation strategies earn a higher net income of Rp 12,150,000 compared to passive ones. The Role of Government (X2) has a positive and highly significant effect (p = 0.000): every one-unit increase in the perception index of the role of local government institutions predicts an increase in income of Rp 8,420,000, confirming the importance of public policy stimulus in capital recovery.

Disaster Exposure (X3) has a negative and highly significant effect (p = 0.000) with the largest standardized beta coefficient (-0.412), proving that physical exposure to disasters is the most dominant factor suppressing income. Worry (X4) has a negative and significant effect (p = 0.045): high psychological anxiety makes business actors defensive, holding back capital investment, thus inhibiting the rate of independent business recovery.

All independent variables have VIF values below 10 and tolerance above 0.10 so that the model is free from multicollinearity . The Glejser test and scatterplot indicate that the assumption of homoscedasticity is met, and the Kolmogorov-Smirnov test on the residuals (Sig . 0.172 > 0.05) proves that the residuals are normally distributed. Thus, the regression model meets the criteria for Best Linear Unbiased. Estimator (BLUE).

Transmission of Economic Impact and Effectiveness of Kukar's Ideal Credit Policy

Empirical findings confirm that forest and land fires have significant real economic consequences at the micro level through two transmission channels. In the direct channel, independent smallholder oil palm farmer groups in Kembang Janggut and Muara Kaman bear the brunt of the physical damage; the flames burn plantations, degrade peat soil quality, and destroy production capacity for years to come. In the indirect channel, dense haze damages human capital through a surge in acute respiratory infections (ARI), forcing medical expenses amid depressed turnover, and disrupting daily cash flow due to the loss of productive workdays for business owners.

In the face of post-disaster shocks, regression analysis demonstrates the significant positive impact of local government institutions on revenue recovery. One leading instrument is the Kredit Kukar Idaman (KKI) program, a regional microfinance innovation based on Kutai Kartanegara Regent Regulation Number 11 of 2021. This program offers business capital loans at 0% interest without burdensome collateral. This program serves street vendors (ceiling of Rp 10,000,000), new entrepreneurs (Rp 15,000,000), and micro-entrepreneurs (Rp 25,000,000).

Theoretically, KKI acts as a financial safety net . A safety net that protects micro-entrepreneurs from the clutches of informal loans, loan sharks, and illegal online loans. Through Bankaltimtara , a distributor with Jamkrida Kaltim's risk guarantee , KKI provides crucial liquidity to rehabilitate businesses post-disaster. The program's performance is considered very healthy, with a non-performing loan (NPL) ratio below 2.5%. In 2024, Kutai Kartanegara Regency received a dividend of IDR 21 billion from Bankaltimtara , which was reallocated to increase the program's capital (total equity participation of IDR 42 billion, with actual disbursement exceeding IDR 36 billion).

However, field findings indicate that inclusion barriers persist, with some micro-businesses in remote areas affected by forest and land fires still lacking understanding of the administrative procedures for applying for a KKI due to limited outreach and business formalities (ownership of a Business License (NIB) or Business License (SKU). Therefore, strengthening financial literacy and simplifying access to business permit assistance are prerequisites for ensuring that all MSMEs receive the benefits of disaster response financing equitably.

CONCLUSION AND SUGGESTIONS

The forest and land fires in Kutai Kartanegara Regency have had severe and asymmetric direct economic impacts between rural and urban areas. Smallholder oil palm plantations in Kembang Janggut and Muara Kaman suffered significant physical damage to fixed assets and significant crop losses, while urban areas like Tenggarong and Sanga-Sanga experienced no direct physical damage, although they still experienced a decline in revenue. Indirect impacts were transmitted through the health crisis (ARI), which forced medical expenses and disrupted the daily cash flow of micro-businesses due to the loss of productive workdays.

Wilcoxon test demonstrated a highly significant difference in net income before and after the disaster ($Z = -7.126$; $p = 0.000$). The regression model ($R^2 = 0.524$) indicated that disaster exposure was the most dominant factor depressing income, while business adaptation and the role of government institutions had a significant positive effect on recovery. Theoretically, this study demonstrates that post-disaster microeconomic recovery is not only determined by physical capital and institutional interventions, but also by the psychological aspects of business actors (risk perception).

Based on these findings, regional and central governments are advised to strengthen integrated forest and land fire prevention policies, develop post- forest and land fire mitigation and economic adaptation programs for MSMEs (financial assistance, training, market facilitation, raw material guarantees), build a reliable early warning system, and expand the inclusion of the Kukar Idaman Credit program. MSMEs are encouraged to improve their risk management capacity, build financial resilience through emergency reserve funds, implement commodity diversification, and utilize digital technology. Further research is recommended to conduct long-term longitudinal studies, develop more sophisticated mitigation economic models , and examine the impact of the relocation of the National Capital on MSMEs in the context of forest and land fire risk .

Limitations of this study include its limited geographic coverage to a single district, its reliance on estimates and respondents' perceptions due to limited financial records of micro-SMEs, and its duration, which was unable to capture long-term cumulative impacts. These limitations should be considered when interpreting the findings and should be considered for further research.

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