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Ecological Conflict Resolution in Forest Fire Governance; Local Wisdom and Human Security in Merauke, Papua Selatan

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ABSTRACT

Forest and land fires generate interacting ecological risks, governance tensions, and threats to human security. In Merauke, South Papua, their management requires attention to landscape variation and to the legitimacy of decisions affecting communities. This article examines how locally grounded knowledge and ecological conflict resolution can inform collaborative fire governance and protect human security. It applies a qualitative integrative narrative review of research published in 2017–2026, distinguishing direct evidence from Merauke and Wasur National Park from comparative findings elsewhere. Published Merauke observations show 2,671 MODIS hotspots in 2015 and 534 in 2019, with approximately 98% of burned areas on non-peatland in both years. Recent Wasur research additionally documents seasonality and Indigenous Kanume fire-use knowledge, without establishing uniform practices throughout the regency. The synthesis finds that local ecological observations, inclusive deliberation, reliable attribution procedures, and feasible livelihood alternatives can complement scientific monitoring. It proposes an evidence-sensitive governance framework connecting fire-risk identification, knowledge validation, negotiated responsibilities, grievance review, and human-security evaluation. These mechanisms are propositions rather than empirically established programme outcomes in Merauke. Effective fire governance should therefore combine ecological risk reduction with procedural recognition, accountable participation, and protection of health and livelihoods, while future field research tests the model's implementation and effects.

Keywords: Ecological Conflict, Forest and Land Fires, Local Wisdom, Collaborative Governance, Human Security

INTRODUCTION

Forest and land fires are simultaneously biophysical disturbances, livelihood hazards, and tests of environmental governance. Their immediate signatures flame fronts, smoke, charred vegetation, and altered soil conditions are more readily observable than the social relationships that shape prevention and recovery. A fire may cross administrative jurisdictions while its consequences fall

unevenly on households with different access to information, transport, land, health services, and public decision-making. Treating the problem only as an emergency response would therefore obscure the institutional conditions that determine who is protected, whose knowledge counts, and how the costs of prevention are distributed. In Indonesia, studies of fire interventions and stakeholder perceptions repeatedly identify the limits of fragmented, predominantly technical approaches and the need to address the diversity of affected interests (Carmenta et al., 2017; Jefferson et al., 2020; Schinko et al., 2023).

Merauke Regency, in South Papua, provides an important setting for connecting this ecological problem with the wider field of conflict resolution. Its landscapes include wetland and non-peat environments, distinct vegetation formations, and areas in which communities pursue activities closely tied to seasonal ecological change. Remote-sensing analysis for 2015 and 2019 identified 2,671 and 534 MODIS hotspots, respectively, while reporting that approximately 98% of its estimated burned areas in both observation years lay outside peatland. Swamp scrub accounted for the greatest burned-area category reported in that study. Those findings make it inappropriate to assume that every Indonesian fire-governance lesson derived from peatlands can be transferred directly to Merauke, even though comparison remains analytically useful (Kirana & Nurhayati, 2022; Nurhayati et al., 2025).

The geographical specificity has become clearer in recently published work from Wasur National Park in the Merauke area. That study combined a MODIS time series with interviews involving Kanume informants and documented a seasonal association between hotspot detection, climatic variability, and Indigenous fire use. It describes traditional burning in relation to Kanume seasonal categories termed Tebrasaro and Sep-Sep. These findings constitute location-specific evidence that customary ecological knowledge is relevant to inquiry in the Wasur landscape; they do not establish that all communities in Merauke share identical practices or that cultural burning is intrinsically safe in every season. The distinction between documented practice and generalised inference is crucial for a careful local-wisdom argument (Budiningsih et al., 2026; Kirana & Nurhayati, 2022).

A governance problem arises when environmental risks overlap with competing understandings of land, authority, responsibility, and acceptable livelihood practices. Government regulations, customary institutions, agricultural users, conservation actors, and technical responders may approach a common landscape with different definitions of legitimate action. Published analysis of land-access disputes linked to strategic development projects in South Papua provides an important governance context, but not evidence that such disputes caused any particular fire. Such differences do not demonstrate that a particular fire was caused by a particular group, nor do they prove the existence of violent conflict. They do, however, provide plausible conditions under which rules on prevention and enforcement can become contested. Research on Indonesian peat-fire governance shows that conflicting perceptions of acceptable interventions and overlapping scales of authority can limit implementation even where the objective of reducing damage is shared (Astuti, 2020; Großmann, 2020; Ramandei, 2026).

This article employs ecological conflict as an analytical term for tensions over environmental values, resource access, land-use priorities, recognition, and decision-making authority within fire governance. Ecological conflict resolution consequently involves more than mediating a complaint after a fire. It includes

arrangements that allow disagreements to be voiced before emergency conditions, ensure that scientific data and lived experience can be assessed together, and distribute monitoring and response responsibilities transparently. Environmental justice research highlights procedural, distributive, and restorative dimensions of such arrangements, while scholarship on political recognition in Indonesia illustrates why formal participation may fail when customary claims are heard but not meaningfully considered (Jasmine et al., 2025; Marta, 2025; Rimordiaz & Suswanta, 2025).

Local wisdom is neither treated here as a homogeneous cultural inventory nor romanticised as an automatic solution. The term refers to situated knowledge, customary norms, seasonal interpretation, and forms of social coordination developed in relation to specific environments. These capacities can help identify changes in fuel and moisture, coordinate activities, communicate danger, and negotiate access. At the same time, fire-use practices are dynamic: climatic conditions, demographic change, markets, and state regulation may transform their ecological consequences. Comparative studies of Indigenous fire stewardship and community prevention demonstrate both the value of locally grounded knowledge and the importance of carefully negotiated relationships with formal institutions (Fajarwati & Masruri, 2019; Jolly et al., 2025; Nikolakis et al., 2024).

Human security provides the normative bridge between ecological protection and conflict resolution. It asks how a hazard threatens the conditions of everyday life rather than viewing security exclusively through the capacity to defend territory or control incidents. Smoke may endanger respiratory health; damaged production areas may undermine income and food access; restrictions imposed without dialogue may generate unequal burdens; and accusations made without credible investigation may damage social relations. Indonesian research has explicitly connected fire-related haze to several dimensions of human security, and regional estimates confirm that the health consequences of smoke are serious even though they should not be applied as direct estimates for Merauke.

A substantial evidence base exists on Indonesian fire prevention, particularly in peatland regions, and a growing literature addresses collaborative management, participation, communications, and restoration. Evidence from Bengkalis highlights the relevance of political support, locally demanded intervention, community leadership, social capital, and viable livelihood transitions. Policy-oriented research also finds that fire prevention can improve when government, community, and other institutions engage beyond a narrow suppression mandate. Nevertheless, geographic transfer requires attention to ecosystem differences, legal histories, and local institutional capacity; a framework tested elsewhere cannot substitute for on-site verification in Merauke (Alexandra et al., 2026; Purnomo et al., 2024; Roengtam & Agustiyara, 2025).

Three linked gaps guide the present synthesis. First, spatial descriptions of hotspots and burned areas are not equivalent to causal explanations of land-use decisions or ecological disputes. Second, comparative demonstrations of local knowledge do not by themselves specify the institutional conditions under which that knowledge becomes legitimate evidence in Merauke. Third, conventional measures of fire management often focus on incident counts or burned extent without tracing procedural fairness, livelihood consequences, or the security of vulnerable residents. Recent work on fire governance and environmental conflict supports the need for an analytical bridge linking those domains without collapsing distinct forms of evidence into a single causal claim (Budiningsih et al., 2026; Neger et al., 2024; Schinko et al., 2023).

The study therefore asks two questions: how do published studies illuminate the relationship among fire characteristics, community participation, and potential ecological conflict in Merauke, and through what mechanisms might local wisdom be integrated with collaborative fire governance to protect human security? Its contribution is an integrative explanatory framework, not a new estimate of burned area or an empirical evaluation of a previously implemented intervention. The analysis distinguishes findings directly observed in Merauke or Wasur from Indonesian comparisons and broader conceptual propositions. Such separation is essential when research crosses scales, because otherwise plausible governance recommendations can be mistaken for claims about actual local outcomes.

RESEARCH METHOD

The article adopts a qualitative, integrative narrative review design. The unit of analysis is published knowledge: peer-reviewed empirical studies, scholarly discussions of governance and conflict, and relevant conference research within the period 2017–2026. Rather than estimating an average treatment effect or presenting interview material, the review compares what different bodies of scholarship can legitimately establish about fire risk, public participation, customary knowledge, ecological disputes, and human security. An integrative design is appropriate because these questions are expressed through heterogeneous methods, including remote sensing, interviews, institutional analysis, conceptual interpretation, and comparative cases (Neger et al., 2024; Snyder, 2019).

Evidence was assembled through targeted searches of publisher and scholarly journal pages, with special attention to works that either directly address Merauke or Wasur or illuminate mechanisms relevant to fire governance elsewhere in Indonesia. Search concepts included Merauke hotspots, Wasur fire regime, Indigenous burning, participatory fire prevention, customary land, environmental justice, forest-fire governance, and human security. The bibliography prioritises materials published during the past decade, with three governance articles retrieved from the Journal Governance Society archive to develop the recognition and collaborative-governance dimensions. This approach is transparent about thematic priorities but is not presented as an exhaustive systematic search of every database.

Each publication was examined for location, research design, the type of evidence offered, the scale of the claim, and implications for the research questions. Direct local evidence includes the two-year hotspot and burned-area investigation in Merauke and the long-term fire-regime assessment within Wasur National Park. Comparative Indonesian research supplies tests and examples of participation, institutional design, and local knowledge. International fire-governance scholarship is used primarily to refine concepts of cultural burning, institutional interaction, and justice rather than to assert that its empirical findings already occur in South Papua. These distinctions provide an interpretive safeguard against ecological and cultural overgeneralisation.

The synthesis followed four analytical movements. The first identified ecological observations and the measurement limits of hotspot data; the second coded potential knowledge contributions and institutional tensions; the third compared conflict-resolution and collaborative-governance mechanisms; the fourth translated those mechanisms into possible human-security indicators. Themes were refined when evidence required separating a locally documented

phenomenon from a proposal inferred through comparison. No numerical thematic frequencies or inter-coder reliability statistics are reported because the review was not conducted as a formal coding census. Methodological clarity requires describing what the analysis actually did rather than borrowing procedures or validation claims from another research design.

The review also applied a hierarchy of evidentiary strength. Satellite-derived hotspot detections can characterise certain spatial and temporal patterns but cannot assign responsibility for ignition. Interview-supported local studies can describe reported practices within the investigated community but cannot automatically represent other Indigenous groups. An institutional case study may identify possible mechanisms, yet its results remain context-bound until the conditions of transfer are evaluated. Conceptual works are useful for constructing models but do not measure whether an intervention reduced smoke exposure or improved fairness. The use of different levels of evidence prevents the proposed model from becoming stronger than its empirical foundation.

Ethical considerations concerned representation and inference rather than direct contact with participants, as no interviews, surveys, or observations were undertaken for this article. Indigenous knowledge is discussed only where the cited study documents it, and the review does not publish unpublished cultural information or attribute responsibilities to identifiable groups. It also avoids treating customary actors as internally uniform. Where land rights and livelihood security are discussed, they are approached as issues requiring recognition, documentation, and procedural safeguards rather than as adjudicated findings of wrongdoing by particular stakeholders in Merauke (Lobubun et al., 2026; Marta, 2025; Parwata et al., 2026).

Two limitations frame all findings. First, the literature was selected for analytical relevance rather than through an auditable systematic-review protocol with a fixed retrieval date, independent screening, and a PRISMA flow count. Second, direct empirical studies of Merauke are narrower than the comparative literature, particularly for village-level dispute-resolution experience and household human-security outcomes.

RESULTS AND DISCUSSION

1. Fire regimes and the evidentiary limits of spatial indicators

The primary location-specific result is a patterned yet incomplete picture of fire occurrence. The Merauke study reported 2,671 MODIS hotspots in 2015 compared with 534 in 2019. On the study's own measurement basis, this is a pronounced difference in detections between two selected years; it cannot be interpreted as a linear decade-long decline. Reported burned-area classification was strongly concentrated on non-peatland in both years, at approximately 98% compared with 2% on peatland, and the most affected land-cover class was swamp scrub. The findings indicate why planning should recognise multiple fuel and vegetation environments rather than using peat-drainage remedies as the only conceptual starting point (Kirana & Nurhayati, 2022; Nurhayati et al., 2025).

Table 1. Local fire evidence and analytical boundaries

Evidence category	Published observation / scope	Governance interpretation
Merauke hotspots	2,671 detections (2015); 534 (2019)	Two selected-year counts; not a time-series trend

Evidence category	Published observation / scope	Governance interpretation
Merauke substrate	Approximately 98% non-peat burned area in both study years	Do not prescribe peat-only interventions across the district
Merauke vegetation	Swamp scrub was the largest affected land-cover class	Site-specific fuel and access assessment is needed
Wasur fire season	Dry-season detections; peak around September–October	Align inquiry and warning design with local seasonality
Wasur Indigenous context	Kanume interviews discuss seasonal fire use	Evidence for the studied setting, not all Merauke communities

Source: Analytical synthesis of Merauke and Wasur studies

Table 1 separates observed characteristics from the interpretations they can support. The hotspot comparison is valuable for establishing that observed fire activity differs across selected years, while the land-cover comparison cautions against a single-ecosystem template. Yet the observations do not measure household exposure, document customary decisions, or determine fault. Differences between sensors, seasonal cloud conditions, detection confidence, and analytical procedures further caution against comparing datasets as if their counts were directly interchangeable. An effective governance diagnosis therefore begins with clear source documentation and adds the ecological, institutional, and community information that remote sensing alone cannot provide.

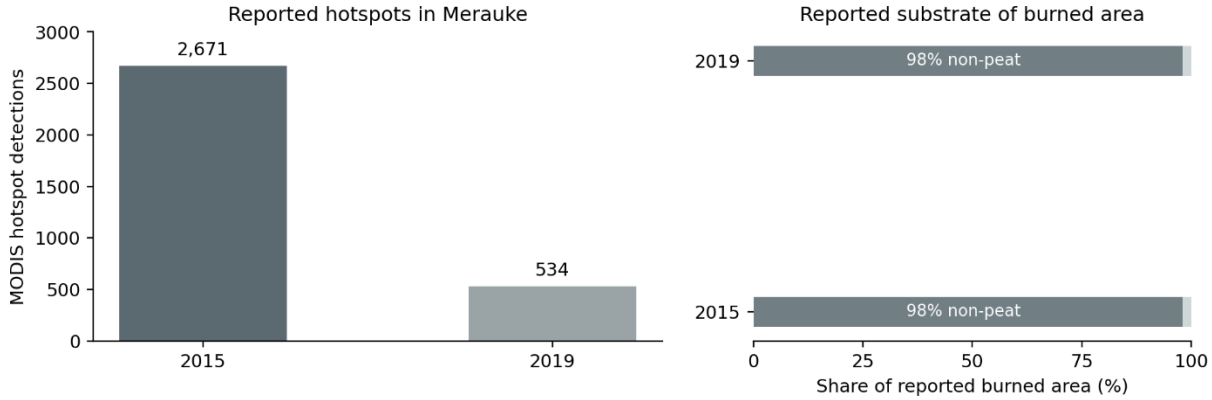


Figure 1. Selected-year hotspot detections and substrate distribution in Merauke
Source: Author, 2026

The independent study of neighbouring Mappi District reinforces the value of attention to local spatial heterogeneity. It documents a decade-long pattern using its own study area and MODIS methods, showing that ecological and temporal characteristics should be examined at the scale relevant to management. Its statistics are not Merauke statistics, and combining two districts into one apparent local trend would obscure the differences that the comparison is meant to reveal. A defensible regional programme should specify whether a map refers to Merauke Regency, Wasur National Park, Mappi District, or a larger planning

jurisdiction before drawing conclusions about community risks or response priorities (Kirana & Nurhayati, 2022; Nurhayati et al., 2025).

Figure 1 visualises the two years of Merauke hotspot observations and the reported burned-area substrate composition without adding new measurements. The steep contrast between the two columns is a contrast between selected observation years only, whereas the split of burned area remains almost identical across the two published summaries. The graphic makes visible a distinction central to this study: numerical indicators establish where additional investigation is warranted, not who caused particular ignitions or whether disputes were present. Those questions need triangulation with land-use histories, weather conditions, and accounts from multiple stakeholders.

The Wasur research adds temporal and ethnographic texture unavailable from the earlier two-year Merauke analysis. Across 2000–2023, hotspot detections in the park were concentrated during the dry season, with an increase beginning in the middle of the year, a peak around September–October, and declining occurrence as the wet season resumed. Rainfall, rainy-day frequency, wind, and relative humidity were associated with hotspot patterns, while interview material addressed the seasonal organisation of Kanume burning. This evidence supports treating fire as part of a coupled social-ecological regime, but it does not justify treating weather and customary use as exhaustive explanations for all local fire events (Brasika, 2022; Budiningsih et al., 2026; Sze et al., 2019).

Temporal specificity matters for practical prevention. A generic yearly awareness campaign may fail to align monitoring effort with weeks of heightened exposure, just as a fixed calendar rule may ignore an unusual dry spell. The challenge is to connect rainfall and moisture observations with locally interpretable warning signs without assigning scientific equivalence before the relationship is validated. Climate-informed scheduling can guide patrol preparation and communication, while community observations can direct attention to access routes, fuel conditions, livelihood activities, and other features difficult to infer from satellite pixels. This combination is best regarded as a proposed design principle for Merauke rather than as an intervention already shown to reduce fires there (Budiningsih et al., 2026; Nurdiati et al., 2021; Thoha et al., 2018).

A critical source of conflict is the passage from detection to accusation. Hotspot records may become contentious if disseminated as evidence that a named settlement, customary group, farmer, or landholder started a fire. Yet a thermal anomaly is not a legal finding: the time of detection, origin of ignition, fire spread, and responsible conduct involve separate evidentiary questions. If preliminary maps are circulated without uncertainty descriptions or channels for correction, disputes can harden before investigators examine alternative explanations. Fair procedures should distinguish ecological alerts, corroborated incident descriptions, and legally or administratively established responsibility (Carmenta et al., 2017; Nadhifah et al., 2024; Schinko et al., 2023).

The pattern also suggests that fire management has to be landscape-specific. In peat-based studies, hydrological interventions and canal blocking can be important, but these are not universal prescriptions for a landscape whose reported burned area is largely non-peat. In non-peat swamp scrub or mixed vegetation environments, seasonal access, water availability, fire spread, and local land-use calendars may require other operational priorities. A site-level planning exercise should therefore classify ecological setting before selecting a prevention package, with explicit attention to which findings originate in other Indonesian provinces and which have been observed locally (Castro et al., 2026;

Kirana & Nurhayati, 2022; Lestari et al., 2024). For conflict resolution, the first implication is epistemic rather than punitive. Actors need a shared distinction between measured evidence, plausible mechanisms, and disputed claims. Joint interpretation of maps, consistent definitions of reported incidents, and documented correction procedures can reduce the chance that technical authority becomes a substitute for dialogue. These measures also strengthen accountability: public agencies can explain what an alert establishes, community members can challenge inaccurate classifications, and independent expertise can clarify ambiguous evidence. Transparent interpretation is a prerequisite for fair collaboration, not proof that interests will automatically converge.

2. Local ecological knowledge, customary practice, and situated legitimacy

The analysis identifies two distinct potential contributions of local wisdom: informational capacities and collective-action capacities. Informational capacities concern seasonal knowledge, remembered fire behaviour, vegetation condition, access to water, and identification of places requiring caution. Collective-action capacities concern norms governing land use, negotiated responsibilities, channels for warning others, and means of settling disagreement within or between groups. These functions are analytically separable because reliable observation does not automatically give an observer authority to make rules, while an accepted community rule does not guarantee ecological adequacy. Combining the two requires explicit arrangements for verification and participation.

The Wasur evidence offers a concrete point of departure for examining local institutions without flattening cultural differences. The Kanume seasonal references to Tebrasaro and Sep-Sep describe a contextual relationship between time, livelihood activities, and fire use within the investigated setting. They should be presented as reported aspects of one local study, not as a universal calendar for every community in Merauke. Further qualitative inquiry should clarify how knowledge is transmitted, how customary decisions are made, who has authority to interpret signs, and whether practices have shifted under changes in climate, access, or enforcement. Recognition requires attention to people's own categories rather than attaching generic labels from other places (Budiningsih et al., 2026; Großmann, 2020; Marta, 2025).

Comparative work gives reasons for both optimism and caution. Research on Dayak Kanayatn communities in West Kalimantan documented locally embedded approaches to the timing and oversight of agricultural fire, while separate work on local knowledge investigated possibilities for early warning based on seasonal and environmental observations. These studies suggest that prevention can draw on practices rooted in community experience. They do not prove that such arrangements are present, unchanged, or effective throughout Merauke, where the ecological setting and governance history differ. A context-sensitive review must resist treating cultural similarity or shared nationality as sufficient evidence for transfer (Fajarwati & Masruri, 2019; Saharjo & Artaningsih, 2022; Saharjo & Nurjanah, 2021).

The comparative literature also warns against reducing Indigenous fire stewardship to the question of whether customary burning should be permitted. Knowledge may involve relationships to territory, responsibilities for habitat, and decision-making institutions that cannot be captured through a single technique. Conversely, locally preferred use of fire may require adaptation when drought intensity, settlement patterns, or surrounding land use changes. The relevant governance task is to create conditions for safe, legitimate deliberation over risks

and options, rather than presuming either that tradition must prevail in every instance or that formal regulation already contains all necessary information (Jolly et al., 2025; Nikolakis et al., 2024; Schinko et al., 2023).

Table 2. Local knowledge and safeguards for collaborative application

Knowledge / institution	Potential governance contribution	Essential validation safeguard
Seasonal indicators	Help contextualise periods of heightened fire risk	Compare with weather, moisture, and incident records
Land and water knowledge	Improve locally intelligible monitoring priorities	Map with community consent; check spatial reliability
Customary fire-use rules	Clarify community expectations and responsibilities	Verify current practice, legal fit, and safety
Customary decision forums	Offer deliberation and social coordination	Ensure inclusivity and right to contest decisions
Community reporting	Provide rapid observations and incident descriptions	Supply feedback and protect against premature blame

Source: Author's synthesis of comparative evidence (Nikolakis et al., 2024; Thoha et al., 2018).

Table 2 converts the synthesis into a decision matrix that explicitly differentiates potential knowledge contributions from the evidence required before local implementation. For example, a warning based on perceived dryness may be valuable but should be compared with weather and fuel observations; a customary rule about fire timing may clarify social expectations but still requires legal and safety scrutiny. The matrix thus rejects tokenistic consultation, in which information is solicited without affecting decisions, and uncritical transfer, in which a practice observed elsewhere is installed locally without verification.

Participation becomes substantive when the person who supplies knowledge receives a meaningful opportunity to assess how that knowledge is represented and used. A technical agency might digitise seasonal observations, but the resulting map should remain open to correction by those who contributed and should not expose sensitive territorial knowledge without consent. Community members may identify practical limits of patrolling or controlled activities that are invisible in a planning office; government agencies may provide weather forecasts, equipment, and legal clarification that residents cannot independently obtain. Integration is therefore a two-way process of institutional learning rather than simple extraction of customary information (Marta, 2025; Purnomo et al., 2024; Toumbourou et al., 2024).

Figure 2 presents a proposed knowledge-to-decision pathway, not a documented flowchart for an existing agency in Merauke. The distinguishing feature is the feedback loop: information contributed by residents should return to the community in the form of interpreted alerts, reasons for decisions, and opportunities to contest or refine the response. Without such feedback, inclusion becomes symbolic and may weaken trust. The diagram also makes clear that legal review, scientific corroboration, and customary deliberation can occur as

complementary forms of scrutiny rather than competing claims to exclusive authority.

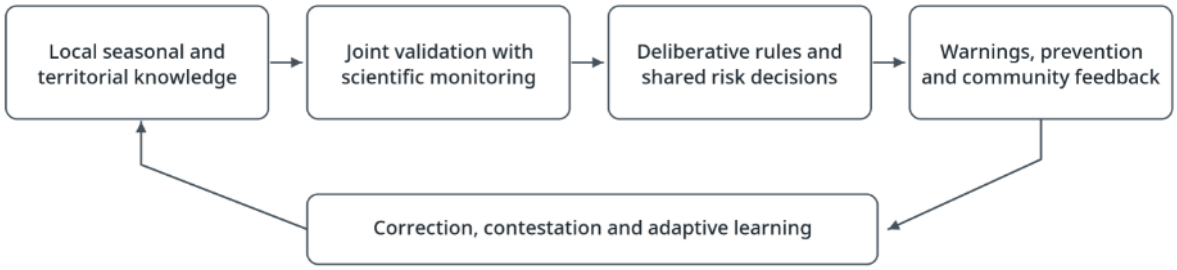


Figure 2. Proposed integration of local knowledge and formal fire governance
Source: Author, 2026

Communication is another necessary condition. Fire-risk messages that rely mainly on fear, blame, or technical jargon may fail to translate concern into feasible action. A recent Indonesian study compared threat-based messages among a small farmer sample and found differences in participation-related responses; its experimental design and location constrain generalisation, but its findings support attention to message intensity and participatory channels. In Merauke, communication should be comprehensible, culturally appropriate, and accompanied by practical information about whom to contact and what assistance is available. Such arrangements would need to be developed with communities, rather than inferred from the results of another province (Dewi et al., 2025; Sundari et al., 2022; Tanpipat, 2022).

Local wisdom also has a temporal dimension. Knowledge developed under one climate or land-use regime may become less reliable when rainfall timing changes, vegetation is transformed, or new infrastructure changes access and ignition opportunities. Validating a practice need not mean subordinating it entirely to external experts; it means designing a repeated process through which different sources of observation are compared, limitations acknowledged, and rules revised where evidence warrants. An adaptive arrangement preserves the community's ability to question official interpretation while also acknowledging that tradition does not eliminate uncertainty. Such mutual revision can be more protective than either unilateral control or unexamined preservation.

The resulting policy implication is modest but important: formal institutions should create a recognised route through which local knowledge can affect risk assessment, prevention calendars, patrol priorities, and evaluations of controversial incidents. Customary institutions, in turn, need clarity about the scope of their role, access to relevant evidence, and safeguards for members who disagree with customary leaders. No single actor should monopolise representation of the community. These arrangements can increase the legitimacy of shared prevention decisions if they are negotiated and monitored; the literature does not yet establish how much they would change fire incidence in Merauke.

3. Ecological conflict resolution as a collaborative governance process

The third finding is a governance proposition: fire-related ecological conflict can be addressed through arrangements that make differences in interest and authority visible before they become entrenched. A dispute about a restricted area may encompass genuine differences over conservation duties, access to subsistence resources, or interpretation of legal responsibility. A meeting solely

devoted to explaining prohibitions may leave these issues unresolved. By contrast, a structured process can identify affected groups, formulate the precise matter in dispute, separate verified facts from allegations, and establish channels for negotiated responsibilities and grievance review. This moves conflict resolution from an episodic reaction toward a preventative component of landscape management.

The importance of procedural design emerges from Indonesian governance literature beyond forest fires. Research on recognition and agrarian conflict demonstrates that legal acknowledgement may remain incomplete when actors lack an effective role in governing their territories. Scholarship on institutional collaboration also highlights overlapping mandates and the practical importance of coordination across agencies, even where the empirical sector differs from environmental management. These studies are used here for their conceptual relevance, not as direct demonstrations that their case-specific problems occur in Merauke. Their shared lesson is that an inclusive forum must have a pathway to decisions, implementation, and accountability (Dalirianto et al., 2025; Marta, 2025; Santosa et al., 2025).

The proposed first step is joint problem definition. Participants should establish whether they are discussing fire ignition, unsafe conditions, loss of land access, restrictions on livelihood activities, emergency communication, or consequences of a previous incident. Different concerns may require different evidence and institutions; treating them as a single undifferentiated "community conflict" risks obscuring the underlying issue. Formal mediation is not an adequate substitute for an environmental investigation, and technical mapping cannot settle a claim about political recognition. A useful forum permits these tracks to inform one another while preserving procedural distinctions.

The second step is stakeholder mapping that pays attention to both formal authority and practical exposure. Relevant parties may include district services, fire responders, protected-area administrators, customary bodies, village residents, land users, women's groups, health services, and organisations with technical or facilitation functions. This list is a potential mapping frame, not a claim that all actors participate in one existing Merauke institution. Mapping should identify who can decide, who is exposed to harm, who holds relevant information, and who might be excluded by meeting schedules, language, location, or the use of official procedures.

Third, discussion needs credible rules. Participants should know how a decision is reached, what evidence is acceptable, when reasons will be published, and how a disagreement is recorded. An established grievance route is particularly important where a decision imposes livelihood restrictions or where an incident is attributed to a specific person. A procedure that allows a community to speak but gives no reasoned response may reproduce unequal authority under the language of collaboration. Procedural justice is therefore not decorative; it is part of the governance infrastructure that determines whether an agreement will be considered legitimate.

Table 3. Proposed conflict-resolution governance sequence

Governance stage	Proposed collaborative action	Accountability or research test
Joint diagnosis	Separate hazards, allegations, and access disputes	Document agreed facts and disputed claims

Governance stage	Proposed collaborative action	Accountability or research test
Representation	Identify exposed groups and formal/customary mandates	Check who participates and who is missing
Negotiation	Agree on rules, responsibility, and grievance pathways	Record reasons, commitments, and appeals
Implementation	Link warnings, prevention, and viable livelihoods	Verify operational response and fair costs
Evaluation	Review fires, complaints, and human security	Measure outcomes and revise decisions

Source: Framework informed by governance and justice literature (Marta, 2025; Schinko et al., 2023).

Table 3 outlines a staged and testable governance design rather than reporting the performance of a functioning Merauke programme. The distinction matters: a proposed conflict-resolution forum is not evidence that such a forum currently exists, that Indigenous communities have consented to a particular protocol, or that fire rates have declined. The table includes potential evidence sources and accountability tests because collaborative arrangements may otherwise be praised without evaluating whether they redistributed voice, improved response, or protected those facing the greatest risks.

A fourth step is to align fire prevention with feasible livelihood choices. Evidence from peatland restoration shows that durable behaviour change may depend on locally demanded alternatives, political support, viable business arrangements, and continued institutional capacity. In a different ecological setting, these lessons should prompt questions rather than ready-made prescriptions: what activities depend on fire, which affordable alternatives are available, and who bears the cost of compliance? A rule that transfers every prevention burden to the least-resourced residents may produce apparent formal consistency while undermining cooperation. Distributional consequences must be made explicit in programme design (Carmenta et al., 2021; Purnomo et al., 2024; Toumbourou et al., 2024).

Conflict-sensitive enforcement does not imply abandoning environmental rules. It requires reliable investigation, predictable application, and an opportunity to contest an inaccurate finding. Technical teams may need the capacity to respond quickly to dangerous ignition, while the social process should avoid assigning collective guilt to a village or customary group on the basis of spatial proximity. This distinction also guards the legitimacy of legitimate sanctions: when evidence, authority, and reasons are openly recorded, measures can be better distinguished from arbitrary decisions. The same logic applies to non-punitive measures such as awareness campaigns, equipment distribution, and support for preventive land management (Abdurrahim et al., 2026; Huidobro et al., 2024; Putra et al., 2019).

A fifth step is continuous learning. Forum minutes, incident reviews, local warning observations, operational response reports, and complaints could be examined together at agreed intervals. Evaluation would then consider whether programmes reach high-risk periods and previously underserved users rather than merely counting the number of meetings. Research on intervention packages suggests that effectiveness depends on combinations and landscape conditions, while work on Indonesian organisational arrangements shows that technical and

community-based mechanisms are often weakened by weak coordination. Monitoring should therefore examine relationships among interventions rather than viewing each activity as an isolated success (Carmenta et al., 2021; Jefferson et al., 2020; Roengtam & Agustiyara, 2025).

Institutional scale is another source of complexity. Fires do not follow the precise division between protected areas, settlements, and administrative services; responsibility for prevention, suppression, ecological monitoring, and social assistance may be dispersed. A local agreement must therefore specify when an issue can be handled at village level, when district support is required, and when another authority has final legal responsibility. Collaborative governance becomes credible when it complements rather than obscures statutory mandates, and when participants understand which decisions are binding and which remain recommendations (Astuti, 2020; Dalirianto et al., 2025; Santosa et al., 2025).

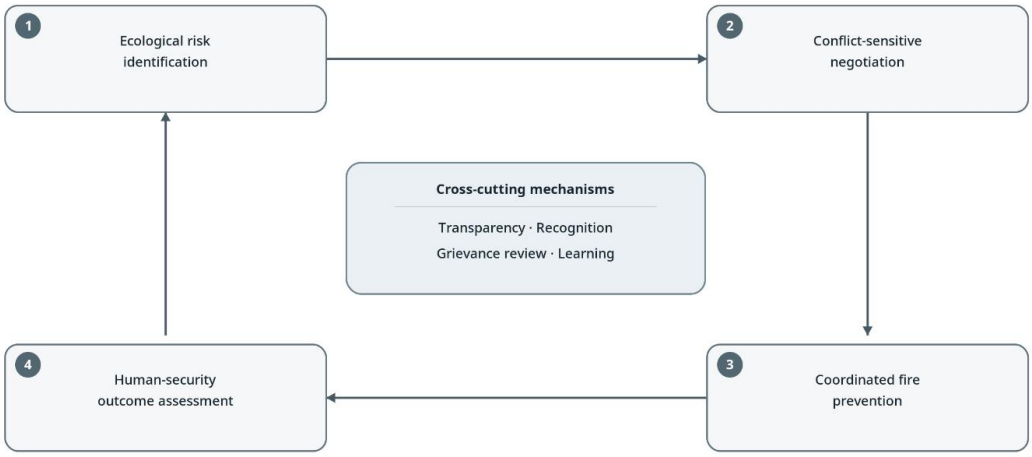


Figure 3. Integrated ecological conflict resolution and human-security pathway
Source: Original conceptual synthesis (Fachrie, 2020; Schinko et al., 2023).

Figure 3 integrates the ecological, relational, and human-security parts of the argument. It identifies a proposed sequence from hazard identification to inclusive decision-making, cooperative prevention, and evaluation of protection outcomes, with two feedback arrows: incident evidence informs revised protocols and community assessments can reopen disputed assumptions. This figure is a conceptual model derived from the reviewed scholarship; it is not a causal diagram estimated from Merauke data.

The central question for future evaluation is whether collaboration changes more than meeting attendance. A credible assessment would document how community input altered a patrol route, warning threshold, response procedure, resource allocation, or dispute outcome. It would also examine who was unable to participate and whether complaints were resolved without retaliation. If improvements occurred only for well-connected groups, the apparent success of a forum could coexist with continued insecurity elsewhere. Such questions follow from research on power asymmetries in forest governance and from the distinction between procedural and distributive justice (Großmann, 2020; Marta, 2025; Muttaqin et al., 2023).

4. Human security as an evaluative standard

Human security is the substantive criterion against which the proposed governance arrangement should ultimately be judged. Lower numbers of alerts or

incidents may indicate a beneficial change, but they do not reveal whether residents enjoy safer livelihoods, access to health information, or confidence in public procedures. Nor do they disclose the distribution of costs among people who rely on different land-use practices. A framework that centres everyday security complements ecological indicators rather than displacing them. Its value lies in forcing the evaluation to ask whether risk reduction has translated into a reduction in human vulnerability.

Health security is the most immediate channel. Smoke can travel beyond the burned patch, making exposure a problem for households that did not initiate or benefit from the activity connected to the fire. Regional research has documented substantial air-quality and public-health effects from vegetation and peat fires, while a human-security analysis of Indonesian haze describes consequences extending beyond conventional environmental damage. For Merauke, however, such findings motivate local air-quality monitoring and health-service coordination; they cannot be turned into an unmeasured district-specific burden estimate. Assessments should record exposure during events and the ability of vulnerable households to obtain guidance and care (Fachrie, 2020; Kiely et al., 2020).

Economic security involves both losses from fire and the costs of preventive compliance. A household may face reduced access to productive land, interruption of work, damaged equipment, or additional transport expense during hazardous conditions. Conversely, a restriction adopted to lower ignition risk may impose time and financial costs even when no fire occurs. For policy to be socially sustainable, public agencies need evidence on these trade-offs and on whether alternatives are practicable for different livelihood groups. Research on participatory peatland restoration and on the political economy of fire indicates why attention to economic incentives and structural constraints cannot be separated from ecological goals (Abdurrahim et al., 2026; Purnomo et al., 2024; Sundari et al., 2022).

Food security connects ecological disturbance to household well-being. Fire may interrupt gathering, farming, transport, or market access, while a prevention programme may also affect the timing and methods through which people obtain food. The effects will depend on livelihood systems and cannot be inferred from land-cover classification alone. Future assessment should therefore examine both the experience of temporary disruption and the longer-term adjustment of livelihood practices. It should also recognise that households living in the same settlement may face different vulnerabilities according to their access to alternative income, customary rights, and social support.

Environmental security covers the conditions that support life beyond the immediate fire season. Loss of habitat, vegetation structure, water quality, or local environmental services may affect daily activities and ecological recovery. Studies of tropical peat ecosystems illustrate how repeated fires can change forest structure over years, whereas South Papua landscape studies demonstrate the importance of local vegetation and fire dynamics. These research settings differ in important ways, and the ecological effects identified in one ecosystem should not be copied as local outcome estimates in another. Nevertheless, together they justify monitoring restoration, recurrence, and access to valued environmental resources alongside fire incidents (Kirana & Nurhayati, 2022; Nurhayati et al., 2025; Toumbourou et al., 2024).

Personal and community security involve more than physical escape from a flame front. People may also fear being blamed without evidence, losing access

through an opaque decision, or facing disputes for which no trusted mediator is available. These risks make the credibility of complaint procedures and clarity of responsibility relevant to the security framework. A fair process should permit multiple accounts of an incident and should distinguish disagreement over land use from allegations of wrongdoing. Recognition of customary authority and access to review can contribute to a sense of safety, but their effect in Merauke remains an empirical question rather than an established result (Großmann, 2020; Marta, 2025; Parwata et al., 2026).

Political security and participation concern the capacity to influence decisions that affect collective life. A community invited to a meeting after the rules have been fixed cannot exercise the same influence as one involved in defining risks and options. Yet simply increasing the number of participants is not sufficient, because participation may conceal internal hierarchies. A future governance study should ask whose statements changed an agreement, how minority voices were represented, and whether public agencies provided reasons for accepting or rejecting proposals. These questions connect environmental management to substantive political recognition and guard against the assumption that every customary institution speaks with one voice (Marta, 2025; Muttaqin et al., 2023; Santosa et al., 2025).

The dimensions are interdependent rather than neatly separable. Disruption to income can influence access to food and health care; weakened trust can reduce reporting of new fire risks; environmental degradation can alter future livelihood choices; and opaque restrictions can damage both political participation and the credibility of ecological interventions. A monitoring programme should therefore combine selected outcome indicators with community accounts of how threats interact. The purpose is not to reduce human security to one numerical index, but to ensure that policies are assessed for their combined material and procedural effects.

5. Policy implications, transferability, and future research

The proposed policy agenda begins with an evidence protocol. Merauke's relevant agencies and community partners could jointly define how hotspot alerts, field-confirmed incidents, burned-area assessments, and social reports are classified and shared. Maps should include the year, sensor or evidence source, geographic scope, and uncertainty where relevant. Cases requiring investigation should be labelled accordingly rather than presented as settled explanations of responsibility. Such a protocol can create common ground for dialogue while respecting the different tasks of technical responders, customary representatives, local administrators, and legal authorities (Budiningsih et al., 2026; Kirana & Nurhayati, 2022; Syaufina et al., 2024).

A second agenda is the careful construction of a participatory seasonal warning system. The Wasur study provides a reason to investigate Kanume seasonal categories and ecological observations in the geographical setting to which they belong, while comparative research offers examples of how local knowledge might be aligned with weather data and communication mechanisms. The design should test agreement and disagreement between indicators, document changes in observed conditions, and specify operational actions linked to each warning. Importantly, evidence from one customary setting should not be imposed on other communities as a presumed common tradition (Budiningsih et al., 2026; Fajarwati & Masruri, 2019; Thoha et al., 2018).

Third, authorities could embed a conflict-resolution route within routine fire governance. It would begin with stakeholder identification and shared problem definition, followed by an accessible forum, documented decisions, an appeal process, and scheduled evaluation. Neutral facilitation may be important when different actors have unequal access to official evidence or resources. The mechanism should not replace emergency command during an active dangerous fire; instead, its preventive and retrospective functions should support stronger trust and clearer responsibilities before and after incidents. Different legal and customary jurisdictions would need to determine the final design through locally legitimate procedures (Dalirianto et al., 2025; Marta, 2025; Schinko et al., 2023).

Fourth, livelihood transition should be treated as a practical design question, not a slogan. Where authorities judge a particular practice unsafe under specified conditions, they should assess whether affected households have affordable alternatives and adequate time, training, or assistance to adopt them. Regional Indonesian evidence indicates that prevention can depend on bundles of interventions rather than a single instrument, while community-based restoration studies underline the importance of political support, locally perceived benefit, and continuity beyond a short project cycle. These lessons require testing against Merauke's ecology and livelihoods before large-scale adoption (Carmenta et al., 2021; Purnomo et al., 2024; Roengtam & Agustiyara, 2025).

Fifth, programmes need an evaluation system that measures both effectiveness and legitimacy. Ecological indicators may include confirmed incidents, repeated fire occurrence, response delay, and burned-area characteristics. Social indicators could include participation breadth, the proportion of reports receiving feedback, completion of agreed actions, the time required to address grievances, and perceived fairness. Human-security indicators would be selected with communities and might examine smoke exposure, livelihood interruptions, or access to emergency information. None of these indicators is claimed to have been measured by this study; they constitute a transparent research and policy agenda.

The transferability of this framework is deliberately conditional. The literature on peatland rewetting demonstrates how intervention success varies with hydrological setting and implementation quality, while Indigenous stewardship research shows that different legal relationships with the state produce different opportunities for fire management. Merauke's non-peat fire profile and Wasur's documented customary seasonal knowledge therefore require a locally adapted package, not mechanical replication of programmes from Sumatra, Kalimantan, Australia, or India. Comparative literature helps articulate questions and alternatives; local evidence must determine whether those alternatives fit (Castro et al., 2026; Kirana & Nurhayati, 2022; Nikolakis et al., 2024).

Further empirical work should begin with a clearly delimited field design in Merauke, including sites selected to capture differences in vegetation, administrative setting, and community institutions. Interviews or group discussions could explore how residents recognise fire danger, how decisions are made, and where disputes are resolved; observation and document analysis could examine whether formal procedures match reported practice. Such research must avoid presuming that all communities have the same experiences or that the fire-regime findings from Wasur represent the district. Its principal aim would be to test the proposed links among knowledge recognition, procedural fairness, cooperation, and measurable protection outcomes.

A stronger evaluation phase would compare sites or periods with carefully documented changes in governance arrangements, while accounting for weather, fuel conditions, and other factors influencing fire. Measuring meeting attendance alone would not reveal whether joint decisions altered behaviour, and comparing raw hotspot totals without attention to sensor characteristics or seasonal exposure would risk misleading conclusions. The central causal question is whether procedural improvements generate earlier credible warnings, more feasible prevention decisions, and better security for exposed households relative to plausible alternatives. The present review cannot answer that question, but it specifies the observations needed to investigate it.

The article's conceptual contribution is therefore an evidence-sensitive sequence rather than a claim of local programme success. Fire patterns identify the need for action; situated knowledge clarifies conditions that formal indicators may miss; conflict resolution provides rules for negotiating competing interests; collaborative institutions translate those agreements into operational choices; and a human-security lens broadens evaluation beyond incident suppression. Each link is open to falsification or revision when local data become available. This orientation retains the environmental imperative of prevention while making public legitimacy, recognition, and lived consequences part of what counts as successful governance.

CONCLUSION

This integrative review demonstrates that forest and land fire governance in Merauke is best approached through a distinction between established ecological observations and governance mechanisms that still require field testing. Published Merauke evidence identifies contrasting MODIS hotspot totals in 2015 and 2019, predominantly non-peat burned areas, and important swamp-scrub involvement; recent work from Wasur National Park adds location-specific observations on seasonal fire patterns and Kanume fire use. Neither finding permits the automatic attribution of ignition or ecological conflict to particular actors. Together they instead provide an empirical reason to design fire governance around locally differentiated ecosystems and social practices.

The principal theoretical finding is that local wisdom may contribute through environmental information and collective-action rules, but only where the relevant knowledge is documented, validated for current conditions, and integrated through meaningful participation. Conflict resolution supplies procedures for addressing differences over access, responsibility, recognition, and the interpretation of evidence. Collaborative governance can make these procedures operational through shared risk assessment, transparent decision rules, complaints handling, and regular learning. These are conditional mechanisms supported by comparison and theory, not outcomes shown to have occurred across Merauke.

Human security is essential to judging whether such arrangements work. Beyond the reduction of fire occurrence, future evaluation should consider exposure to smoke, livelihood and food-system disruption, environmental continuity, procedural fairness, and the capacity of residents to influence decisions that affect them. A fire programme that improves one ecological indicator while leaving vulnerable groups unheard would represent an incomplete public-governance achievement. Conversely, participation without credible ecological risk reduction would also be insufficient. The integrative framework requires both forms of accountability.

The article is limited by its narrative-review design and the absence of primary field research. Its recommendations should therefore guide, rather than pre-empt, a locally negotiated research and policy process. A subsequent programme of interviews, spatial analysis, institutional observation, and human-security monitoring could test whether the suggested mechanisms reduce preventable fire risk while strengthening recognition and public trust. Such evidence would allow future scholarship to distinguish promising arrangements from demonstrably effective practice and would offer Merauke a more defensible basis for collaborative fire governance.

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