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Network Governance Dynamics in Zero-Burning Land Management Policy: Lessons from South Sumatra

Ujang Alnema*, Alfitri, Raniasa Putra, Abdul Nadjib
Universitas Sriwijaya, Indonesia
Email: ujangalnema46@gmail.com*, alfitri@unsri.ac.id, raniasaputra@fisip.unsri.ac.id, abdulnadjib@fisip.unsri.ac.id

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ABSTRACT

Forest and land fires remain a persistent environmental challenge in South Sumatra, Indonesia, despite the implementation of the *Zero-Burning Land Management Policy*. This study examines the dynamics of network governance in the implementation of the policy by integrating Social Network Analysis (SNA) and in-depth interviews within a mixed-method framework. The research aims to analyze the structure of governance networks, coordination mechanisms, conflict and power dynamics, and adaptive responses among key actors, including provincial and district governments, plantation companies, NGOs, and local communities. The findings reveal a moderately centralized governance structure, with the provincial government acting as the dominant coordinating entity. While the network exhibits characteristics of a lead organization model, horizontal collaboration—especially in operational coordination—is also evident. Formal mechanisms such as inter-agency meetings and integrated task forces are complemented by informal coordination based on trust and personal relationships. However, the network is influenced by unequal capacities, resource imbalances, and overlapping authorities, which affect the stability and effectiveness of collaboration. The research also identifies adaptive responses, including the formation of integrated task forces, technology-based fire monitoring systems, and adjustments to local regulations. While these responses demonstrate institutional flexibility, adaptation remains largely reactive to crises rather than being integrated into systematic learning processes. Theoretically, the findings contribute to adaptive network governance by highlighting the interdependence of network structure, coordination quality, and adaptive capacity in environmental policy. For developing countries facing ecological pressures, strengthening trust, data integration, and institutional continuity is key to improving policy resilience and long-term fire prevention effectiveness.

INTRODUCTION

Forest and land fires are among the most complex environmental problems in Indonesia, especially in the Sumatra and Kalimantan regions (Albar et al., 2018; Purnomo et al., 2019; Syaufina, 2018; Thoha et al., 2019; Yananto et al., 2017). South Sumatra Province is one of the epicenters of peatland fires that recur almost every dry season, with a major crisis in 2015 and increases again in 2019 and 2023. The characteristics of peatlands, which dry out easily due to changes in hydrological systems and land clearing, make this region highly vulnerable

to ground fires that are difficult to extinguish and that produce large amounts of carbon emissions (Page et al., 2002; Tacconi, 2016). The impact is not only ecological, in the form of biodiversity loss and degradation of peatland hydrological functions (Gaveau et al., 2014), but also global through increased carbon emissions, as reflected in the 2015 crisis (Field et al., 2016).

Socially and economically, land fires trigger health crises due to exposure to transboundary haze, increasing the risk of respiratory diseases and premature death (Koplitz et al., 2016). Economic losses resulting from the 2015 fires are estimated to have exceeded USD 16 billion, or about 1.9% of Indonesia's GDP (World Bank, 2016). This condition has encouraged the government to strengthen the Zero-Burning Land Clearing Policy, which emphasizes clearing land without fire, enhanced supervision of companies, and stricter law enforcement. At the regional level, including in South Sumatra, this policy is implemented through the establishment of integrated task forces and cross-sectoral coordination involving government agencies, the private sector, local communities, and non-governmental organizations.

However, the implementation of the Zero-Burning policy does not occur within a simple institutional setting. Land fire governance is multi-actor and multilevel, with interdependence among central and local governments, plantation companies, law enforcement agencies, and local communities. In the context of governance networks, policy effectiveness relies heavily on coordination, resource distribution, trust, and adaptive learning mechanisms (Provan & Kenis, 2008; Klijn & Koppenjan, 2016). Differences in economic interests, inequalities in institutional capacity, and overlapping authority often hinder consistent implementation. Thus, the Zero-Burning policy cannot be understood solely as a regulatory instrument but rather as a dynamic network governance process within a complex socio-ecological system.

The literature on land fires in Indonesia has been dominated by techno-ecological approaches that emphasize land cover change and climate variability (Margono et al., 2014; Sloan et al., 2017), as well as regulatory studies focusing on the effectiveness of law enforcement (McCarthy et al., 2012; Sahide et al., 2016). While important, such approaches tend to position policies within a hierarchical and linear framework. In reality, in polycentric and multi-actor systems, decision-making is distributed across interdependent networks (Rhodes, 1997; Sørensen & Torfing, 2007). In addition, empirical studies that integrate network structure analysis with institutional adaptive capacity remain relatively limited. The adaptive governance perspective emphasizes the importance of collective learning and institutional flexibility in the face of uncertainty (Dietz et al., 2003; Armitage et al., 2009), but its integration into analyses of the Zero-Burning policy at the regional level has not been widely explored.

Based on this gap, this study analyzes the dynamics of network governance in the implementation of Zero-Burning Land Management in South Sumatra by integrating the perspectives of governance networks and adaptive governance. In particular, this study addresses three main questions: how the structure and dynamics of governance networks shape the implementation of the Zero-Burning policy; how patterns of coordination, collaboration, and conflict emerge among actors; and what adaptive lessons can be drawn for policy strengthening. These three questions are interrelated, as the structure of the network shapes

interaction patterns that ultimately affect the adaptive capacity of the system. The purpose of this study is to analyze the dynamics of network governance in the implementation of the Zero-Burning Land Management Policy in South Sumatra by integrating the perspectives of governance networks and adaptive governance. Thus, this study contributes to the development of a conceptual model of adaptive network governance for land fire control in the context of developing countries experiencing high ecological stress.

METHOD

This study employed a mixed-methods approach with an integrative design that combined Social Network Analysis (SNA) and in-depth interviews to analyze the dynamics of network governance in the implementation of the Zero-Burning Land Management Policy in South Sumatra. This approach was selected because environmental policy governance is complex, involving relational structures among actors that can be analyzed quantitatively, as well as interaction processes and relational meanings that require qualitative exploration. The mixed-methods approach allowed the researchers not only to map intersectoral interconnections but also to understand how these relationships were formed, maintained, and changed in the context of policy implementation (Creswell & Plano Clark, 2018).

The research design followed an embedded explanatory model, in which network analysis was first conducted to identify the structure and positions of actors, followed by in-depth interviews to explain the dynamics of coordination, conflict, and adaptive capacity within the governance system. This approach aligned with the need to understand both structural and procedural dimensions of policy networks.

Data collection began with defining network boundaries to identify relevant actors involved in implementing the Zero-Burning policy. Actors were identified through policy documents, fire task force membership lists, and snowball sampling based on initial informants' recommendations. These actors included provincial and district government agencies, law enforcement bodies, plantation companies, non-governmental organizations, and representatives of local and fire-aware communities. This approach ensured that the analyzed network reflected the actual governance system (Scott, 2017).

Data for Social Network Analysis were collected using a network questionnaire distributed to representatives of each actor. Respondents identified coordination partners, communication frequency, types of relationships (e.g., coordination, collaboration, or conflict), and flows of information and decision-making. The relational data were then converted into an adjacency matrix for structural analysis.

In addition to quantitative network data, qualitative data were collected through in-depth, semi-structured interviews with key informants selected based on their strategic positions within the network. These interviews explored coordination mechanisms, trust and conflict dynamics, adaptive responses to fire incidents, and changes in actor roles over time, enabling a deeper understanding of governance dynamics (Kvale & Brinkmann, 2009).

Data analysis was conducted integratively using both quantitative and qualitative approaches. First, Social Network Analysis was applied to examine network structure using indicators such as degree centrality, betweenness centrality, and network density and centralization. This analysis provided an empirical overview of whether the network was centralized, fragmented, or collaborative (Wasserman & Faust, 1994).

Second, interview data were analyzed using thematic analysis. The process involved coding and grouping data into key themes related to coordination, collaboration, conflict, learning, and institutional adaptation (Braun & Clarke, 2006). This analysis helped explain relational dynamics that were not fully captured by network structures.

Finally, findings from both approaches were integrated to develop a comprehensive interpretation. For example, actors identified as central in the network were further examined through interview data to understand their roles in facilitating coordination. Similarly, fragmented network patterns were interpreted considering reported conflicts or low levels of trust. This integration supported the development of an empirical model of adaptive network governance, illustrating the relationships among network structure, coordination mechanisms, and adaptive capacity.

To ensure research rigor, several strategies were applied. Triangulation was conducted by integrating network and interview data to strengthen validity (Fetters et al., 2013). Member checking was used to confirm interview summaries with key informants, ensuring interpretive accuracy. The reliability of network data was enhanced through cross-verification of reported relationships among actors. In addition, an audit trail was maintained by documenting all stages of data collection and analysis, improving transparency and enabling analytical replication.

RESULT AND DISCUSSION

A. Actor Mapping in Zero-Burning Governance

The results of the Social Network Analysis (SNA) show that the network structure of Zero-Burning governance in South Sumatra consists of five main groups of actors, namely the provincial government, district government, plantation companies, local communities, and non-governmental organizations (NGOs). Network analysis reveals that the network is neither fully centralized nor fully decentralized, but rather shows a semi-centralized pattern with the dominance of provincial government actors as the main node in coordination.

The provincial government occupies the position with the highest degree of centrality and betweenness centrality, which indicates the dominant role as the main coordinator in the network. The provincial government serves as a liaison between district governments, plantation companies, and NGOs, especially in the context of cross-sector coordination meetings and the establishment of fire task forces. This position shows a model that approaches lead organization governance, where one actor plays a key coordinating role in the network structure. In-depth interviews confirm that provincial governments are often the initiators of technical policies and facilitators of inter-stakeholder communication.

District governments have a fairly high level of connectivity, but tend to function as implementers at the local level. Their relationship is more intense with local communities and companies operating in their respective administrative areas. Despite having autonomy in technical implementation, their cross-sectoral coordination capacity is relatively more limited than that of provincial governments. This is reflected in the lower value of centrality betweenness, suggesting that the main liaison role remains at the provincial level.

Plantation companies show a pattern of selective relationships and tend to be directly connected to provincial and district governments, but relatively less connected to NGOs and local communities outside their operational areas. This structure demonstrates a formal relationship based on regulations and reporting obligations, but has not yet fully formed a

strong horizontal collaboration. In some cases, interviews reveal a reactive relationship—companies are more active in coordinating during fires or inspections, than in the prevention phase.

Local communities and fire care communities have a more peripheral position in the network structure based on degree centrality analysis. Although they are formally involved in fire prevention programs, their connectivity to other actors is relatively limited. However, interviews show that in the context of field operations, the role of the community is very significant as an actor in early detection and early response to fires. This shows that there is a gap between structural positions in formal networks and functional roles in the field.

Environmental NGOs occupy positions as alternative connecting actors, especially in advocacy, information dissemination, and community capacity building. In some network clusters, NGOs act as brokers who bridge communication between the community and the district government. Although their centrality value is not as high as that of provincial governments, the analysis of betweenness shows that on certain issues, NGOs serve as strategic nodes that strengthen the flow of information and social learning.

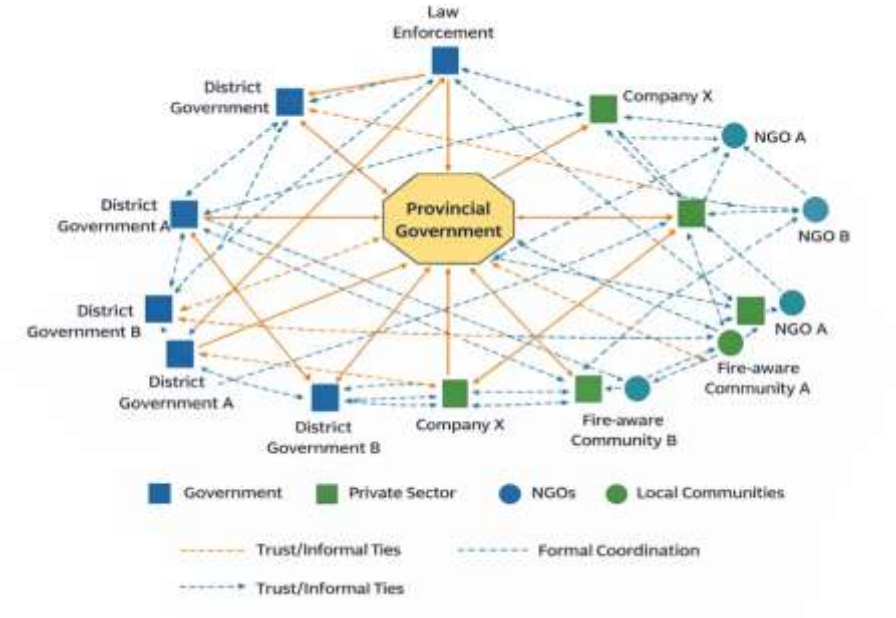

Figure 1. Zero-Burning policy governance network
Source: Social Network Analysis (SNA) data and in-depth interviews, 2026

Overall, the structure of the Zero-Burning network in South Sumatra shows a moderately centralized network pattern with the provincial government as the dominant actor, but still shows elements of decentralization through the role of district governments and NGOs. This structure reflects a combination of the lead organization model and the collaborative governance element. The network is not completely hierarchical, but it is also not completely horizontal.

These findings indicate that policy effectiveness is highly dependent on the capacity of central actors to facilitate coordination and maintain stability in inter-stakeholder relations. However, semi-centralized structures also harbor potential risks, especially if the dependence on central actors is too high and not balanced with capacity building at the local level.

Thus, actor mapping shows that Zero-Burning governance in South Sumatra operates in a relatively stable network structure but still requires strengthening horizontal connectivity, especially between companies, communities, and NGOs, to increase policy resilience in the long term.

B. Coordination Mechanisms

The results of the analysis show that the coordination mechanism in Zero-Burning governance in South Sumatra takes place through a combination of formal, informal, and enforcement mechanisms. These three forms of coordination complement each other and form the operational foundation of the land fire governance network.

Formally, coordination is institutionalized through cross-sector forums and the establishment of a task force (*satgas*) to control forest and land fires. The provincial government acts as the main coordinator in organizing periodic coordination meetings involving district governments, plantation companies, security forces, and other technical agencies. Based on network analysis, this formal forum strengthens vertical connectivity between the provincial and district levels and increases network density in the dry season phase. The increased value of network density during the fire-prone period shows that formal meetings and task forces function as a platform for consolidating relations between actors.

In-depth interviews revealed that formal forums have two main functions: first, as a space for exchanging technical information related to hotspots and field conditions; Second, as an instrument of rapid response coordination when a fire occurs. Nevertheless, some informants highlighted that the effectiveness of formal coordination is often situational and increases dramatically only when the risk of fire is high. This suggests that formal mechanisms tend to be reactive rather than preventive.

In addition to formal coordination, informal mechanisms play a significant role in maintaining smooth inter-stakeholder interaction. Personal relationships between government officials, company managers, and community leaders have become alternative communication channels outside of official forums. In some cases, informal communication speeds up field responses because it is not tied to bureaucratic procedures. Interviews show that the level of trust between actors greatly determines the quality of coordination. Actors who have strong interpersonal relationships tend to be more open in sharing information and faster in resource mobilization.

An analysis of betweenness centrality in SNA shows that some actors, although they do not have the highest formal authority, serve as important liaisons because they have extensive interpersonal relationships. This shows that the structure of the network is not only shaped by formal hierarchies, but also by social networks that develop organically. Thus, trust is a key variable that strengthens network stability.

On the other hand, the enforcement mechanism or law enforcement functions as a control instrument that supports compliance with the Zero-Burning policy. Law enforcement officials and environmental monitoring agencies have a role in conducting inspections, investigations, and enforcement of violations. In the network structure, law enforcement actors show strong connectivity with provincial and district governments, but their relationships with companies tend to be formal and based on regulatory obligations.

Interviews indicate that the effectiveness of enforcement is influenced by the consistency of the application of sanctions and the transparency of the legal process. When law enforcement is strictly enforced, networks show increased collective compliance. Conversely, enforcement inconsistencies have the potential to undermine policy legitimacy and lower the level of trust in the network. Thus, enforcement is not only a control instrument, but also a factor that affects the relational stability between actors.

Overall, the coordination mechanism in Zero-Burning governance in South Sumatra shows a hybrid pattern between institution-based formal coordination, informal coordination based on social relations, and law enforcement as regulatory instruments. The semi-centralized structures identified in the previous subchapter are strengthened through formal coordination led by the provincial government, but the sustainability of the network depends heavily on the quality of interpersonal relationships and the level of trust between actors.

These findings suggest that the effectiveness of Zero-Burning policies depends not only on the existence of formal coordination structures, but also on the capacity of networks to build trust and maintain enforcement consistency. The combination of these three mechanisms is the foundation for governance stability and resilience in the face of dynamic fire risk.

C. Conflict and Power Dynamics

Analysis of conflict dynamics and power distribution in the Zero-Burning governance network shows that the previously identified semi-centralized structures are not completely free of internal tensions. Although formal coordination is relatively stable, there are capacity inequality, resource asymmetry, and overlapping authority that affect the effectiveness of policy implementation.

Capacity inequality is one of the main sources of latent conflict dynamics in the network. The provincial government has greater coordination capacity, access to information, and resource support than the district government. In network analysis, this difference is reflected in the higher centrality value of provincial-level actors. However, in-depth interviews revealed that district governments often face limited budgets, personnel, and firefighting equipment, which ultimately limits the ability to implement at the local level. This inequality creates a vertical dependence on provincial governments, while also creating potential friction when technical policies are considered not to fully consider local conditions.

Resource asymmetry is also seen in the relationship between the government and plantation companies. Large companies generally have stronger financial and technical resources, including internal monitoring systems and self-extinguishing capacity. In the network structure, large companies show strong connectivity with provincial governments, especially in formal forums. However, interviews show that these relationships are not always symmetrical in terms of influence. In some cases, companies with significant economic contributions have a stronger bargaining position in technical policy negotiations. This creates a power dynamic that is not fully visible in the formal structure of the network, but has an effect on implementation practices on the ground.

On the other hand, local communities occupy the position with the most limited resources in the network. Although they have an important operational role in early detection and prevention of fires, their access to decision-making forums is relatively low. In the SNA

analysis, the position of the community tends to be peripheral, reflecting the limitations of direct connectivity with central actors. Interviews show that community participation is often programmatic and relies on government or NGO initiatives. This inequality has the potential to lead to a conflict of perception, especially when the Zero-Burning policy is considered to limit traditional land clearing practices without adequate economic alternatives.

The overlap of authority between agencies is also a source of power dynamics in the network. The decentralization of government gives significant authority to local governments, but in practice, coordination between the central, provincial, and district governments does not always run harmoniously. The interview revealed that there is ambiguity in the division of roles between technical agencies, law enforcement officials, and local governments in handling fire cases. This creates a gray area in policy enforcement and has the potential to slow down the collective response.

In some cases, open conflicts are rare due to the existence of formal mechanisms that maintain network stability. However, latent conflicts in the form of differences in policy interpretation, dissatisfaction with the distribution of resources, and perceptions of injustice remain. Semi-centralized structures allow for conflict control through vertical coordination, but also reinforce the dominance of central actors in decision-making.

Overall, the power dynamics in the Zero-Burning network show that governance structures are shaped not only by formal relationships, but also by the uneven distribution of capacity and resources. These inconsistencies do not necessarily result in open conflicts, but they affect the quality of collaboration and network stability in the long run. These findings show that the effectiveness of policies is determined not only by the existence of coordination mechanisms, but also by the ability of systems to manage capacity inequality and power asymmetry adaptively.

D. Adaptive Responses

The results of the study show that the Zero-Burning governance network in South Sumatra is not static, but experiences various forms of adaptive responses in line with the dynamics of fire risk and policy pressures. This adaptation is reflected in the formation of new institutional structures, the use of monitoring technology, and changes in local regulations in response to previous fire experiences.

One of the most prominent forms of adaptive response is the establishment of an integrated task force (task force) for forest and land fire control. This task force integrates various actors in a more operational coordination structure, including provincial governments, district governments, security forces, technical agencies, and company representatives. From the perspective of Social Network Analysis, the formation of a task force increases network density and strengthens connectivity between actors that was previously fragmented. The value of the provincial government's centrality remains high, but the horizontal relationship between actors becomes more intense during the operational period of the task force.

In-depth interviews revealed that the task force not only functions as a formal coordination structure, but also as a collective learning space. Through regular evaluation of fire incidents, actors in the network gain shared experiences that strengthen feedback loops.

This adaptation shows that the network is able to make institutional adjustments by creating new structures when the previous mechanisms were considered less effective.

Another adaptive response can be seen in the increased use of monitoring technology, especially the use of satellite-based hotspot data, early warning systems, and spatial mapping of fire risk. The integration of this technology changes the pattern of coordination in the network. Information that was previously reactive is now more proactive, allowing for early detection and faster response. In network analysis, the use of technology strengthens the flow of information between actors and reduces reliance on mere informal communication.

Nevertheless, interviews show that the effectiveness of technology is highly dependent on the capacity of local actors to interpret and act on data. In some districts, limited human resources and infrastructure hinder the optimization of the monitoring system. This indicates that technological adaptation requires institutional support and capacity building to function optimally.

In addition to the formation of task forces and the use of technology, changes in local regulations are also important indicators of adaptive response. Several local governments have made adjustments to technical regulations related to the company's obligations in providing fire prevention facilities and strengthening reporting mechanisms. These regulatory changes often come after major post-fire evaluations, which encourage reflection on the weaknesses of previous systems. In the context of adaptive governance, changes in local regulations reflect the system's ability to learn from experience and make structural adjustments.

Overall, adaptive responses in the Zero-Burning network show that governance systems have the capacity to evolve through the formation of new structures, technology integration, and rule adjustment. However, such adaptation is still partial and is often triggered by crises, rather than entirely by preventive learning mechanisms. The semi-centralized structures that have been identified earlier facilitate rapid responses, but the long-term sustainability of adaptation depends on strengthening the capacity of local actors and expanding horizontal connectivity within the network.

These findings show that the effectiveness of Zero-Burning policies is not only determined by coordination and law enforcement, but also by the ability of networks to build sustainable adaptive mechanisms. The adaptive responses that emerge are the foundation for the development of an adaptive network governance model that is more resilient in the face of environmental uncertainty.

The findings of this study show that Zero-Burning Land Management governance in South Sumatra does not fully reflect a single governance model, but rather is in a hybrid spectrum between the lead organization model and the shared governance element. Structurally, the Social Network Analysis shows the dominance of the provincial government as the actor with the highest level of centrality, which plays the role of the main coordinator in the network. This pattern shows the characteristics of lead organization governance, in which one actor holds the main coordinating and facilitative functions in the network (Klijn, Steijn, & Edelenbos, 2010). However, horizontal relationships between actors—especially between district governments, companies, and NGOs—suggest a relatively autonomous space for collaboration in certain operational contexts. Thus, the evolving governance model can be

categorized as a hybrid governance structure, which combines strategic centralization with operational decentralization.

From the perspective of adaptive capacity, this study found that institutions in the Zero-Burning network showed a moderate level of flexibility. This flexibility can be seen in the formation of an integrated task force, the use of satellite-based monitoring technology, and the adjustment of local regulations after major fires. The ability to make these structural adjustments indicates the existence of an institutional capacity to respond to external pressures (Duit & Galaz, 2008). However, the adaptation that occurs tends to be responsive to the crisis, not entirely based on institutionalized preventive learning mechanisms. The learning mechanism still relies on informal evaluation and post-incident reflection, rather than on a permanently integrated monitoring and evaluation system. In the governance literature, the ability of systems to internalize learning and change practices in a sustainable manner is an important indicator of adaptive capacity (Termeer, Dewulf, & van Rijswick, 2011). These findings suggest that although adaptation has occurred, systemic learning capacity still needs to be strengthened.

Several important lessons can be drawn from these network dynamics. First, trust has proven to be the main foundation of network stability. Interpersonal relationships and trust between actors accelerate coordination and reduce transaction costs, especially in emergency situations. The collaborative governance literature emphasizes that trust is a prerequisite for the effectiveness of multi-stakeholder networks (Klijn, Edelenbos, & Steijn, 2010). Second, cross-sector data integration is an urgent need. Although monitoring technology has been used, information flows are still not fully integrated between the provincial, district, and non-state actors. The lack of data interoperability has the potential to hinder rapid response and collective learning. Third, institutional sustainability is a strategic issue. Structures such as the integrated task force show high effectiveness in the short term, but their semi-ad hoc nature raises questions about long-term sustainability. Permanent institutionalization with clear mandates and resources can improve network stability and reduce reliance on crisis mobilization.

Theoretically, the findings of this study reinforce the importance of integration between network governance approaches and adaptive governance in the context of environmental policies in developing countries. This study shows that the structure of the network alone is not enough to explain the effectiveness of policies; Adaptive capacity and learning mechanisms play equally important roles. In the context of developing countries with high ecological pressures and varying institutional capacities, the adaptive network governance model becomes relevant to explain how governance systems evolve under conditions of uncertainty (Biesbroek, Termeer, Klostermann, & Kabat, 2013). In addition, this study expands the governance literature by showing that hybridization between lead organization and horizontal collaboration can be a pragmatic strategy in dealing with the complexity of land fires.

Thus, this discussion confirms that the success of the Zero-Burning policy is not only determined by the strength of formal regulation or the dominance of central actors, but by a combination of stable network structures, evolving adaptive capacities, and integrated collective learning. The adaptive network governance model that emerged from the South Sumatra context makes a conceptual contribution to the study of environmental governance in areas with high ecological stress and an ever-evolving institutional structure.

CONCLUSION

This study analyzed the dynamics of network governance in implementing the Zero-Burning Land Management Policy in South Sumatra using Social Network Analysis and in-depth interviews. The findings indicate that governance operated within a semi-centralized network, with the provincial government acting as the dominant coordinating actor, while horizontal collaboration persisted among district governments, companies, NGOs, and local communities, particularly in operational contexts. Policy effectiveness was supported by both formal coordination mechanisms and informal, trust-based relationships; however, challenges such as capacity inequality, resource asymmetry, overlapping authority, and the peripheral role of local communities in formal decision-making limited overall network performance. Although the system demonstrated adaptive capacity through task forces, monitoring technology, and regulatory adjustments, these responses were largely reactive rather than based on institutionalized learning. Overall, the study highlights that effective environmental governance depends on balancing centralized coordination with strong horizontal linkages, trust-building, and continuous adaptive learning. Future research should focus on developing and testing mechanisms to institutionalize long-term learning and strengthen the role of local actors within governance networks to enhance policy sustainability.

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