Institutional fragmentation of peat fire management in Indonesia: a knowledge management perspective

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Abstract. The importance of intersectoral collaboration in policy implementation has been widely accepted. Concepts of intersectoral collaboration and policy coordination are theoretically appealing; however, it is challenging to implement in practice, including in forest fire management. This paper aims to map the institutions on forest fire management and analyze the rationality in using knowledge in their duties and authorities. Using stakeholder mapping combined with the Concern-Knowledge-Action approach, this study is conducted at the national level in Indonesia, and takes two sub-national levels, South Sumatera and Central Kalimantan, as the case study. There are many institutions involved in fire management in all governance levels, including at the provincial-district level, as well as at the sub-district-village level, but the institutional fragmentation in peat fire management is still found. In managing fire in South Sumatera and Central Kalimantan, it is not handled by a specific institution having the most influential and important positions. They have different authorities but the same potential power to prevent and combat fire. A complex interconnection among them indicates the need for effective institution integration. Less connectivity among the knowledge pool is also found, especially between private – community, NGO – academia, and government – community. Finally, knowledge improvement on fire prevention method especially in defining a community livelihood offset, as well as the ex-post fire management (measuring the level of fire impact and its recovery methods) is needed to fill the gap of knowledge. A stakeholder Forum is one of the options to improve intersectoral coordination in managing forest fire in peatland and enhance the effectiveness of knowledge sharing. At community level, conducting informal discussion and capacity-building programs would be feasible options for better coordination and improving knowledge.

1. Introduction
The importance of synergy and intersectoral collaboration in policy implementation has been widely accepted [1–4] Furthermore, effective coordination in deforestation reduction among activists, local
people, non-governmental organizations, and international donors does not occur spontaneously but is driven by political dimensions of land use governance [2]. However, the concepts of intersectoral collaboration and policy coordination are theoretically appealing but rather difficult to implement in practice [4]. The big challenge is stakeholders that have different values and knowledge-driven by their respective institutions.

The study would like to examine synergy and intersectoral collaboration and knowledge management in the organization in the field of peat fire management in Indonesia, where peat fire is still put a national and global concern. The Government of Indonesia has actually noticed fire as the top national priority, by imposing laws and regulations restricting the use of fire for land clearing, supported by the use of innovative approaches for fire management, and established fire management institutions to manage forest and land fire. Although forest fire areas has been decreased significantly by more than 80%, from 2.6 million ha in 2015 to 510 thousand ha in 2018, as well as the number of hot spots also decreased more than 86%, from 70,971 hot spots in 2015 to 9,251 hot spots in 2018 [5]; see also www.sipongi.menlhk.go.id for further monitoring of the dynamic site data), however, peat fire is the remaining issues for all national and global entities and community living in and around peat ecosystem.

It is indicated that there is a lot of knowledge on peat fire and its management system in Indonesia. Through knowledge management, organizations (in this context is peat fire management institution) seek to acquire or create potentially useful knowledge and to make it available to those who can use it at a time and place that is appropriate for them to achieve maximum effective usage to positively influence organizational performance [6].

Therefore, the basic question is whether or not the forest fire management system in Indonesia has been effective in carrying out collaborations, strategies and activities using existing knowledge pools and those provided by others. In line with that, this paper aims to: (1) map institutions on forest fire management, (2) analyze to what extent the institutions use the body of science in their activities and strategies.

2. Conceptual framework and method
The study uses two main concepts i.e. intersectoral coordination and knowledge management in organization. The following section describes briefly each concept.

2.1. Intersectoral coordination
Policies and programs, including peat forest fire management policy, involve multi-sector with various objectives. To integrate multi-sectors in peat forest management policy, it is needed good intersectoral coordination from planning to implementation. In addition, good intersectoral coordination is required to more effectively and efficiently achieve the various objectives [7].

However, natural resource management is one of the arenas of actions for how multi-sectors not only integrate but also compete. According to [8], an example that can be seen is the forestry sector and its competitors in REDD+ and the One Map Policy program in Indonesia. Although these two programs are national priority goals the authority of the Ministry of Forestry is decreasing because its formal responsibilities and duties are gradually being shared with other state institutions.

Formal tasks and responsibilities among sector are complex in forest fire management in Indonesia. Responsibilities of bureaucracy in the forestry sector in Indonesia are classified into two categories: forest management and forest administrations [9]. Referring to those two categories, peat forest fire management has a responsibility to be more on-site such as fire management planning, firefighting, and forest fire monitoring. While peat forest fire management administrations cover works establishing regulation, general planning and design, and granting rights.

The main characteristics of bureaucracy for intersectoral collaboration are (i) rules as the foundation for action (ii) offices for the management of rules, (iii) knowledge of action that is oriented in records, not in individuals, (iv) expert knowledge management to perform offices, (v) official professionals as the main activity of individuals holding office and (vi) management of the offices that is governed by a set of rules [9].
More recently, numerous social scientists have suggested that bureaucracy’s era is over and that it is rapidly being replaced by other organizational forms. These new forms share some characteristics of non-bureaucratic organic organizations originally identified by contingency theorists: flexible and multi-skilled jobs rather than rigid divisions of labor, control via collaboration in a relatively ‘flat’ networked structure rather through a command hierarchy, and an emphasis on worker participation and commitment [10].

2.2. Knowledge management in an organization

Knowledge Management (KM) perspective will be used to make sure that forest fire management system is effective in controlling fire under multi-sector involvement. There are numerous definitions proffered by experts. However, there is no universally accepted definition of knowledge management. For a conceptual basis, this discussion refers to a couple of opinions on the terminology of knowledge management. Knowledge management is a process of identifying, acquiring, distributing and maintaining knowledge that is essential to the organization [11]. In line with that, the definition of knowledge management is as planning, organizing, motivating, and controlling of people, processes and systems in the organization to ensure that the knowledge-related assets are improved and effectively employed [6]. Another one is that knowledge management refers to identifying and leveraging collective knowledge in an organization to help the organization compete [1].

Most knowledge management activities have one of three aims [1]: (1) to make knowledge visible and show the role of knowledge in an organization, mainly through maps, yellow pages, and hypertext tools; (2) to develop knowledge-intensive culture by encouraging and aggregating behaviors such as knowledge sharing (as opposed to hoarding) and proactively seeking and offering knowledge; (3) to build knowledge infrastructure, not only a technical system, but also a web of connections among people given space, time, tools, and encouragement to interact and collaborate.

To understand the current role of knowledge management (KM) in peat fire management in Indonesia, it needs to identify all of the process models of KM. They are a. process model [6], the model that starts from creation and acquisition of knowledge, followed by knowledge refinement, storage, transferring, sharing, and knowledge utilization. In the end, overall process will contribute to the performance of the organization or institution. b. process model [12] that links three main components of knowledge management process, namely: knowledge creation and sensing, knowledge organizing and capture, and knowledge sharing and dissemination.

2.3. Method

The study uses two steps of analytical work, they are stakeholder mapping adopted from [13] and identifying concern-knowledge-action of the main stakeholders modified from [14].

2.3.1 Stakeholder mapping. Stakeholders mapping is conducted in 3 governance levels: national, provincial, and district levels. A case study is conducted in two selected provinces: South Sumatera, and Central Kalimantan to see the evidence for provincial and district levels. These two provinces represent two regions of Indonesian national priority in peat fire prevention strategy.

Stakeholder mapping is conducted by internal workshops and group discussions involving FOERDIA (Forest and Environment Research Development and Innovation Agency, Ministry of Environment and Forestry) and other local research institutions (University of Palangkaraya, FOERDIA Local Office), including related Non-Government Institutions (such as BOSF, Yayasan Tumbuhak Sinta), that are conducted in Bogor (West Java), Pontianak (Central Kalimantan), and Palembang (South Sumatera). The workshops and group discussion cover:

• Brainstorming consisting of notes of all key stakeholders. The main question is that who (people or institutions) can prevent fire in the peat land ecosystem?
• Clustering stakeholders in a specific group based on the similarities of work and responsibility.
• Defining who is most influential and important for peat fire management.
• Determining how they are connected, how they influence each other. It is also should consider knowledge best work, connection, eg. committees advisor, planning processes, etc.

2.3.2 Examining concern, knowledge, and action of main stakeholders. This research also identifies concerns, knowledge, and action of key stakeholders regarding peat forest fire management system by in-depth interview through audience with selected key institutions in provincial and district levels. Concern refers to the main task and function of organization. Knowledge refers to what extent the main stakeholders play a role in knowledge creation, knowledge organizing, and knowledge sharing. Meanwhile, action refers to stakeholder programs.

3. Result and discussion

3.1. The map of stakeholders on fire management

There are many stakeholders involved in fire management, from the national level to the site level. At each level, there are stakeholders whose role is important in fire management, but there are those who are the most influential. Further explanation is presented in the following sub-chapters.

3.1.1. National level. Stakeholder map for the national levels is illustrated in figure 1. The map shows three main clusters of government agencies. At the peak are the President and the People Representative Council, together with high-level government agencies (Presidential Staff Office, Coordinating Ministry for Economic Affairs, Ministry of Finance, Ministry of National Development Planning, Coordinating Ministry for Political, Legal and Security of Indonesia, and Ministry for Internal Affairs) and the Indonesia Council of Ulama (MUI) are the most influential stakeholders. The President and the People Representative Council are lobbied directly by heads of neighboring nations (especially Singapore, Malaysia, and the Philippines) and through ASEAN's Agreement on Transboundary Haze Pollution (ATBHP). The result of stakeholder mapping illustrates in Figure 1.

![Figure 1](image_url)

**Figure 1.** Preliminary stakeholder map for the international and national levels.

The second cluster of government agencies shows Peat Restoration Agency (BRG) linking directly up to the President and down to government agencies/entities, especially for 7 priority provinces. Those that are identified as important are PSKL (Social Forestry and Environmental Partnership), PPKL (Development of Field Cooperative Extension Officers), PPI (Directorate General of Climate Change), Ministry of Villages, Development of Disadvantaged Areas and Transmigration, Ministry of Agriculture, and BNPB* (Indonesian National Board for Disaster Management). Others in this cluster are the Directorate General of Management of Sustainable Production Forests, MoEF, Ministry of Public Works and Public Housing, Agency for the Assessment and Application of Technology, National Institute of Aeronautics and Space, and Indonesian Agency for Meteorology, Climatology, and Geophysics.
The third cluster of government agencies are those that are charged with law enforcement: National Police, National Armed Forces, Directorate General of Law Enforcement), Attorney General of the Republic of Indonesia. The law enforcement activities of this cluster are targeted at both the private sector and other government agencies.

The second cluster (BRG, PSKL, PPKL, and PPI) are connected to a cluster of research institutes (all of which are identified as important: Center for International Forestry Research (CIFOR), International Centre for Research in Agroforestry (ICRAF), Australian Center for International Agricultural Research (ACIAR), Agriculture Research and Development Agency) that provide technical support and advice, information products and data, and in the case of PPKL and PPI, fire management training. A cluster of several international development agencies is primarily described as providing a source of funds to research institutes and government agencies (together with technical support) for managing peatland fire-related issues, two of which are identified as important (Department of Foreign Affairs and Trade (DFAT), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Norway, Canadian International Development Agency (CIDA), Food and Agriculture Organization (FAO), the World Bank, Asian Development Bank (ADB), United Nations Development Programme (UNDP), International Fund for Agricultural Development (IFAD)). Universities (Gadjah Mada University, and IPB University) and some influential researchers are characterized as close collaborators and data/information sharers with research institutes and as an important source of technical support to the private sector and government agencies.

A group of national and international NGOs – GGGI (Global Green Growth Institute), WWF (World Wide Fund for Nature), Wetlands International, FSC (Forest Stewardship Council), Partnership, Greenpeace Indonesia, and WALHI (Indonesian Forum for the Environment) – is described in terms of the roles of stakeholders and their activities in managing forest and land fires, as well as engaging with the private sector through the collaboration (GGGI) and certification process (FSC).

The private sector cluster comprises APHI (Asosiasi Pengusahaan Hutan Indonesia), PT RMU (Rimba Makmur Utama), private palm oil companies, APP Group and APRIL Group. The map connects this sector to government agencies through policy and law enforcement, to international development agencies and universities through technical support.

3.1.2 Provincial and district level

3.1.2.1 South Sumatera. The study finds a lot of institutions involved in managing peat fire at provincial, and district levels, including at the site level in villages. They involve in preventing fire directly and indirectly as listed in Appendix A. The study identifies 6 clusters of stakeholders related to forest and land fire at provincial and district levels (Case of Ogan Komering Ilir), namely: government, law enforcement institutions, academic research institutions, partnerships, corporations, and NGOs. Each stakeholder has a different level of importance and level of influence according to their duties. Based on the opinions of stakeholders and reviewing the duties and functions of each institution, it can be compiled into a stakeholder analysis map as is presented in figure 2.

The Governor has a role in drafting Provincial Regulations related to forest and land fire, optimizing BPBD (Regional Disaster Management Agency), requiring agricultural entrepreneurs to have infrastructure facilities and giving sanctions to the perpetrators of land burning, and allocating budgets for the control of forest and land fires in the regions. One of the first steps taken by the Governor is to establish a Forestry Task Force through the South Sumatra Governor's Decree Number: 654/KPTS/BPBD-SS/2015 consisting of Provincial BPBD, UPTD (Regional Technical Implementation Unit) for forest and land fire control, Natural Resources Conservation Center (BKSDA), Forestry Office, Plantation Office, Agriculture Office, Transportation Agency, Meteorology, Climatology and Geophysics Agency (BMKG), Counseling Coordination Agency (Bakorluh), Health Office, Environment Office, Provincial Police (Polda), Indonesian National Army (TNI), Regional Secretary, and High Prosecutor's Provincial Office (Kejati). The Task Force Commander is Commander of the 044/Gapo Military (Danrem) Resort.
Remarks:
1 Prevention declaration
2 Prosecution

Figure 2. Chart of stakeholders of forest and land fires in South Sumatra.

The Forest and Land Fire Task Forces (Satgas Karhutla) are formed when the situation is in an emergency. At the provincial level, the Task Force is formed based on the governor’s decision, while the district task force is formed based on the regent’s decision. This task force is not a fixed but only an ad-hoc institution that is usually limited to one year in carrying out its duties. The forest and land fire Task Force will generally start working when forest and land fire alert status is set and it ends when the emergency status of forest and land fire is revoked. This task force is generally based or under the coordination of the Regional Disaster Management Agency (BPBD).

The head of the South Sumatra provincial police (Kapolda) usually announces "Prohibition of Combustion of Forests, Land or Shrubs" to agricultural-plantation-forestry extension, village midwives, Friday prayer sermons in the OKI Regency, Ogan Ilir, Muba, Banyuasin, and Muara Enim (for fire prevention activities). The existence of NGOs, universities, and partnerships has not yet had a significant influence on the control of forest fires. In general, NGOs focus on improving the villagers understanding and capacity in preventing forest and land fires.

At sub-district and village levels, there are at least 3 groups of institutions in charge of fire management (figure 3). The first one is formal and informal leaders (including Village Head, Religious
Leader, and Sub Village Head or *Ketua RT*). The second one is a community, including the MPA (*Masyarakat Peduli Api*/*Fire Care Community* established by the government), and KTMA (*Fire Care Community* established by the company), and landowners. The third one is the force commander at the site level (including Police, Army, Fire Force, and Forest Ranger). The last one is a private company operating within and surrounding the village. An extension agent is connecting the community and force commander.

The Sub-district Government has the role and function of coordinating village officials to safeguard their territory from fire hazards. Whereas the Village Government has a role and function in disseminating fire hazard warning information to the community, mobilizing citizens to involve in guarding their land against fire hazards, and receiving reports of land burning activities to prepare agricultural or plantation land.

The Community Fire Control Team (*Fire Care Community - MPA/ RPK/BPK/KMPK*) has a role and function in conducting counseling to residents about fire control techniques, observing community activities on land that will be opened/burned with the community/village officials, reporting on burning land/forest incidents in his village, and putting out fires in the village area. It is also important to distinguish that there are three types of tenure system in general, namely: concession rights, community possession, and potential conflict land. Those types of tenure contribute to the different patterns of fire management and approach. The approach will refer to the stakeholders who have access to the land, formal and informal ways, and the media communication that is adjusted with the level of knowledge and understanding of the stakeholders about fire management.

3.1.2.2 Central Kalimantan. The stakeholder map at the provincial and district levels for Central Kalimantan is shown in figure 3. The map shows the project partners as the providers of evidence-based information and advice and project-related funds at the provincial and district levels: YTS, BOSF (with links to the NASA project), FOERDIA Banjarbaru co-located with BP DAS (Watershed Management Office), and UPR (University of Palangkaraya) and its CIMTROP (Center for International Cooperation in Sustainable Management of Tropical Peatland). The result of the stakeholder mapping process in Central Kalimantan is illustrated in Figure 3.

![Figure 3. Stakeholder map for the provincial and district levels in Central Kalimantan.](image)

The core cluster of the map shows the suite of district-level government agencies/entities. At the top leadership is the Bupati (Regent of Pulang Pisau), together with a deputy, and the Legislature (District Representative Council). Each district-level government agency is shown as a connecting agent to other
higher-order government agencies/entities or non-government bodies for a specific purpose, which is characterized as canal blocking, firefighting, and development including alternative livelihoods.

Regarding canal blocking, Public Works Provincial Service connects with the TRGD (Provincial Restoration Team/Tim Restorasi Gambut Daerah under the national-level BRG) and the Swamp Research institute of Banjarbaru/Balai Penelitian Rawa BJB (an experimental station in Banjarbaru). Several influential academics from UPR and its CIMTROP are shown as sources of evidence-based advice and information to TRGD. Regarding fire management, the map shows BPBD (Provincial/District National Board for Disaster Management) as the main connector to district-level government, as the convener of an integrated fire management team comprising the police, army, and the UNOPS GAMBUT (Generating Anticipatory Measures for Better Utilization of Tropical Peatlands) project.

The Provincial Development Planning Agency (BAPPEDA, Badan Perencana Pembangunan Daerah), is closely connected to several entities engaged in significant development activities in the district, which are co-located in BAPPEDA’s office (GGGI, USAID Lestari and Kemitraan). Alternative livelihoods are prominent features of these development activities, with the connections to related district-level agencies –Environmental Office, Extension Office, Agriculture Office, Community Empowerment Office, Animal Husbandry, and Fisheries Office. Several NGOs/entities are identified as operating agencies in the province, but they are not considered as important based on not currently delivering significant projects within the district of concern – WWF, Wetlands International, BNF (Borneo Nature Foundation), and Sebangau National Park.

A cluster of provincial government agencies/entities are shown as feeding agencies into district-level decision-making: Forestry Service, Agency for Meteorology Climatology and Geophysics, Nature Conservation Agency, Forest Management Unit of Kahayan Hilir, and Climate Change Office. It is only the Forestry Office that is identified as having a district-level function that is the core to peatland management.

In Central Kalimantan, the focal villages will be those that surround FOERDIA’s Litbang Banjarbaru Tumbang Nusa Research Forest Area; the two nearest of which are Tumbang Nusa and Taruna. Figure 4 shows the preliminary stakeholder map at the sub-district and village levels.

**Figure 4.** Stakeholder map for the sub-district and village levels in Central Kalimantan.

The most influential actors related to fire prevention at the sub-district level are the Sub-district Head (Camat), and the Customary Leader (Damang). While at the village level, the most influential actors are the Village Government Officers (Pemdes, which consists of a village head, village secretary, division heads and neighborhood unit heads), Village Assembly (BPD), Customary Leaders (Mantir Adat), and the Fire Care Community (MPA). Those actors work with the Sub-district Police Department (Polsek), and the Sub-district Army (Koramil) when there are fire incidents within the village area. Both Polsek and Koramil must catch individuals, groups, companies, and other actors who cause a fire in peatlands and bring them before the law. They also have a responsibility to help with fire suppression within their
administrative areas. In addition, they have received a circular letter reminding them to enforce the regulations on the forest fire ban issued by the central government in 2015.

Taken together, the Sub-district Head, Sub-district Police Department, and the Sub-district Army are called the Forum Muspida, which stands for Forum Masyarakat Pemerintah Daerah (local government discussion forum). Those actors/institutions collaborate with forest fire prevention-related organizations such as the Peatland Restoration Agency (BRG), Nature Conservation Agency (BKSDA), and Forest with Special Purposes (KHDTK) Tumbang Nusa. Those agencies also coordinate with the village government (Pemdes) and fire care community (MPA) to run their programs. The KHDTK provides equipment, vehicles, and training to prevent and suppress peatland fires. But the vehicles are no longer used, as the MPA members say they do not have funding to cover their operational costs.

The village livelihood institutions consist of fishery actors (fishermen, collectors, and traders), farmers’ groups (farmers), rubber actors (farmers, traders, collectors), livestock farmers, swift-neck house owners, and oil palm smallholders. Those actors work closely with the village government and the customary leader when dealing with land ownership issues and conflict mediation among the villagers. About Dayak agricultural practices, those actors tend to burn forest/land to claim the land title, as in the Dayak tradition, land ownership is recognized by land clearing, burning, and planting particular crops. Currently, there are more than 60–80% of the community in Tumbang Nusa and Tanjung Taruna rely on fishing in the local river and swamp as their main source of livelihood. Besides that, villagers also work as rubber tappers and livestock farmers. Most of those current livelihood activities do not require land burning, and the land burning ban regulation issued in 2015 make them afraid of burning forest or using fire to clear land.

Palm oil collectors and processing units may sometimes seek to widen their business activity by working with the community through a ‘plasma’ system. They provide funds to villagers who want to plant palm oil on their land and sell their palm oil fruit-bunch to the company. The company purchases the palm oil fruit-bunch under specific terms and conditions agreed between the two parties.

There are also other actors to consider, such as palm oil companies, the private sector, illegal loggers, local mafia, palm oil collectors, and processing units. Those actors have a kind of secretive relationship with the sub-district and village government officers. Their communication uses private channels with an underground network. Sometimes there is a secret agenda among them, which only they who know about.

Various village-based institutions exist, and they are based on their specific target members groups, such as women’s groups (PKK), Youth Organization (Karang Taruna), Livelihoods Cooperative (Koperasi), Community Healthcare Center (Puskesmas), Integrated Healthcare Unit (Posyandu) mainly for mothers and toddlers, and educational institutions (preschool, primary school, and junior high school). Those actors/institutions have potential as social channels for the research projects.

3.2. Concern, knowledge, and action of main stakeholders

Purposively revisititation is also implemented to map their concern, knowledge, and action (table 1). The revisititation is to BRG, National Planning Agency, MoEF, Ministry of Agrarian Affairs, National Disaster Management Agency, and Ministry of Agriculture at the national level. National institution concern, at least, comprises to several types. There is a focus on restoration targets within and outside state forest areas in 7 provinces, the other one is concerned with improving peatland management quality including forest fire management, and some others focus on overcoming natural disasters from a forest fire.

Such different concern implies different basic knowledge used to deal with their institutional objectives and actions in peat and forest fire management. Those stakeholders have similar objectives and complement each other towards sustainable peatland management but in different strategies, based on the institutional main duties. The study indicates an inline concern among key stakeholders, for instance, BRG, MoEF, and the BNPB. Officially they are concerned to prevent and control peat forest fire both in the forest area and outside the forest area. The 3R, Peat Hydrological Area, Strategic Environmental Assessment (KLHS), forest fire-prevention, and zero burning land clearing are the
concern that institutional harmonization. However, there are also indications of the need for cross-sectoral coordination to align targets and management systems for dealing with peat fires. In this context, the Ministry of National Development Planning can potentially take a lead role among stakeholders in coordinating and harmonizing various programs of fire management. The Ministry of Agriculture, for instance, focuses on realizing the development of integrated swamp/peatland use to support food security.

Table 1. Concern knowledge action of main stakeholders at the national level.

| Key stakeholder | Concern | Knowledge | Action |
|-----------------|---------|-----------|--------|
| Peat Restoration Agency (BRG) | Coordinating and facilitating peat restoration covering an area of ±2 million ha in 7 provinces, namely Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, South Kalimantan, and Papua Provinces. | The knowledge of BRG is divided into 3 principles or approaches, namely raising peatland water tables (rewetting), revegetation of degraded peatlands (revegetation), and creating alternative livelihoods for local communities (revitalization). | - Establish an indicative map of peat restoration through the Decree of the Head of BRG No. SK.05/BRG/Kpts/2016 regarding Indicative Map of Peat Restoration (PIR). - BRG partners have built up a wetting infrastructure in the form of 1,000 drilled wells, 30 canal blocking units and the installation of a water level monitoring device (TMA) in the peat ecosystem, totaling 142 units. - Execution of burnt area revegetation by BRG's partners in South Kalimantan. - Developing “Desa Peduli Gambut” program - The compilation of the National Peat Ecosystem Restoration Plan and the Peat Ecosystem Restoration Plan (RREG) in 7 priority provinces on 36 KHG covering an area of 7,537,647 ha. - Fostering community groups (Pokmas) to manage local commodities, honey bee cultivation, cattle farming, and fisheries. |
| Ministry of National Development Planning/National Development | Coordinating national and international development cooperation (bilateral, unilateral, and multilateral) to tackle Peat restoration knowledge is important for realizing the National Priority (Prinas), namely the Health Service and the Village and Rural Area Service. | - Encouraging the implementation of Low Carbon Development (PRK) through the formation of a Strategic Coordination Team for Wetland |
| Key stakeholder                              | Concern                                                                 | Knowledge                                                                                                                                                                                                                         | Action                                                                                                                                                                                                 |
|---------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Planning Agency                             | forest and land fires through peat restoration.                         | The Health Service is directed to reduce the potential for ISPA due to forest and land fires, while the Village Office and Rural Areas are directed to increase the empowerment of peatlands through the restoration of 400 thousand ha of peat ecosystems spread across 7 provinces, namely Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, South Kalimantan, and Papua Province. | Management (KepmenPPN Number KEP.89/M.PPN/HK/10/2020).                                                                                                                                               |
| Ministry of Environment and Forestry c.q Directorate General of Pollution and Environmental Damage Control | Improve the quality of peatland management                              | Knowledge in peat ecosystem management (PP No.71/2014) regarding the Protection and Management of Peat Ecosystems through the Peat Hydrological Unit (KHG) approach, namely the existence of a peat ecosystem located between 2 (two) rivers, between rivers and the sea. | - Construction of canal blocking (tabat) reaches 627 units in 8 provinces, namely Aceh, North Sumatra, West Sumatra, Jambi, Riau, West Kalimantan, Central Kalimantan and East Kalimantan.                                                                                 |
| Ministry of Agrarian Affairs and Spatial Planning/BPN | Identify the control and use of peatland by the community by spatial planning directions, and provide spatial | Knowledge of the KLHS (Strategic Environmental Assessment) document which is prepared as a supporting document for Verifying Indicative Maps of Peat Restoration Priorities in the 7 designated provinces. |                                                                                                                                                                                                       |
| Key stakeholder                        | Concern                                                                 | Knowledge                                                                                           | Action                                                                                                                                 |
|---------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| National Disaster Management Agency (BNPB) | Overcoming natural disasters from forest and peatland fires.            | Knowledge to reduce risks and preparedness of forest and land fires in an integrated manner, as well as assist the community to prevent forest and land fires. | - An educational approach and socialization of the use of peatlands without burning, this field school activity targets the community, especially farmer groups, to make alternative uses of natural-friendly peatlands so that forest and land fires in peatlands can be prevented.  
- Early detection of hotspots, air patrols, and extinguishing hotspots that arise through deploying ground and air personnel are some of the efforts that have been and will continue to be made in handling forest and land fires in Indonesia.  
- Participatory mitigation of forest and land fires through the use of peatlands without burning. |
| Ministry of Agriculture               | Realizing the development of integrated swamp/peatland use to support food security. | Knowledge to facilitate the application of land clearing/preparation without burning on agricultural land. | - Increasing the use of tidal swamps and swamps/peat for rice cultivation.  
- Improving the quality of soil fertility and water in swamp/peatlands in an integrated manner for rice cultivation without damaging the environment.  
- Increasing the production and productivity of tidal swamp and swamp/peatland rice sustainably. |

Similarly, such a situation is also found at provincial and district levels. Many institutions care about fire prevention and control, watershed-based rehabilitation, conservation of protected forest areas, and peat restoration using formal knowledge in each sector to achieve their goals. However, plantation and
agriculture sectors have different concerns; hence, they need to integrate their target in improving plantation and agricultural productivities by implementing friendly environment farming and plantation practices (without burning), need to provide farmers with crop information for dry and rainy seasons, and need to provide training and land clearing equipment (without burning). The need for intensive inter-sectoral coordination is also found for the public work and the housing sector since the concern is to support the use of peatland infrastructures (see Appendix C and Appendix D).

In addition, a new approach has been promoted by the Central Government to be implemented in provincial and district jurisdictional areas in peat and forest fire management. The inclusion of Provincial and District Army and Police in paramiliteristic approach in managing fire is a new insight and it represents a positive result in reducing fire in South Sumatra and Central Kalimantan.

Provincial and District Police Command give warnings and prohibitions on burning according to the Governor’s and Regent's instructions, as well as enforcing the law following the violations on land burning regulations. The Forest and Land Fire Task Force is formed in an emergency. At the provincial level, the Task Force is formed based on the Governor Decree, while a district task force is formed based on the Bupati’s Decree, as an ad-hoc institution and usually it is limited to one-year duty. The Task Force generally comes into operation when a fire alert status is set and it ends when the emergency status of the forest and land fire is revoked. This task force is generally based or under the coordination of the Provincial and District Disaster Management Agency.

National and sub-national institutions appear and carry out their concerns and activities according to their background knowledge. All of the institution clusters play an important role as a knowledge pool. In general, their formal knowledge definitively comes from national directions and technical guidelines on each relevant sector. Formal knowledge comprises statutory laws, ministerial regulation, or official letters. Coordination meetings, training, and direct instructions are the media of knowledge transfers among them. The adoption and recognition of other formal knowledge from other clusters (academic communities, NGOs, other official institutions) as well as informal knowledge from local communities are conducted by incidental mechanisms, such as knowledge exchange in seminars, FGDs, workshops, field works, and any other events. Most of them, national and sub-national organizations, are categorized as knowledge organizing agents. They do not have any knowledge acquisition and knowledge sharing activities, except academia clusters and NGOs.

3.3. Implication for policy improvement
The study finds many lessons learned on fire management institutions in Indonesia from a knowledge management perspective. The first issue, the study indicates the complexity of institutions involving peat fire management at national and sub-national levels. There are many typologies of organizations, although they can be classified into several clusters. Each institution has specific background information (see Appendix A and Appendix B). It is implied to the need for high effort on inter-sectoral coordination. Some clusters have been connected to other clusters in conducting the duties in peat fire management. However, some other clusters are not connected especially in transferring and exchanging knowledge. Lack of connectivity between knowledge pools, especially between private – community, between NGOs – academics, and between government agencies – communities, lead fire management institutions to use, for the most part, their knowledge

Cluster linkages with other clusters indicate the fragmentation of fire prevention institutions in Indonesia, as well as sectoral competition [8]. This has implications for the need for channeling and the need for an effective knowledge transfer mechanism between organizational clusters. The next challenge is how to maximize coordinating agencies both for national and sub-national levels to minimize fragmentation. In another way, it is also a challenge on creating a new mechanism in connecting the clusters. The improvement of inter-sectoral coordination is important, as referred to [7] to achieve different objectives to be more effective and efficient. In addition, improving connectives of fire managements stakeholders is to get good characteristics of inter-sectoral collaboration, especially in maximizing knowledge of action that is oriented in records, and expert knowledge management to perform offices [9].
To deal with this issue, it is proposed the formation of a stakeholder forum as an option following with integrated programs among stakeholders to improve inter-sectoral coordination in managing forest fire in peatland and enhance the effectiveness of knowledge sharing. At the community level, conducting informal discussions and implementing capacity-building programs regularly would be feasible options for better coordination and improving villagers’ knowledge. Multi-level governance and multi-stakeholder partnership programs at the site level can potentially generate better conditions for fire management.

The second issue is that the inclusion of army forces and police in integrated fire management organizations in provincial and at the site levels using paramilitaristic approach have been recognized and potentially contribute to the scientific discussion and practical implementation. Although it is still needed to be tested in the statistical calculation, however, this new approach is officially and socially affecting in reducing fire. Conceptually, indeed, the paramilitaristic approach is going back to the colonial era, in practice paramilitaristic approach is quite effective to control stakeholder violation in the fire.

The third issue is the lack of post-fire revegetation activities. Most of the clusters, both at the national and sub-national levels, focus on fire prevention and fire control. In determining restoration and rehabilitation activities, these clusters do not pay attention to the level of damage after the fire. Post-fire revegetation activities have been dominated by the BRG and the provincial environment office, together with some partners on the site level. Hence, post-fire assessment by mapping the destruction level of the peatland area to determine revegetation or restoration or rehabilitation strategies is an important step. In addition, knowledge improvement on fire prevention methods especially in defining a community livelihood offset is also important to improve community participation.

4. Conclusion and policy recommendation
This study concludes that there are many institutions involved in fire management in Indonesia, as well as at provincial and district levels, especially based on this study in South Sumatera and Central Kalimantan. Peat and forest fire management institutions could be classified into several clusters (such as regulating agencies, executing agencies, law enforcement agencies, academia, and advocacy agencies), however, there is a complex interconnection among clusters that contribute to the need of how to integrate those institutions effectively. There is no similar specific institution that has the most influential and important in managing fire at the national level, in South Sumatera, and in Central Kalimantan, as well as in OKI and Pulang Pisau Districts. The Governor, District Head, Army, Police, Manggala Agni have the same potential power to prevent and combat the fire. However, the role of other institutions is at the next level of importance according to their perspectives. The study also notes that some clusters are connected to other clusters in conducting duties in peat fire management; however, some other clusters are not connected especially in transferring and exchanging knowledge. This less connectivity indicates the existence of institutional fragmentation on fire management in Indonesia.

This study proposes policy recommendations to fill the gaps. Stakeholders forum following with integrated programs among stakeholders is a good pathway to improve inter-sectoral coordination in managing forest fire in peatland and enhance the effectiveness of knowledge sharing. At the community level, conducting informal discussion and capacity-building programs would be a good feasible option for better coordination and improving villagers’ knowledge. Knowledge improvement on fire prevention methods especially in defining community livelihood offset, as well as the ex-post fire management (measuring the level of fire impact and its recovery methods) is needed to fill the gap of knowledge. At the community level, conducting informal discussion and capacity-building programs would be a better option for coordination and knowledge improvement.

References
[1] Li B, Huikuru, Zhang Y and Chen W 2015 Motivating intersectoral collaboration with the Hygienic City Campaign in Jingchang, China Environ. Urban. 27 285–302
[2] Ravikumar A, Larson A M, Myers R and Trench T 2018 Inter-sectoral and multilevel coordination
alone do not reduce deforestation and advance environmental justice: Why bold contestation works when collaboration fails Environ. Plan. C Polit. Sp. 36 1437–57

[3] Supratman, Alam S, Emban Ibnu R, Adrayanti S and Sahide M A K 2019 Institutional Synergy Model of Awota Forest Management Unit in South Sulawesi Province IOP Conference Series: Earth and Environmental Science vol 270

[4] Zingerli C, Bisang K and Zimmermann W 2004 Towards Policy Integration: Experiences with intersectoral coordination in international and national forest policy Berlin Conference 2004 on the Human Dimension of Global Environmental Change “Greening of Policies - Interlinkages and Policy Integration” pp 1–16

[5] [MoEF] Ministry of Environment and Forestry 2019 Update Laporan Posko Pengendalian Kebakaran Hutan Dan Lahan Tanggal 14 Januari 2019 (Update Report of Land and Forest Fire Station per January 14th, 2019) (Jakarta)

[6] King W R 2009 Knowledge Management and Organizational Learning Ann. Inf. Syst. 4 3–13

[7] Giessen L and Krott M 2009 Forestry joining integrated programmes? a question of willingness, ability, and opportunities Allg. Forst- und Jagdzeitung 180 94–100

[8] Wibowo A and Giessen L 2015 Absolute and relative power gains among state agencies in forest-related land-use politics: The Ministry of Forestry and its competitors in the REDD+ Programme and the One Map Policy in Indonesia Land use policy 49 131–41

[9] Sahide M A K and Giessen L 2015 The fragmented land-use administration in Indonesia - Analysing bureaucratic responsibilities influencing tropical rainforest transformation systems Land use policy 43 96–110

[10] Damarin A K 2015 Bureaucracy, Sociology of. International Encyclopedia of the Social & Behavioral Sciences: Second Edition vol 2 (Elsevier)

[11] Kucza T 2001 Knowledge Management Process Model (Finland: Julkaisija-Utgivare Publisher - Technical Research Centre of Finland)

[12] Botha A, Kourie D and Snyman R 2008 Coping with Continuous Change in the Business Environment, Knowledge Management and Knowledge Management Technology (London: Chandice Publishing Ltd)

[13] Elizbeth C. McNie, meine van Noordwijk, William C.Clark, Nancy M. Dickson, Niken Sakuntaladewi, Suyanto, Laxman Joshi, Kurniatus Hairiah, Noviana Khususiyah. 2008. Boundary Organization, Objects, and Agents: Linking Knowledge with Action in Agroforestry Watershed. Working Papers. Center for International Development at Harvard University.

[14] The World Bank & International Finance Cooperation (2016). Public-Private Dialogue (PPD) Stakeholder Mapping Toolkit. Washington DC: The World Bank Group.

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Appendices

Appendix A. Background information of the key stakeholders

| Key Stakeholders | Background Information |
|------------------|------------------------|
| **Central Government (located at Provincial Level)** | |
| BRG (Peat Restoration Agency) | BRG has functions associated with fire prevention and peatland restoration program. |
| Balai PPI and Karhutla (Climate Change and Fire Management Office) | Balai PPI and Karhutla have functions associated with preventing and combating fire. |
| BPHP (Production Forest Management Office) | Supporting the Forest Management Unit in designing the program to prevent and control forest and land fires |
| BPDAS-HL (Watershed and Protected Forest Management) | BPDAS-HL has functions associated with preventing fire and restoration based on watershed management |
| BKSDA (Natural Resources Conservation Center) | BKSDA operationalizes the Fire Danger Rating System (SPBK), provides fire hotspot data in the province and surrounding areas, provides guidance to the community to be jointly involved in the prevention of forest and land fires (MPA), as well as extinguishes forest fires, especially in conservation areas. |
| Provincial Police | Provincial Police has functions associated with combating fire. |
| Korem (Army Regiment Commandment) | Korem has functions associated with combating fire. |
| Manggala Agni Daerah Operasi (Operation Area of Fire Force) for the district | Manggala Agni has functions associated with combating fire, as mentioned previously |
| BMKG (Meteorology, Climatology and Geophysics Agency) | BMKG provides annual dry season forecast information to local governments, prepares daily updates of 3-day weather forecasts on the BMKG website, receives and processes weather and climate data from field officers, and provides fire hazard data to the Provincial command center |
| **Provincial Government** | |
| Governor | The Governor has a role in drafting Perda (regional regulations) related to Karhutla (forest and land fire), optimizing BPBD (Regional Disaster Management Agency), requiring agricultural entrepreneurs to have infrastructure facilities and giving sanctions to the perpetrators of land burning, and allocating budgets for the control of forest and land fires in the regions. One of the first steps taken by the Governor is to establish a Forestry Task Force comprising Provincial BPBD, UPTD (Regional Technical Implementation Unit) for forest and land fire control, Natural Resources Conservation Center (BKSDA), Forestry Service, Plantation Service, Agriculture Service, Transportation Agency, Meteorology, Climatology and Geophysics Agency (BMKG), Counseling Coordination Agency (Bakorluh), Health Office, Environment Agency (BLH), Regional Police (Polda), Indonesian National Army (TNI), Regional Secretary (Regional Secretary) and High Prosecutor's Office (Kejati). The Task Force Commander is Commander of the Military Resort (Danrem). |
| Provincial House of Representatives | The Provincial House of Representatives has functions associated with fire management regulation. |
**Key Stakeholders** | **Background Information**
--- | ---
DLHP (Provincial Office of Environment and Land) | DLHP disseminates information on forest and land fire early warnings, assesses the impacts of forest and land fires, and initiates the establishment of community groups concerned with fire (KMPK).
BPBD (Regional Disaster Management Agency) | BPBD coordinates the prevention of forest fire with technical agencies, then provides emergency response budgets, coordinates the forest and land fire disaster management post, and receives and updates early warning information (weather and hotspots) to all agencies and communities.
TRGD (Provincial Peat Restoration Team) | TRGD has functions associated with fire prevention and peatland restoration.
Bappeda (Regional Development Planning Agency) | Bappeda has planning and coordination responsibilities among agencies for forest and land fire management programs.
Dishut (Provincial Forestry Service) | Dishut makes efforts to prevent and suppress fires in State forest areas (HL, HP, HPT, HPK), as well as rehabilitate post-fire forests.
Disbun (Provincial Plantation Office) | Disbun guides and supervises plantation practices without burning. In addition, the Regional Technical Implementation Unit for Control of Forest and Land Fire (UPTD PKHL) of South Sumatra releases monitoring of hotspots from Modis Satellite (post-fire suppression and handling efforts).

**Government (Prosecution)**

Kapolda (Head of the South Sumatra Regional Police) | Kapolda has announced "Prohibition of Combustion of Forests, Land or Ilalang/Shrubs" to agricultural-plantation-forestry extension agents, village midwives,
Polda & Polres (Regional Police) | Polres and Polda give warnings and prohibitions on burning according to the regent's instructions, as well as enforce the law further to violations of land burning regulations.
Satgas Karhutla (TNI) | A forest and land fire task force (Satgas Karhutla) is formed in an emergency. At the provincial level, a task force (Satgas) is formed based on the Governor's decision, while a district task force is formed based on the Bupati's decision. A task force is not a fixed institution; it is ad hoc and usually limited to one year in carrying out its duties. A forest and land fire task force generally comes into operation when a fire alert status is set and ends when the emergency status of the forest and land fire is revoked. This task force is generally based or under the coordination of the Regional Disaster Management Agency (BPBD).
Kodam & Kodim | With collaborative action with other provincial stakeholders to support the program of fire prevention and to support the legal action of land and forest fire accidents.

**District Government**

District Head | The District Head has functions associated with preventing and combating fire.
District Plantation and Livestock Office | The District Plantation and Livestock Office has functions associated with fire prevention through their programs
District Environment Office | District Environment Officer has functions associated with fire prevention and restoration program
### Key Stakeholders

| Stakeholders | Background Information |
|--------------|------------------------|
| District Agriculture Office | The District Agriculture Office has functions associated with fire prevention through agricultural programs. |
| Food Crop Agriculture Service | The Food Crop Agriculture Service supports farmers to implement friendly environmental farming practices (without burning), provides farmers with crop information for the dry and rainy seasons, and provides training and land clearing equipment (without burning). |
| Bappeda (District Development Planning Agency) | Bappeda district has functions associated with developing land fire prevention planning. |
| BPBD (District Disaster Management) | BPBD has functions associated with combating fire coordinating with Provincial BPBD |
| BPMD (District Community Development Office) | District BPMD has functions associated with fire prevention. |
| KPH (Forest Management Unit) | KPH has functions associated with preventing and combating fire. |

#### Academia

- **Sriwijaya University, University of Palangka Raya**
  - This university has functions associated with fire prevention and post-fire rehabilitation programs collaborated with the technical institutions at the national and provincial level

#### Private Companies

- **APHI (Association of Logging Company in Indonesia)**
  - Coordinating the forest fire management among the forest plantation companies
- **HTI/forest plantation companies**
  - HTI is a Plantation Forest Company, and a member of APHI has functions in fire prevention, fire suppression, and post-fire rehabilitation at its concession area. Also to conduct coordination related to fire management with stakeholders.
- **GAPKI (Association of Palm Oil Company in Indonesia)**
  - Coordinating fire management program among the palm oil company.
  - Each oil palm company has functions in fire prevention, fire suppression, collaborating with other stakeholders around its concession area.
- **Sinar Mas Forestry Group**
  - Sinar Mas Forestry Group has functions associated with preventing and combating fire.

#### NGOs and other donor-based institution

- **ICRAF**
  - ICRAF is conducting a project in designing the Green Growth Development Program in South Sumatra and also conducting a project in which is one of the targets is in fire prevention on the peatland around the peatland hydrological unit.
- **CIFOR**
  - Together with Sriwijaya University conduct a project on livelihood options in peat restoration.
- **HAKI (Hutan Kita Institute)**
  - Local NGOs has a function associated with empowerment community programs, including in fire management
- **WRI Indonesia**
  - WRI Indonesia is affiliated with World Resources Institute, a global environmental assessment institution based in Washington D.C. WRI Indonesia has functions associated with fire management database and planning in South Sumatra
- **Belantara**
  - NGO which has an affiliation with Sinar Mas Group is acting as a funding agency for some forest fire management and peat restoration projects in South Sumatra.
**Key Stakeholders** | **Background Information**
--- | ---
SHI (Serikat Hijau Indonesia) | It is a local NGO that has functions associated with a fire management program.
UNOPS representative for South Sumatera | UN agency has functions associated with fire prevention programs. A new agency in Palembang still has no clear objective of the program.
### Appendix B. Background information of key stakeholders in Sub-district level

| Key Stakeholders | Background Information |
|------------------|------------------------|
| **Government**   |                        |
| Sub-district Government | Sub-district government has the role and function of coordinating village officials to safeguard their territory from fire hazards. |
| Village Government | The role and function of village government are in disseminating fire hazard warning information to the community, mobilizing citizens to be involved in guarding their land against fire hazards, and receiving reports of land burning activities in preparing agricultural or plantation land. |
| **Community executive** |                        |
| Village Head | Responsible for the prevention and control of forest and land fires in the village area, by coordinating all programs related to forest and land fires in the village. Giving appeals to the community both verbally and in writing about the dangers of forest and land fires. |
| Religious Leader | Giving a moral message to the community to implement religion properly by their religion and beliefs, including not burning forests and land. |
| Sub-Village Head or hamlet leader (Kepala Dusun) | Warning the community that land preparation for agricultural cultivation should not be done by burning. This was conveyed when there were meeting events at the sub-village level |
| **Local community** |                        |
| MPA (Masyarakat Peduli Api; the Fire Care Community established by the government) | The role and function of the Community Fire Control Team (Fire Care Community – MPA/ RPK/ BPK/ KMPK) are to counsel residents about fire control techniques, observe community activities on land that will be opened/burned with the community/village officials, report on land/forest burning incidents in the village, and put out fires in the village area. |
| KTMA (the Fire Care Community established by the company) | The role and function of the Fire Care Community established by the company are protecting company areas from fires and extinguishing fires that occur on company land; reporting to company management if there is a fire on the company's land. |
| Farmers/landowners | The landowner will guard his land against fire and conduct suppression when a fire occurs. If they cannot do it themselves, they will ask for help from their neighbors in the village |
| **Site-level enforcement** |                        |
| Babinkamtibmas/Sub District Police) | Prevention and control of forest and land fires through providing education to the public about the dangers of fire through counseling, patrolling, suppression, etc. under the coordination of the Chief of sectoral Police of the Republic of Indonesia for the sub-district |
| Babinsa (TNI/Army) | Prevention and control of forest and land fires through providing education to the public about the dangers of fire through counseling, patrolling, suppression, etc. under the coordination of the Head of Koramil (Military Headquarters at the ward level). |
| Key Stakeholders                     | Background Information                                                                                                                                 |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Babinkamtibas and Babinsa           | the field level, Babinkamtibas and Babinsa usually are conducting joint patrols to the villages.                                                  |
| Manggala Agni (Fire Force)          | Prevention and suppression action of land and forest fires; handling post-forest fires. It is a land and forest fire brigade under the management of the Climate Change and Fire Management Office Regional Sumatra, Ministry of Environment and Forestry. |
| Polhut (Forest Ranger)              | Monitoring and patrol around the state forest, socialization the prevention of forest and land fire to the community, executing legal action to forest fire accident.     |
| Agricultural extension officer      | Socialization of prohibition using fire for land preparation, facilitation the communication and agriculture programs among community/farmer and other government agencies.   |
| Private companies                   |                                                                                                                                                        |
| Forest plantation company           | Each company has its program for the prevention and control of forest and land fires in the region. Companies also have to extinguish fires when they occur in and surrounding their land concession. |
| Oil palm plantation company         | Each company has its program for the prevention and control of forest and land fires in the region. Companies also have to extinguish fires when it occurs in and surrounding their land concession. |
## Appendix C. Concern Knowledge-Action of main stakeholders in South Sumatera

| Key Stakeholders                                      | Concern                                      | Knowledge                                                                 | Action                                                                 |
|-------------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------|------------------------------------------------------------------------|
| Climate Change and Fire Management Office of Sumatra  | Preventing and combating fire                | Direction and technical guidelines from MoEF                              | Preventing fire, combating fire, the establishment of fire care communities, operationalizing Manggala Agni. |
| Watershed and Protected Forest Management (BPDASHL) of Musi | Preventing fire and rehabilitation based on watershed management | The main knowledge of the office comprises technical rehabilitation for the critical areas, including nursery development. The knowledge comes from direction and technical guidelines from MoEF. | Replanting critical land based on watershed management, developing nurseries, community involvement in rehabilitation measures, and seedling readiness. |
| BKSDA (Natural Resources Conservation Center) of South Sumatra | Protecting and sustainabilities forest conservation area, including habitat and flora fauna protection | Forest, habitat, and flora fauna conservation are the knowledge available in BKSDA. The KSDA is not a knowledge provider, since the knowledge comes from direction and guidelines from the national office based on statutory laws and ministerial regulations. | Operationalizing the Fire Danger Rating System (FDRS), providing fire hotspot data in the province of South Sumatra and surrounding areas, providing guidance to the community to be jointly involved in the prevention of forest and land fires (MPA), as well as extinguishing forest fires, especially in conservation areas. |
| Provincial Police of South Sumatera                   | Combating fire                                | Paramilitieristic and repressive technical and approaches                | Integrative patrol, repressive measures in peat and forest fires         |
| Korem (Army Regiment Commandment) of Garuda Dempo      | Combating fire                                | Paramilitieristic and repressive technical and approaches                | Integrative patrol, repressive measures in peat and forest fires         |
| BMKG (Meteorology, Climatology and Geophysics Agency) | Climate and weather information              | The dynamics of rainfall, wind, air temperature, as well as the information system on flood and landslide to support climate forecasting | Provides annual dry season forecast information to local governments, prepares daily updates of 3-day weather forecasts on the BMKG website, receives and processes weather and climate data from field officers, and provides fire hazard data to the Provincial command center |
| Governor of South Sumatra                             | Taking a lead on preventing and combating peat and forest fire in provincial jurisdiction | Political and networking knowledge                                        | The Governor has a role in drafting the Perda (regional regulations) related to forest and land fire, optimizing the BPBD (Provincial Disaster Management Agency), requiring agricultural entrepreneurs to have |
| Key Stakeholders                        | Concern                                | Knowledge                                                                 | Action                                                                                                                                                                                                 |
|----------------------------------------|----------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Provincial House of Representatives    | Fire management regulation determination and its implementation | Social welfare, social and economic impact of fire in local and regional areas | Public consultation, monitoring, and evaluation of provincial regulation                                                                                                                                 |
| DLHP (Provincial Office of Environment and Land) of South Sumatra | Controlling forest and land fire | Knowledge is managed by coordination meeting, mail and regulation of Head of BRG, coordination facility, socialization, planning. | Disseminates information on forest and land fire early warnings, assesses the impacts of forest and land fires, and initiates the establishment of community groups concerned with fire (KMPK).                                                                 |
| BPBD (Provincial Disaster Management Agency) of South Sumatra | Disaster management and fire prevention (especially in peat) in collaboration with District BPBD | Knowledge in disaster management, preventing and combating fire comes from in house and external training activities | BPBD coordinates the prevention of forest fire with technical agencies, then provides emergency response budgets, coordinates the forest and land fire disaster management post, and receives and updates early warning information (weather and hotspots) to all agencies and communities. |
| Key Stakeholders | Concern | Knowledge | Action |
|------------------|---------|-----------|--------|
| TRGD (Provincial Peat Restoration Team) of South Sumatra | Fire prevention and peatland restoration. | Peat restoration planning through institutional coordination, facilitation, and evaluation | Establishment of rewetting infrastructures in South Sumatera |
| Provincial Forestry Service of South Sumatra | Forest and land fire can be controlled, critical forest areas can be rehabilitated, good forest areas can be protected | Knowledge is managed by coordination meeting, mail and regulation of Head of BRG, coordination facility, socialization, planning. | Prevent and suppress fires in state forest areas (HL, HP, HPT, HPK), as well as rehabilitate post-fire forests. |
| Disbun (Provincial Plantation Office) of South Sumatra | Plantation productivity improvement by zero burning | Knowledge in zero burning land clearing, HCS, and HCV development and establishment is part of the plantation sector to implement | Guides and supervises plantation practices without burning. In addition, the Regional Technical Implementation Unit for Control of Forest and Land Fire (UPTD PKHL) of South Sumatra releases monitoring of hotspots from Modis Satellite (post-fire suppression and handling efforts). |
| Polda & Polres (Regional Police) | Reducing forest fire crime | Paramiliteristic and repressive technical and approaches | Polres and Polda give warnings and prohibitions on burning according to the regent's instructions, as well as enforce the law further to violations of land burning regulations. |
| Satgas Karhutla (TNI) | Reducing forest fire occurrence | Paramiliteristic and repressive technical and approaches | A forest and land fire task force (Satgas Karhutla) is formed in an emergency. At the provincial level, a task force (Satgas) is formed based on the Governor's decision, while a district task force is formed based on the Bupati's decision. A task force is not a fixed institution; it is an ad hoc agent and is usually limited to one year in carrying out its duties. A forest and land fire task force generally comes into operation when a fire alert status is set and it ends when the emergency status of the forest and land fire is revoked. This task force is generally based or under the coordination of the Regional Disaster Management Agency (BPBD). |
| District Plantation and Livestock Office of OKI | Fire prevention through plantation and Fire management and techniques through training, workshop, and | | Promoting the establishment of kelompok tani peduli api/KTPA; providing tools and equipment for |
| Key Stakeholders                        | Concern                                      | Knowledge                                                                 | Action                                                                                                                                 |
|----------------------------------------|----------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| District Environment Office of OKI     | Fire prevention and restoration              | Knowledge is managed by coordination meetings, mail, and regulation of the Provincial Environmental Office, coordination facility, socialization, planning. | Disseminates information on forest and land fire early warnings, assesses the impacts of forest and land fires, establishment and maintenance of fire care communities in district jurisdiction area. |
| Food Crop Agriculture Service of OKI district | Fire prevention through the agricultural program. | Specific knowledge on local best agricultural practices under the direction and guidelines from provincial and national institutions | Implements environmentally friendly farming practices (without burning), provides farmers with crop information for the dry and rainy seasons and provides training and land clearing equipment (without burning). |
| BPBD (District Disaster Management) of OKI | Disaster management and fire prevention (especially in peat) in collaboration with Provincial BPBD | Knowledge in disaster management, preventing, and combating fire comes from in-house and external training activities. | - Pra disaster: prevention measures  
- SOS operation during disaster  
- Post-disaster: rehabilitation and reconstruction of community livelihoods |
| Forest Management Unit of Sungai Lumpur – Riding and FMU of Lempung Mesuji | Preventing and combating fire | FMU uses RPHJP (Long Term Forest Management Plan) in understanding forest area characteristics. The FMU also uses direction and national guidelines on forest management from the central government. | Preventing and combating fire, socialization, and community awareness-raising, replanting and rehabilitation measures, and forest inventory. |
| Sriwijaya University                   | Have functions associated with fire prevention? | Providing knowledge and techniques in fire prevention, monitoring, fire suppression | In collaboration with other academies such as ICRAF and IPB University transferring knowledge through research, training course, workshop with stakeholders in South Sumatra |
## Appendix D. Concern-Knowledge-Action of main stakeholders in Central Kalimantan

| Key stakeholder | Concern | Knowledge | Action |
|-----------------|---------|-----------|--------|
| Environment Office, Central Kalimantan Province | Forest and land fire can be controlled | Knowledge is managed by coordination meeting, mail and regulation of Head of BRG, coordination facility, socialization, planning. | - Developing peat rewetting infrastructures by canal blocking and bore wells.  
- Rewetting operation on Drought-Prone Peat  
- Implementing Rapid Wetting Operation on Renewable Peatlands  
- Revegetation is carried out in the red zone of fire  
- Executing Revitalization of livelihoods including land-based, water, and tourism activities. Commodities: 22 thousand sengon seedlings, 22 members in one group, cattle, fish, bioflog (fish cultivation in artificial plastic ponds), sengon, cassava. |
| Provincial Peat Restoration Team of Central Kalimantan | Post-fire peat restoration | Peat restoration planning through institutional coordination, facilitation, and evaluation | Establishment of rewetting infrastructures in Pulang Pisau District |
| UPR/CIMTROP | Peat protection, and peat cultivation based on peat properties | CIMPTROP conducts researches (taking a role on knowledge producer). Peat with clay properties is potentially cultivated, but a peat with spirit properties is highly needed to be protected. | - Peat hydrological restoration  
- Emission measurement developing rehabilitation concept through social involvement (bio-living tree – buy a growing tree)  
- early childhood education on the impact of smoke on health, bringing in national storytellers/storytellers, writing books. |
| District Environmental Office of Pulang Pisau | Controlling peat fire | Several activities for knowledge management, namely: coordination meeting, letters, and regulation of Head of BRG, facilitation of coordination, socialization, planning. | - Rewetting peatland through deep wells and canal blocking as main infrastructures. There were 950 deep wells and 717 canal blocking have been built. |
| District Agriculture Office of Pulang Pisau | Agriculture cultivation in supporting community welfare |
|------------------------------------------|------------------------------------------------------|
| The agriculture office refers to the Ministry of Agriculture Decree and various guidelines issued by the central government. There is also knowledge transfer to farmers and farmer groups from assistance. |

| District Public Work and Housing Office of Pulang Pisau | Support infrastructure of peatland cultivation |
|--------------------------------------------------------|------------------------------------------------|
| - Semi technical and full technical knowledge |
| - There are field monitoring staffs who get any pieces of training from the provincial office. The task is such as recording hydro climatology tools/instruments. |

| District Disaster Management Office of Pulang Pisau | Disaster management and prevention (especially in peat) |
|------------------------------------------------------|------------------------------------------------------|
| - Conduct technical team training for 50 personnel for navigation. |
| - There is a peat hydrological knowledge found in villagers by their previous generation. |

| Gohong Village | The use of peatland for villagers livelihoods |
|----------------|---------------------------------------------|
| Peat-based cultivation knowledge has been granted from previous generations. The government is always to communicate to the villagers that peat is must be in wet condition to prevent fire. |

| Forest Management Unit of Kahayan Hilir | Controlling peat fire |
|----------------------------------------|-----------------------|
| FMU uses direction and technical guidelines from the Forestry Office and Ministry of Environment and Forestry to |

- Handling Facilitation of essential Ecosystem Area (KEE) in Taruna Jaya Village, namely Bagantung Lake as a buffer zone of peat ecosystem
- Providing Facilitation of canal blocking establishment and coordination measures with Provincial Peat Restoration Team of Central Kalimantan.
- Zero burning land clearing for rubber
- Agriculture assistance in all villages
- Support food estate in Pulang Pisau through facilitation of paddy field establishment and drainage improvement.
- Deep wells establishment, peat distribution mapping, depth peatland mapping, peat protection area mapping
- Establishment of canal blockings, inspection roads, dams, spillways.
- Pra disaster: prevention measures
- SOS operation during disaster
- Post-disaster: rehabilitation and reconstruction of community livelihoods.
- Village Forest Management in peatland area
- Canal blocking on every 500 m on ex-Peat Land Project area.
- Most of FMU’s activities on forest fire management are collaborating with BPBD. FMU allocates
| Tumbang Nusa Village | Forest fire prevention and the use of peatland improvement | Allocating the Village Fund to prevent fire |
|----------------------|----------------------------------------------------------|------------------------------------------|
|                      |                                                          |                                                          |
|                      |                                                          | personnel and supporting instruments                          |
|                      |                                                          | - Socialization of forest and land fire management          |
|                      |                                                          | - Patrol                                                   |
|                      |                                                          | - Establishment of Fire Care Community                      |
|                      |                                                          | - Replant                                                  |
|                      |                                                          |                                                          |
|                      |                                                          | - Improving the role of the Fire Care Community through the census of migration and villagers activities within the village to prevent forest fire |
|                      |                                                          | - Establishing Social Forestry Enterprises Groups of 1000 ha by facilitating from BPSKL Kalimantan |
|                      |                                                          | - Promoting *purun* processing tools in Tumbang Nusa Village |
|                      |                                                          | - Engaging BUMDES (village-owned enterprise) to contribute to *purun* trading. |
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