The potential for peatland villages to prevent fire: Case study of Tumbang Nusa Village Central Kalimantan

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Abstract. Peatland fires have become a global concern due to the negative impacts of smoke and greenhouse gas emissions produced which can reach ten times than from fires on mineral land. The village of Tumbang Nusa has been known as a fire resistant village in the Central Kalimantan peatland. Fire is always triggered by the people who are accustomed to burning their lands uncontrollably. Community empowerment research to prevent fires is therefore very important. The study of resource potential in the village has been carried out through observation and interviews. The results of the study show that rural communities have the potential for natural resources, human resources, and some infrastructure that can be developed as a basis for community empowerment efforts that will reduce the need to use fire for land clearing. These activities include local fish cultivation in beje and keramba ponds, development of purun plants, rubber, peat swamp tree nurseries and agroforestry developments including tree plantations of belangeran (Shorea belangeran), jelutung (Dyera spp.), and gemor (Nothapoebe coriacea) mixed with vegetable and fruit crops such as pineapple. Through developing these alternative land use activities, awareness of fire prevention in the community increases. However, dissemination of prevention rules, agricultural training, fire control, and methods for utilizing left over organic materials (i.e. disposal of crop residues without use of fire) need to be carried out continuously.

1. Introduction
Forest and land fires almost occur every year starting in 1983/1984 in East Kalimantan. Fire events can occur in all types of forest such as mountain forest, lowland forest, brackish forest and peat. While land fires occur on plantations and community agriculture. Among all the fire incidents, fire that occurred on peat land have become the world’s attention due to the negative impact of smoke and the resulting greenhouse gas emissions can reach 10 times more than the fire in mineral fields. Fires are always triggered by the people who are used to burning land uncontrollably, especially communities around the forest. Research that leads to community empowerment in the context of fire prevention was the most important aspect besides the improvement of peat ecosystems, early warning systems, and early suppression techniques.

Tumbang Nusa villagers were taking public and forest fire observers in Indonesia and worldwide attention. The villagers are seen as disaster resistant community especially for land and forest fire disaster. Since the peat land forest fire disaster in 1997/1998 to 2015, Tumbang Nusa and Tanjung Taruna villagers are affected the most by smog for about 3 months every year. Tumbang Nusa community empowering is very needed to have knowledge and awareness of land and forest fire that
very harmful for their social activities and environment. On the other side, ability acceleration is needed to prevent the fire.

The community empowering program especially for underdeveloped, is an effort to strengthen the capacity of local communities including reduction of poverty (Saharudin, 2009). Empowerment can be approached through local wisdom. Poverty is one of the concrete evidences in underdeveloped regions. The impacts of poverty had to do with the problem of fires, which were agricultural practices that were cheap but unfriendly, and which were often practiced in land clearing through burning. The main fire users in the communities around the peat swamp forest in Central Kalimantan were burning of idle land, cleaning of bush vegetation around the natural beje to get fish, farmers, opening up access to the forest, and fishing.

For this reason, it is necessary to observe whether the community has the potential to anticipate a fire disaster. What are their natural and social conditions which include village biophysical conditions, level of welfare, land use, socio-cultural conditions, religion, customs, and village institutions. What actions need to be taken to build public awareness to prevent forest fires. This paper aims to describe the natural and social conditions of the people of Tumbang Nusa village to get any opportunities that can be used as a momentum so that the community has a commitment to prevent land and forest fires voluntarily.

2. Materials and methods
The research was conducted in Tumbang Nusa Central Kalimantan. The selection of research locations considered the frequency of occurrence of disasters of forest and land fires in a village since 1997/1998 until 2015 in peat swamp forests. Data collected in the form of primary data and secondary data using questionnaires, both qualitatively and quantitatively from the community and institutions that play a role in recording the condition of the target villages and by making observations in the field. Secondary data were collected from the Environmental and Forestry Research and Development Institute, Care International Indonesia, Jari Team, village documents and the Kapuas District Government. Data analysis was performed using tabulation and descriptive analysis methods. The conditions of the resources that existed in nature, human resources, and infrastructure were presented in the form of descriptive analysis associated with efforts to prevent forest and land fires.

3. Results and discussion
3.1. The origin of Tumbang Nusa Village
Tumbang Nusa village in the south is directly adjacent to Tumbang Nusa Special Purpose Forest Area (KHDTK). KHDTK Tumbang Nusa is a peat swamp research forest managed by the Banjarbaru Environmental and Forestry Research and Development Institute, Research Development and Inovation Agency, Ministry of Environment and Forestry. According to village documents, Tumbang Nusa Village originated from the name of a village, namely Kaleka (Swadaya), which originated on the island of Salat/Nusa Island, about 2 km from the present settlement. The forerunner of the village was under the government of Pilang village around year 1920. Nusa Island was chosen because the place was suitable for developing businesses such as malan (farming), seeking for ahas (rattan), bujungan/halatung, mamuar (honey), pantung and damar/nyating after catching fish and hunting (mandup). They lived in this village for years with family. In 1911, they got difficulties in marketing natural products and it was also difficult to get the needs of life, finally they agreed to move their domicile to Tumbang Nusa village now. The development of the leadership of Tumbang Nusa village was presented in Table 1.

I'in Timbang became the longest village leader for 31 years. The name of the village of Tumbang Nusa came from the history and legends of previous people where "Tumbang" came from the Dayak Ngaju language which means river estuary, while "Nusa" came from the name of someone who was miraculously can change shape to the dead Big Dragon laid in the village area, precisely on the island of Salat Nusa which is now known as Hantasan Salat Nusa (Nusa Island). Initially, the population of Tumbang Nusa came from the village of Gohong/Pulau Petak, then the migration came from Banjar,
Kahayan, Kapuas, Barito and others. Making trenches and rubber plantations emerged since Inin Timbang's leadership from 1946-1977, even every resident who came was given a place to build a house so they settled. Likewise, public school buildings have been built since the leadership of Inin Timbang.

**Table 1.** The order of Tumbang Nusa Village leadership.

| No | Name of the leader | Time occurrence prediction |
|----|---------------------|-----------------------------|
| 1  | Laga (L), Bintang (P), dan Liwan (L) | Kaleka (Swadaya) village, year 1911—1920 |
| 2  | Unjung (Pilang village leader) | Swadaya village, year 1920—1946 |
| 3  | Inin Timbang 1946-1977 (direct election) | Tumbang Nusa village, 1946-present. There was an award from President Soeharto in year 1977 in Kapuas District |
| 4  | Abdul Sidik (direct election) | 1977—1997 |
| 5  | Arsik J. Timbang 1997-2002 (democracy) | 1997—2002, Kapuas District |
| 6  | Sukrinata, SH | 2003—2008, Pulangpisau District |
| 7  | Gumerhat S. Liwan | 2009—2012, passed away |
| 8  | Udeng Sabransyah (temporary official leader) | January—June 2013 |
| 9  | Dio Abdul Sidik | 2013—2019 |
| 10 | Lili | 2019 - present |

**Figure 1.** Map of location of Tumbang Nusa village, Central Kalimantan.

Now the village of Tumbang Nusa is administratively included in the Jabiren Raya sub-district, Pulang Pisau District, Central Kalimantan, which occupied a land area of ± 200 km² (Figure 1). Access to the District Capital can be reached for ± 1 hour (20 km), and to the capital of Pulang Pisau District is taken for ± 2 hours (62 km) road trips. From the village of Tumbang Nusa to capital city of the Province of Palangkaraya can be reached for ± 40 minutes by road (35 km). The location of the village of Tumbang Nusa is very strategic, where the village is on the Trans Kalimantan route, which is the road crossing Kalimantan, and on the edge of the Kahayan watershed. This condition facilitates public transportation facilities for access to the city as a center of economy and trade. Tumbang Nusa Village consists of 4 neighborhood association (RT) where RT 1, 2 and 3 are in Tumbang Nusa Bawah near the Kahayan watershed, while RT 4 is in Tumbang Nusa Atas, which is on the Trans Kalimantan road. Administratively, the boundaries of the village of Tumbang Nusa are as follows: The East is bordered by Desa Pilang. The West is bordered by Tanjung Taruna Village. The South is bordered by
the Sebangau District, Palangka Raya City. The north is bordered by Katunjung Village, Mantangai District, Kapuas.

3.2. Natural resources as social support
The village biophysical conditions are explained as follows: Topographically, the area of Tumbang Nusa village is at an altitude of 10 m above sea level. Average rainfall is 2715 mm/year. The average temperature ranged from 29-33°C. Most of the area is lowlands with peat swamp land types. Peatlands have a horizontal hydrological system that experiences extreme drought in a long dry season and land fires occur every year. Decreasing in soil surface height on peatlands tend to occur continuously if rehabilitation measures are not carried out on critical lands. When the tide rises and the size of the river flows from upstream in the rainy season will result in an increase in the surface water that causes flood conditions around the village. The flood condition is a result of a meeting between the tide flow and the upstream flood. Inundation season occurs from January to May. Inundation height can reach 25 cm from the ground.

Tumbang Nusa village has about 200 ha area, lands are not used optimally yet by the villagers. There are a lot of critical lands have not been worked on and over-grown by shrubs. The people are not work on shrubbed land optimally because it floods in rainy season and burns in dry season. Types of business related to land utilization can be seen in Table 2.

| No. | Business types       | Amount | Information                                                   |
|-----|----------------------|--------|---------------------------------------------------------------|
| 1   | Agriculture:         |        |                                                              |
|     | - ricefield          |        | Agricultural plants cultivation cannot be done yet due to poor nutrition, flammable, submerged, of peatland, some villagers plant vegetables in pots. |
|     | - field (vegetables, etc) | 5 Ha   |                                                              |
|     | - fisherman          | 249 persons |                                                              |
|     | - Beje/pond          | 8 units |                                                              |
| 2   | Plantation           |        |                                                              |
|     | - rubber             | 15 Ha  | Rubber, rambutan and rattan are planted in private land, while purun grows naturally in maintained land. |
|     | - rattan             | 12 Ha  |                                                              |
|     | - purun              | 100 Ha |                                                              |
|     | - rambutan           | 5 Ha   |                                                              |

The condition of the forest around Tumbang Nusa village before burning in 2015, still had a fairly high diversity of species. The forest is mostly located in the KHDK Tumbang Nusa area which is managed by the Environment and Forestry Research and Development Institute. In one hectare of forest area, there were 23 species of seedling of forest trees, 26 species of saplings, 24 species in pole level, and 29 species in tree level. The species found based on the analysis of vegetation were include: Bintangur (BR), Meranti bunga (MA), Pisang-pisang (PG), Meranti batu (MU), Malam-malam (MM), Pantung (PA), Martibu (M ), Rahanjang (R), Tanah-tanah (TT), Ramin (RN), Pasir-pasir (PR), Guava (JU), Gerunggang (GG), Pampaning (PI), Galam tikus (GS), Terentang (TG), Rambutan hutan (RN), Mailas (MS), Darah-darah (DH), Kapurnaga jangkar (KR), Perupuk (PK), Nyatoh (NH), Medang galangal (MS), Lilin-lilin (LN), Ketapi hutan/Papung (KN), Paning-paning (PP), Nangka-nangka (NA), and Meranti balau (MB).

The data in Figure 2 showed that the types of tampilan, meranti bunga, meranti batu, malam-malam and pantung were the dominant species at the tree level which were characterized by an important value higher than the other types. Rambutan hutan and punak were quite hard to find, so they ranked in the lowest important value. However, rambutan hutan had provided tree commodities that function as food. Local people have often eaten the fruit. In addition to the forest rambutan type, it was also found Manggis Hutan and Mangga Hutan species, both were edible. At certain spots found Shorea belangeran and Notaphoebe coreacea that were hunted by many people. The main function of
the forest that has been known is timber producers for the construction of houses and other wooden buildings.

![Tree Condition](image)

**Figure 2.** Condition of tree-level forest vegetation that can potentially be developed in Tumbang Nusa. *INP=Important value indeks. [2]*

### 3.3. The condition of human resources as social capital

#### 3.3.1. Population.
The population of Tumbang Nusa village based on previous data reached about 1014 people from 282 households, but the results of data collection/census by JARI (NGO that assist communities in advocacy for participatory village planning) in 2015, said that the total population of Tumbang Nusa village was 943 people from 231 households (JARI Indonesia Central Kalimantan, 2015). According to sex, the population consisted of 506 men and 508 women. Whereas based on age, the age composition of the population of Tumbang Nusa consisted of: 0-12 years = 31 people, 12-16 years = 315 people, 16-20 = 70 people, 20-60 = 577 people, and above the age of 60 years were 21 people.

#### 3.3.2. Education.
The education conditions of the people in Tumbang Nusa village were already quite good, where there were already many residents who have education to tertiary institutions. This was probably due to the location of the village which position is still quite close to Palangkaraya as the provincial capital. The 9-year basic education school program from elementary school to junior high school has taken place in the village of Tumbang Nusa. The government program for 9-year compulsory education with various budget policy and BOS (School Operational Assistance) policies had helped the community to provide opportunities to get a better education, at least junior high school level. High school was outside the village. The nearest high school was in the village of Kalampangan, Palangkaraya. The composition of the education status of the Tumbang Nusa community can be seen in Table 3.

#### Table 3. Number of population by education level.

| Education level | underaged/ uneducated | Elementary school | Junior high school | High school | University |
|-----------------|-----------------------|-------------------|--------------------|-------------|------------|
|                 | 134                   | 347               | 233                | 228         | 64         |

Source: Some part of data taken from comprehensive survey by JARI Team, Central Kalimantan, 2014.

#### 3.3.3. Livelihood.
Most people in Tumbang Nusa Village rely their lives on the fisheries sector or work as fishermen. A small percentage of the people who work as entrepreneurs, civil servants and
farmers, especially rubber, pineapple and palm oil plantations as well as nursery of jelutung, belangiran and others. In detail, the livelihoods of the Tumbang Nusa community can be seen in Table 4.

Table 4. Composition of Tumbang Nusa community occupation.

| Occupation                        | Under 5 years old | Students | Civil servant | Private company | Farmer/Fisherman |
|-----------------------------------|-------------------|----------|---------------|-----------------|------------------|
|                                   | 122               | 302      | 42            | 237             | 240              |

Source: comprehensive survey by JARI Team, Central Kalimantan, 2015.

Community livelihoods were strongly influenced by the skills they have. Based on the interview results with the Tumbang Nusa community it was known that there were several skills identified as presented in Table 5.

Table 5. Skills of Tumbang Nusa residents.

| Skills on using natural resources | Public service skills |
|----------------------------------|-----------------------|
| Making traditional fish trap     | Trading               |
| Weaving tikar                    | Making cakes          |
| Making boats                     | Building houses        |
| Raising cattle                   | Public transportation  |
| Tree nursery                     | Vehicle repair shop    |
| Farming                          | Company worker         |
| Rubber tapping                   | Photocopy              |
| Making wooden building material  | Typing service         |
|                                  | Photo printing         |
|                                  | Fishing                |
|                                  | Computer operating     |
|                                  | Gold mining            |

Lately, there are many people who make a house or swallows nest as a new business innovation. Currently, there are around 30 swallow nest units in Tumbang Nusa village.

3.3.4. Level of welfare. The floods and droughts that hit the village of Tumbang Nusa every year have resulted the majority of the Tumbang Nusa people is in the poverty line. Most people have a very high dependence on life for natural resources, while the nature is influenced by the unpredictable seasons. Community control of the prices of superior commodities such as fish is also weak. There is no adequate capacity for processing agricultural products. The community is also very dependent on food supplies from outside. Food security of the people is very weak because the land is not possible for developing agricultural commodities such as rice and other crops due to land that is submerged very often.

3.3.5. Socio-cultural conditions. The socio-cultural and religious conditions in the people of Tumbang Nusa village tend to be homogeneous because basically the people in Tumbang Nusa village still have a relationship with each other. Even if there were migrants from outside, they often settle and do marriages with indigenous people.

3.3.6. Religion. The majority of the Tumbang Nusa people are moslem, where the number reaches about 93%. However, the tradition rituals of the belief of kaharingan are still exist, marked by the number of altar for ancestors in a small part in front of the houses. According to public information, the death ceremony ritual called Tiwah on the Hindu Kaharingan religion was last carried out in 1982. The Christmas is not celebrate very much because only 7% of the population are Christians. On the contrary, Islamic religious events appear more lively throughout the year. These Islamic religious
celebrations include Teraweh in the month of Ramadan, the celebration of Eid (Idul Fitri), the Birthday of the Prophet Muhammad S.A.W., Isra-Mi'raj, and other events.

3.3.7. Customs and culture. The traditions and local religious culture of Kaharingan remained in the daily lives of a small portion of the Tumbang Nusa village community. The Tumbang Nusa community even though they no longer embrace the Kaharingan religion, but some of the rituals associated with Kaharingan rituals are still carried out in the context of respect for ancestors and the belief that there are other forces outside of human power. People still believe if they have a certain purpose and come true, they are used to putting yellow cloth on trees or in places they consider sacred. There are still areas that are considered dangerous called *Pahewan*. *Pahewans* place is a sacred area in which it becomes a wildlife habitat and it is believed by the community that the place is inhabited by astral creatures called *hantuen*. The community can be harmed if they take actions that are not pleasing to the place. The place is on Nusa Island. The culture of mutual cooperation called *handep* is still quite strong in the community, especially in carrying out national and religious holidays. The *Mapas Lewu* program or village cleaning program from bad things is done almost every year and when a new area is going to be opened that is considered to have *hantuen* (ghosts), the community also performs the *manyanggar* ceremony.

3.3.8. Village institution. Tumbang Nusa Village consist of 4 RTs (Neighbourhood association) whose division consisted of RT 1 headed by Taji P. Walwas, RT 2 chaired by Edi Sani, RT 3 led by Hadi U., and RT 4 chaired by Anggang. One rather separate hamlet is Bereng Kajang hamlet led by Dian P. Karau. The village administration in its implementation is accompanied and controlled by the Village Consultative Agency (BPD). In addition, there are institutions with religious nuances in the context of fostering and developing village potential. The population based on religion can be seen in Table 6.

| Religion (person)     | Protestant Christian | Katholic | Kaharingan | Islam | Total |
|-----------------------|----------------------|----------|------------|-------|-------|
|                       | 61                   | 9        | -          | 944   | 1014  |

Tumbang Nusa Village has a Fire Care Community (MPA) team with a membership of 20 people led by a chairman, secretary and treasurer. The community team were about the fire named "Pioneer" which has been facilitated with forest and land fire fighting equipment.

3.4. Condition of facilities and infrastructure for social support

Facilities and infrastructure in the village of Tumbang Nusa is presented in Table 7. High school age children have to continue their education to Kalampangan Sub district, Jabiren District, and Palangkaraya City. For toilet purposes, the community still used riverbanks. There is no permanent Command Post for fire prevention and control facilities.

The SWOT analyses showed that the conditions of the facilities and infrastructure in Tumbang Nusa village actually still require government facilitation such as: (1) Village Port which can transport and market the produce at the same time in connection with the availability of the Kahayan river, (2) The market is very necessary for the trade of fish and other crops, and (3) Sports fields are needed to ensure the health and sports skills of people. The existing soccer field was less strategic (flooded) so there needs to be another place that will be free from puddles.

In an effort to prevent fires, actually in the village of Tumbang Nusa a village fire control team (Masyarakat Peduli Api/MPA) has been formed, there are 30 fire pump units to extinguish peat fire and one thousand bore wells as a reserve of extinction water. However, its activities are constrained by the unavailability of operational funds, so there needs to be routine funds in the village that can mobilize the team. In fact, the activities that can be carried out by the MPA team ahead of the fire season are to conduct the early detection through fire patrols, to coordinate with Manggala Agni and Regional Disaster Management Agency (BPBD). But because it requires transportation costs and so on, the activity is not realized. Especially for the 2015 fire incident in Tumbang Nusa, community said
the fire had spread wide and large from outside the village of Tumbang Nusa. They were affected by
the smog and finally unable to anticipate the fire.

Table 7. Facilities and infrastructure in Tumbang Nusa Village in 2019.

| No. | Facilities/Infrastructure          | Amount | Information                                                                                                                                 |
|-----|-----------------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1.  | Village office                    | 1      | The village office was still in poor condition with no electricity and malfunctioned toilet due to the absent of clean water. There was no furniture like normal office while the building was still in a good condition. |
| 2.  | Village Meeting hall              | 1      | Still functioning as the village meeting hall. It was an old building with faded paint and the windows closed by wood improperly.                |
| 3.  | Kindergarten school building      | 1      | Still in good condition, no Kuran kindergarten yet.                                                                                         |
| 4.  | Elementary school building        | 2      | A quite proper building, but playing and sports facilities were not maintained well. The playground was often submerged.                    |
| 5.  | Junior high school building       | 1      | Very good condition                                                                                                                          |
| 6.  | Mosque                            | 2      | The mosque in RT 1 was in good condition. Mosque in RT 4 was not finished yet but wudhu and toilet were functioning well.                   |
| 7.  | Musholla (small mosque)           | 1      | Unused                                                                                                                                     |
| 8.  | Auxiliary Health Center           | 1      | Apprehensive building condition with unsettled medical personals.                                                                           |
| 9.  | Village health center             | 1      | A good condition and accessible, but the midwife was not settled in the village                                                            |
| 10. | Women and Children health center  | 1      |                                                                                                                                              |
| 11. | Church                            | 1      |                                                                                                                                              |
| 12. | Village bridge/Titian             | 1      | Bridge as infrastructure to link Tumbang Nusa Atas and Tumbang Nusa Bawah was not in a good condition, worsen by a great fire in November 2014 that burned the bridge |
| 13. | Village road                      | 1      | Soil road, not utilized maximally.                                                                                                           |
| 14. | Security center                   | 3      |                                                                                                                                              |
| 15. | Clean water tower                 | 12     | The quality of clean water was not good enough, it still smelly and dirty, influenced by river water.                                        |
| 16. | Public cemetery                   | 1      | Located on the end part of the village alongside by Kahayan river, prone to landslides                                                       |
| 17. | Fire fighting equipment           | 30     | 30 units of fire pump engines, mostly still in good condition                                                                               |
| 18. | Drilling well with a depth of 25 meter | 1000  | Well 1000 units have been available as blackout water stock                                                                               |

Minimizing the accumulation of fuel on the forest and land floor is the most definite action to
prevent wildfires occurring in dry season. If every ruler and landowner, both company and community
in the form of groups and individuals is required to reduce the presence of minimal fuel during the dry season, then surely a big fire will not occur. Law enforcement for users of fire and burners on arbitrary land is still very weak. When the dry season arrives, usually fire users quickly clear their land by burning and firing even though many fire appear due to negligence. Law enforcement on community land burners is very minimal. The lands of the community, especially the villagers, were usually directly adjacent to the forest or less supervised from shrubs density of fine fuel under the stands. If the fire has entered the forest, there were no people around the forest who care to put it out when they were small. It seems that the government regulation that regulates the minimum standard of fuel for plantations and natural forests needs to be held.

If summarized from two regulations on fires, namely Law No. 41 of 1999 and Government Regulation No.4 of 2001, forest and land fires throughout Indonesia are the duties and responsibilities of every citizen, business, provincial government, district government, and central government. Articles that are relevant to the tasks and responsibilities of stakeholders are read:

1. Every person is obliged to prevent forest and land fires.
2. The government is responsible for controlling forest fires in state forests.
3. Responsible for businesses, individuals, state-owned enterprises, the private sector, and regions, cooperatives, and foundations, are responsible for fire control in their business locations.
4. Fire control in private forest is carried out by the holders.

4. Conclusion

There are potential for natural resources, human resources, and several infrastructures that can be developed in the village of Tumbang Nusa in an effort to empower the community. Efforts that need to be facilitated by related parties are fisheries, purun development, rubber and agroforestry with jelutung, and gemor trees combined with pineapple, with community compensation being a deterrent to forest and land fires in their village. Socialization of fire prevention rules, agricultural training and land fire control needs to be improved which includes information on legal sanctions, improvement of livelihood skills, and training in the use of slash organic material into organic fertilizer, briquette charcoal and wood pellets. The rules for fire prevention were quite complete and synergistic, but they were not socialized to the village community. Efforts for facilitation from the government needed for community business include the formation of purun farmer groups (*Eleocharis dulcis*) and purun plant development, local fish cultivation in beje ponds & cages, rubber plantation, and agroforestry system by combining jelutung (*Dyera polyphilla*) with pineapple or Belangiran (*Shorea belangiran*) with pineapple (*Ananas comosus*) mixed with Gemor (*Notabhoebe coreacea*). The existing natural conditions have made people unable to grow rice (*Oryza sativa*).

5. Acknowledgements

I thank to the organization and institutions that funded this research. Part of this research activity was funded by ACIAR (Australian center for international agricultural research) and the other part was from Banjarbaru Environment and Forestry Research Institute in Agency For Forestry Research and Development, Ministry of Forestry.

6. References

[1] Akbar A 2009 Protecting the plantation forest from fire in alang-alang grassland (case study in Riam Kiwa, South Kalimantan) in Proceedings International seminar (Bogor: Centre for Plantation Forest Research and Development)

[2] Akbar A, Sukhyar F, Andriani S and Syaifuddin 2013 Kebakaran Hutan dan Lahan Rawa Gambut: Penyebab, Faktor Pendukung, dan Alternatif Pengelolaannya in Prosiding Ekspose Hasil Penelitian 30 Tahun BPK Banjarbaru dalam Pembangunan Kehutanan (Banjarbaru: BPK)

[3] Chandler G P, Cheney P, Thomas, Trabaud L and Williams D 1983 Fire in Forestry. Forest Fire Management and Organization (New York: John Wiley & Sons)
[4] Charman D 2002 *Peatlands and Environmental Change* (England: John Wiley & Sons Ltd. Baffin Lane, Chichester, West Sussex PO19 1UD)

[5] Dennwas R A, Mayer J, Applegate G, Chokkalingam U, Colfer C J P, Kurniawan I, Lachowski H, Maus P, Permana R P, Ruchat Y, Stole E, Suyanto and Tomich T P 2005 *Human Ecology* 33 465-504

[6] Dwashut Kalteng 2011 *Laporan Tahunan Dinas Kehutanan Provinsi Kalimantan Tengah* (Palangka Raya: Dwashut)

[7] Dohong A 2006 *Swastem Penabatan Kanal Sebagai Instrumen Pencegahan Kebakaran Hutan dan Lahan Gambut di Kalimantan Tengah: Studi Kasus Hasil Ujicoba Penabatan Kanal Eks-PLG melalui program CCFPI* (Kalimantan Tengah: Buletin Pemberdayaan Masyarakat)

[8] Heikkella T V, Gronovist R, Jurvelius M and Opetushallitus F 1993 *Handbook on Forest Fire Control* (Finland: Helsinki)

[9] Jari Tim 2015 *Laporan Pendataan Penduduk Desa Tumbang Nusa, Kalimantan Tengah* (Palangkaraya: Jari Tim)

[10] Lawrence D and Schleinger W H 2001 *Ecology* 82 2769-80

[11] Moore P F 2003 *Community Base Fire Management (CBFiM)* in International Wildland Fire Summit Paper No. 5 (Sidney: CBFiM)

[12] Sumartono 2009 *Pendampingan pada Masyarakat Marginal di Malang Selatan* in Laporan Penelitian P4M (unpublished)