Identifying forest fires causes in Kawah Kamojang Nature Reserve (Mount Guntur), Garut, West Java

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Abstract. Forest and land fires have caused losses on social, economic, and ecological aspects in Indonesia. Forest and land fires management will not be optimal without knowing factors causing them. Mount Guntur which belong to Kawah Kamojang Nature Reserve (Mount Guntur) (KKNR) is suffering from forest and land fires almost every year. This study aims to identify the factors causing forest and land fires in KKNR. The research used field observation, in-depth interviews, and field data collection. The results indicate that the factors causing forest and land fires are human factors from sand mining, land preparation, and bird poaching. Drought due to long dry season trigger the fire occurrences. Here, we strongly suggest increasing the knowledge and awareness of forest fire to the people in KKNR to prevent the area from the further destructive forest fire.

1. Introduction
The worst forest and land fires in Indonesia for decades occurred in 2015 when the fires consumed 2.6 million Hectares area, resulted in a loss up to US$ 16.1 billion [1]. Mount Guntur, which included in Kawah Kamojang Nature Reserve area (KKNR) is one of the areas suffering from this worst forest and land fire with a burnt area of 429.98 hectares. However, research on the factors causing forest and land fires in the region of Mount Guntur is not done yet. This problem in turns may result in the un-optimal of forest fire control in the area.

Forest and land fires occurrences, if not immediately controlled, will threaten the KKNR condition and impact the surrounding communities. Therefore, the identification of the factors causing forest and land fires in KKNR needed in order to effectively reduce the rate of forest and land fires and optimize the forest and land fires control.

2. Method
Here, we used the forest fires data in 2014 - 2018 from Regional Conservation Office, Garut; hotspot data from MODIS Terra / Aqua LAPAN catalogue (≥ 80% confidence level) [2]; administration map of Garut Regency from Indonesia Geospatial Agency [3]; monthly rainfall data (2014-2018) from Bogor Climatological Station; and Southern Oscillation Index (SOI) and Sea Surface Temperature (SST) Nino Anomaly 3.4 (2014-2018) data from the National Oceanic and Atmospheric Administration (NOAA) [4,5]. The social and economic data of KKNR derived from field observation and in-depth interviews from 30 people surrounding the area by using the Snowball technique.
3. Results and discussion

Our depth-interviews to the people in KKNR reveal that sand mining and long dry season are becoming main factors of fire occurrences in KKNR. Other factors are land preparation, bird poaching, and the belief of the people that fires may come up from rocks friction and myths (Table 1).

| No. | Causative factor         | Percentage (%) |
|-----|--------------------------|----------------|
| 1   | Sand Mining              | 29             |
| 2   | Long dry season          | 27             |
| 3   | Land preparation         | 17             |
| 4   | Friction between rocks   | 17             |
| 5   | Myth                     | 5              |
| 6   | Bird poaching            | 3              |
| 7   | Cigarette butt           | 2              |
|     | Total                    | 100            |

3.1. Sand Mining Activities

This study shows that sand mining activities in the area significantly trigger the fires. Illegal sand mining at Mount Guntur is done traditionally and may categorize as open mining. The process of sand mining begins with the intentional burning (Figure 1) on the area in a slope that burnt all of the above-ground vegetation. The fire then stopped but left the soil bare without any vegetation. As a result, sand that is remaining in the area will have eroded when the rain came. The surface flow carried out the sand to the foot far from the borders of KKNR, a place where the illegal miners then safely collect the sand using a truck. The slope in the KKNR range from moderate to steep slope between 2° - 75° [6]. This steep slope may accelerate the fire spread and rapid movement of the sand to the foot through surface flow when heavy rains come.

Figure 1. Illustration of sand mining in KKNR, clockwise: (1) Condition of the vegetation in the area before the fire. (2) The process of burning the land. (3) The bare soil after the fires. (4) Surface flow from heavy rain eroded sand to the foot. (5) Sand piled up at the foot, and the miners began to collect the sand. (6) Transporting sand mining material.
3.2. **Long dry season**

The long drought in KKNR significantly reduces the water supply in the areas, resulting in the severe dry condition of the area and thus providing the ease of fires to be ignited and spread. Figure 2 showed the relation between precipitation and the burnt area in KKNR. The decline of rainfall will increase the extent of fires. Rainfall is a factor that affects weather and climate on forest and land fires in addition to the wind, air humidity, and air temperature [7].

![Figure 2 Monthly precipitation and burned area in KKNR, 2014 to 2018](image)

From Figure 2, we can understand that drought due to long dry season may exacerbate fires, as found in 2014, 2015, and 2018. The world experienced a weak El-Nino in 2014 and 2018, 2015 is a very strong El Nino, while 2016 and 2017 is a weak La Nina and El Nino in 2018 is weak [8].

3.3. **Land preparation**

Some farmers prepare their agricultural land by burning, generally known as slash and burn [9]. The first step for this field preparation is clearing the land manually. Then the farmer making stacks in a circle form. Everything in the stacks is drying naturally under the sun. The farmer burnt the dries biomass in the stacks for the final stage of their land preparation.

If this land preparation is doing correctly, the farmers could control the fire spread. However, in most cases, the unskilled farmers could not control the fire after they start combustion, resulting in considerable wildfires in the area. In other cases, some respondents witnessed the uncontrolled fires start from burnt of piles of dried biomass by the unknown person. Finally, the origin of fires in KKNR sometimes is unclear. Land preparation by farmers usually occurs in July to October, resulting in the number of fires that is more frequent in these months (Table 6).

![Table 2 Number of fires in KKNR, 2014-2018](table)

| Month      | 2014 | 2015 | 2016 | 2017 | 2018 | Monthly Total |
|------------|------|------|------|------|------|---------------|
| January    | -    | -    | -    | -    | -    | -             |
| February   | -    | -    | -    | -    | -    | -             |
| March      | -    | -    | -    | -    | -    | -             |
| April      | -    | -    | -    | -    | -    | -             |
| May        | -    | -    | -    | -    | -    | -             |
| June       | -    | -    | -    | -    | -    | -             |
| July       | -    | 2    | -    | 2    | 2    | 6             |
| August     | -    | 1    | -    | 5    | 3    | 9             |
| September  | 1    | 3    | -    | 4    | 6    | 14            |
| October    | 1    | 2    | -    | 1    | 4    |               |
| November   | -    | -    | -    | -    | -    | -             |
| December   | -    | -    | -    | -    | -    | -             |
| **Total**  | 2    | 8    | -    | 11   | 12   | 33            |
3.4. Friction between rocks
According to Handayani [6], Mount Guntur has a basaltic and andesitic lava rock that includes igneous rock with skori structure. Some peoples in KKNR believe that friction between rocks that occurred when there is a landslide on the slope will produce sparks that can start a fire. However, the friction between rocks will not start a forest fire as heat resulted from the frictions not enough to ignite any fuel.

3.5. Myth
Since the first forest and land fires in KKNR taken for granted by people around. There was a belief from people surrounding, that the rainy season will following forest fires occurrences in Mount Guntur [10]. The similar myth also found in Banjar and Bandung, West Java since ancient times. They believe that the burning of Mount Bayonet is a sign of the rain will fall in Banjar. Villagers of Buninagara Village, Bandung still believe the myth that to end the dry season they should burn weeds in Mount Singa. People believe that the smoke of burning thatch will become a black cloud [11].

3.6. Bird Poaching
According to our respondents, illegal bird poaching is one of the causative factors of forest fires in KKNR. The poacher did not originate from people living in KKNR and surrounding. In the beginning, they start a smoke by burning a litter under a tree to scare birds. Birds that fly away from the trees due to smoke will be easy to be caught by the poacher. The fires start from the left-over burnt litter that not suppressed properly by the poachers. However, this illegal bird poaching is no longer exist after the KKNR officials ban the activities and perform regular patrol.

3.7. Cigarette butt
Even the heat from cigarette butts not enough for a fire [12], people in KKNR still believe the cigarette butt as one of the causative factors of forest fires in KKNR. They stated that cigarette butt is causing fires near a hiking trail and near camping ground. The belief of people surrounding KKNR on the myth and cigarette butts as factors causing fires may reflect that they still have a lack of knowledge on a forest fire.

4. Conclusion
The result of the study is pointing out that the repeated fires in KKNR are human-caused. That fires are from sand mining, land preparation by using fires, and illegal bird poaching. Drought due to long dry season triggers the fires. Some peoples in KKNR still believe the myth and cigarette butts as a causative factor of the fires, strongly suggest the need for knowledge introduction of forest fires to people there. Increasing knowledge of forest fire will educate the people for not using fires for sand mining, land preparation, and bird hunting.

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