Pollution of Pb Metal on Soil at Burned Forest Areas at Baluran National Park - East Java Indonesia.

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Abstract. Burned Forest at Baluran National Park occurs almost every year, especially the peak of the dry season. Forest fires cause soil nutrients on the surface and in the soil decrease in both quantity and quality; thus, affecting plant growth and development. The purpose of this study was to distinguish the contents of Pb metal in the soil in areas that burned and non-burned areas. The method used was a purposive sampling area. In each of the same stands were taken 5 soil samples with different coordinate points and considered as one sample. The sampling obtained up to 10 points which are considered as replications. The results of research were from the soil taken at National Park Baluran the area burned with areas that have never been burned with a repetition of 10 times. It can be concluded that the Pb contents on the soil in the burned area and not burned areas significantly differ.

Keywords: Forest fire, Pb metal content, soil, Baluran National park

1. Introduction
Baluran National Park is located in Wonorejo village and Sumberanyar village, Banyuputih district, Situbondo district, East Java province. Geographically, it is located between 7°29′10″-7°55′55″ south latitude and 114°29′10″-114°39′10″ east longitude [1]. Baluran National Park covers an area of 25,000 hectares, almost 80% of savanna fires every year. Based on Schmidt and Ferguson classification, Baluran National Park has a transitional climate type of type D and E. The average annual rainfall ranges from 800-1400 mm/year. The lowest average rainfall conditions are May, June, August, September, and November. The soil in Baluran National Park consists of ten types of land. Andosols are distributed on the upper slopes of the mountains. Andosol in the topsoil has a very dark black to dark brown color with a dark brown to dark brown-yellow undercoat. The clay fraction is dominated by allophane (Al₂O₃⋅SiO₂⋅5H₂O). The type of soil porous with low fill weight, crumb structure, has a binding capacity and high-water conductivity. The soil is generally sandy clay texture, has a high fertility potential but will easily erosion. Baluran National Park often experiences fires every year. Fire prevents forest regenerations and maintains grasslands to provide animals [1]. Burned Forest at Baluran Nasional Park occurs annually, especially weeds [2]. The characteristics of Pb. According to Serrao et al., [2] burning in weeds increases pH, exchange of Ca, Mg, Na, decreases in Al, but there is
a decrease in P from the first to the fourth year. Pb metal at burned forest has not been studied primarily in the tropics. Pb is a toxic metal that shows significant anthropogenic enrichment factors.

The characteristics of Lead (Pb), with specific gravity 11.34, gray. Observations were carried out in 1997. Baluran National Park experiences fires every year because for 1-year rainfall is only 1-3 months of rain. Because of the frequent fires the physical properties of the soil change to hard, discoloration, cracking during the dry season. The type of understory in the burned area is 23 species, while the area that is not burned is 13 species, using a plot of 1 x 1 m². In the burning area of the pH of the soil towards the base, of course, it is related to soil nutrition, especially calcium and magnesium salts bound to the soil layer. Calcium salt rises due to fire, such characteristic properties are bound to the soil in alkaline conditions, while Magnesium salts are carried by rainwater. Some of the results of Pb pollution studies affect human life. High Pb contamination was previously confirmed in a mountainous land, common playground soils, and roadside dust and sediments [3-5]. Besides, Bellis et al., [6] provide evidence of Pb long-distance transportation from Asia to Japan. From this reason, environmental monitoring of Pb pollution is needed to prevent human health risk. The purpose of this study was to investigate the total contents of metal in the soil in burned and non-burned areas. Importantly, there is limited study related to annual savannah fire in Baluran National Park.

2. Methods
The preparation of sampling of soil samples was carried out randomly in the burned and non-burned area. The soil taken in the fire is 0-30 cm using a ground drill. The soil was dried and then analyzed using an atomic absorption spectrophotometer (AAS). Repetition was done 10 times. Soil samples of texture and penetration resistance were taken at ground level and 25 cm. The characterization of soil physics analysis included soil texture using a hydrometer method, volume weight using ring printing method, and specific gravity using the pycnometer method. Repetition was done twice. The comparison of savannah fires often occurs every year with a savannah that never experiences fires. The sample points of location at Pondok Mantri and Perengan area were 55 points, Talpat area was 74 points, Briu area was 15 points.

3. Results and Discussion
The Pb content was analyzed by 10 repetitions of Pb content in the topsoil between 3.01-7.52 ppm except for 7 repetitions of soil Pb content <0.0096 ppm. Pb content in the subsoil between 3.40 – 9.83 (Table 1). The analysis using independent Pb sample test showed that p = 0.00 < α = 0.05 means that the Pb element on the ground at the location on the burn and non-burn areas was significantly different. Soil particle size fires and soil specific gravity is expected to increase. According to [7] the pH and sand particles have a regression equation with Pb. To find out metal pollution Pb in terrestrial, wild mice were used [8-11]. To reveal Pb-IR in rat kidneys was relatively accurate which can reflect people polluted with Pb, despite the biological fractionation of Pb isotopes [12]. Follow-up of this study can be done by mammals in areas burned forest. Thus, it is most likely that Pb pollutions source can be identified using Pb isotope analysis from wild rat kidneys that focus on PB-IR in mice. In agricultural land, the use of calcium carbonate + metakaolin + fused calcium-magnesium phosphate fertilizer (CMC) can be used to reduce the amount of Pb metal into seeds of Oryza sativa L. [10].

Burned forest at Baluran Nasional Park occurs every year. The burned area is dominated by weeds. Fires occur in settlements areas. This study will continue whether Pb pollution would be included in an essential matter in settlements including water, agricultural post-harvest, livestock, and fisheries. Based on the results of sampling that follows slopes in the water flow. Pb content in the soil collects on slope 0°-30° (Table 2).
Table 1. Pb Content in Burned Forest and Non-Burned Areas

| Sampling Area | The depth of Soil (cm) | Burned Forest (ppm) | Non-Burned Area (ppm) |
|---------------|------------------------|---------------------|-----------------------|
| 1             | 0                      | 3.77                | 0.19                  |
|               | 25                     | 9.83                | 0.20                  |
| 2             | 0                      | 3.01                | 0.17                  |
|               | 25                     | 3.03                | 0.17                  |
| 3             | 0                      | 5.59                | 0.09                  |
|               | 25                     | 8.62                | 0.21                  |
| 4             | 0                      | 6.01                | 2.22                  |
|               | 25                     | 6.64                | 2.25                  |
| 5             | 0                      | 6.03                | <0.096                |
|               | 25                     | 7.00                | 0.1                   |
| 6             | 0                      | 7.52                | 0.16                  |
|               | 25                     | 8.59                | 0.18                  |
| 7             | 0                      | <0.0096             | 0.12                  |
|               | 25                     | 3.40                | 0.14                  |
| 8             | 0                      | 7.50                | 1.18                  |
|               | 25                     | 8.12                | 2.01                  |
| 9             | 0                      | 6.00                | 0.18                  |
|               | 25                     | 9.34                | 0.22                  |
| 10            | 0                      | 6.27                | 1.15                  |
|               | 25                     | 6.63                | 1.16                  |

Table 2. Pb Content in Burned and Non-Burned Areas at different slopes on topsoil

| Slope       | Burned Forest (ppm) | Non-Burned Areas (ppm) |
|-------------|---------------------|------------------------|
|             | Mean                | Mean                   |
| 0° - 30°    | 9.58                | 0.12                   |
| 35° - 50°   | 8.35                | 0.15                   |
| 60° >       | 3.22                | 0.14                   |

Lead is a microelement naturally present in trace amount in all biological materials, i.e. in the soil, water, plants, and animals. Lead concentration decreases rapidly in the soil with distance from streets, highway and in soil with depth in the soil profile. Burned forest texture is sandy clay loam. The soil becomes hard, but between topsoil, with subsoil the texture does not change much. Non burned area texture is sandy loam and some repetitions of texture sandy clay loam (Table 3, Figure 1).

Table 3. Physical properties of soil in burned forests and non-burned areas

| No | Test Parameter   | Burned Forest | Non-Burned Areas |
|----|------------------|---------------|------------------|
|    |                  | 1   | 2   | 1   | 2   |
| 1. | Texture (%)      | -   | -   | -   | -   |
|    | Sand (%)         | 30  | 39  | 23  | 25  |
|    | Dust (%)         | 39  | 27  | 46  | 46  |
|    | Clay (%)         | 31  | 34  | 31  | 29  |
| 2. | Volume Mass (g/cc)| 1.09| 0.83| 1.08| 0.86|
| 3. | Density (g/cc)   | 2.70| 2.35| 2.56| 2.26|
Figure 1. (a) Burned forest in depth of soil 0 cm, (b) Burned forest in depth of soil 25 cm, (c) Non-burned forest in depth of soil 0 cm, (d) Non-burned forest in depth of soil 25 cm.

Dry wind direction from the northeast and southeast from April to November, while the west and south wind directions are wet between December and March. April to July the highest average rainfall reaches 30 mm (Figure 2a), August to October/November is rarely found in the rain (Figure 2b and Figure 2c). Areas that are burned texture sandy clay loam and soil penetration are higher than the area that is not burned, area not burning texture sandy clay (Figure 1, Table 3, Table 4). Burning forest area soil texture of sandy clay loam and followed by increased soil penetration (Table 4). In water flow location the soil Pb content increases (Table 2). From the direction of 70° > in the direction of 0 – 30° this condition indicates the soil Pb of the ground is carried by rainwater to a lower in direction. Forest fires at Baluran National Parks are caused by high understory biomass, massive understory biomass between 54.12 - 84.51 gram.m⁻² [13], from Reis SM's research and friends that burned forests have biomass 0.4-1.3 gram.m⁻² [14]. The distribution of Pb contamination of burned forest land related to water flow, soil penetration, and soil texture. Pb soil contamination is almost the same as research in Cracow Poland caused by air, water, aquatic sediment and soil [15].
Table 4. Difference soil penetration resistance in burned forest and non-burned areas

| Sampling Area | Depth of Soil (cm) | Burned Forest (Newton/cm²) | Non-Burned Area (Newton/cm²) |
|---------------|-------------------|-----------------------------|-----------------------------|
|               | 0                 | 823.33                      | 667.88                      |
|               | 25                | 850.24                      | 700.32                      |
| 1             | 0                 | 802.11                      | 622.13                      |
|               | 25                | 832.11                      | 650.65                      |
| 2             | 0                 | 680.33                      | 590.21                      |
|               | 25                | 710.22                      | 700.76                      |
| 3             | 0                 | 842.66                      | 642.33                      |
|               | 25                | 850.33                      | 701.22                      |
| 4             | 0                 | 833.14                      | 632.11                      |
|               | 25                | 880.53                      | 628.22                      |
| 5             | 0                 | 821.88                      | 687.11                      |
|               | 25                | 860.14                      | 704.66                      |
| 6             | 0                 | 822.31                      | 654.55                      |
|               | 25                | 831.11                      | 690.33                      |
| 7             | 0                 | 816.82                      | 586.24                      |
|               | 25                | 874.11                      | 587.22                      |
| 8             | 0                 | 816.11                      | 603.11                      |
|               | 25                | 846.33                      | 722.34                      |
| 9             | 0                 | 821.11                      | 645.33                      |
|               | 25                | 865.44                      | 711.15                      |

Figure 2. (a) Soil conditions in October 2017, (b) Plants conditions in October 2017, (c) Plants conditions in May 2017
4. Conclusion
The fire occurred in the Savannah region of Briu, Talpat, Mantri, and Perengan Baluran National Park. The soil Pb content is 3-9.83 ppm which has a fire, while those who did not experience burned fire Pb < 2 ppm. The area of Pb pollution has higher than fires occurred in the Savannah region of Briu, Talpat, Mantri and Perengan Pondok Baluran National Park. The soil Pb content is 3-9.83 ppm which has a fire, while those who do not experience burned soil Pb < 2 ppm. In the fire area, Pb pollution is higher than no fire land. An increased amount of the lead in our environment comes from human activities including burning high understory biomass of the plant. The distribution of Pb land in Baluran National Park is supported by flow rainwater, soil texture, and soil penetration.

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