*Original Article*

# Distribution Pattern of Children with Acute Respiratory Infection during Forest fire at Central Kalimantan Indonesia

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## Abstract

Over the past 30 years, forest fire has been one of main ecological issues in Indonesia. Human-caused deforestation was accused to be the reason behind this matter, apart from the drastic changing in global climate. Palangkaraya is one of the citiesaffected by haze of the forest fire in 2015; considered to be the worst year of forest fire with the value of PM10 was above the normal threshold. As the impact to the community wellbeing, the prevalence of acute respiratory infection (ARI) in October 2015was increasing especially in children. The research aimed to analyse the spatial distribution of children with ARI in October 2015 at Palangkaraya City. Data onARI number were collected from Primary Care under Public Health Office of Palangkaraya City. The PM 10 value was collected bythe Environmental Agency of Palangkaraya City. The spatial analyse method was conducted using theAverage Nearest Neighbour (ANN) method. The result shows that the number of ANN ratio is 0.761801. It means that the distribution pattern of children with ARI in Central Kalimantan during the forest fire in October 2015 was in cluster form.

**Keywords:** Children with ARI;Forest fire2015; Palangkaraya City

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## Introduction

For the past 30 years forest fire has been considered to be one of many important ecological issues in Indonesia. Human-caused deforestation was considered responsible, apart from the circumstances of being a tropical country[1]. The fire in 1994 and 2015 were regarded as the worstso far due tothe combination of the aforementioned causes and El Nino as the effect of climate change[2].In addition, the year of 2015 event was the most catastrophic fire season on the record in Indonesiawith a vast region of Indonesia including Sumatera, Kalimantan, and Papua have been suffering from the fire for months and neighboring countries such as Singapore, Malaysia, and Thailand were also suffered from the haze of the fire[3-5].

Central Kalimantan was one of many provinces that affected by the haze during Forest fire in 2015.The continuing haze came fromsmoldering peat land due to forest fire with the high temperature in October 2015 also contributed[6].The haze was covering the city nearby such as Palangkaraya and caused blackout and darkness.Many daily activities have been disturbed such as public transportation, schooling, farming, and trading. Furthermore, schools and offices were closed for days when the haze was very thick.

Forest firehaze is a globally important source of particulate matter (PM)pollution but its public health effects are challenging to assess[3,7]. PM is associated with a higher incidence of upper airway symptoms, such as rhinorrhoea, nasal obstruction, cough, laryngospasm, and vocal fold dysfunction, and lower

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airway symptoms, such as cough, dyspnoea, and wheezing[8].The respiratoy distress syndrome is one of the cause to induce premature rupture of membrane (PROM) to result preterm delivery[9].

The haze also caused eye irritation and disturbance of respiration.Patient's visit to the hospital and Primary Health Center has increased significantly, mainly suffering from acute respiratory infection (ARI). Children had a higher risk to get ARI due to the ongoing process of immunitydevelopment[8].Thus, considering the frequent event of forest fire, the prevalence of ARI had also become more recurrent.

More attention should be paidfor the sake of the future health of the children.An integrated and comprehensive contribution from many sector, government and private alike, are expected to take part. Indeed, to build the effective program, the government and society should have a good understanding of the distribution pattern of the children with ARI due to the unevendistribution of the haze across the region. Moreover, many factors influence the spreading of the haze, such as wind direction, rain fall,geography, etc. These researchesaim to analyse the spatial distribution of ARI in children in October 2015 inPalangkaraya City.

## Method

The data of ARIin October 2015 were collected from Primary Care under Public Health OfficeofPalangkaraya City.Meanwhile, the data of PM 10 in October 2015 were collected by the Environmental Agency of Palangkaraya City and the Meteorological, Climatological, And Geophysical Agency or BMKG, Jakarta. The Average of the Nearest Neighbor (ANN) as a density methodanalysis was utilized to explain the distribution pattern of location points with consider distance, proximity index, z-score, and p-value. Z-score and p-value are a measure of statistical significance that shows the distribution of random data. Nearest neighbor index will be used as the ratio of the average distance of the data to the standard mean distance. The closest neighbor index is expressed as the ratio of the observed distance divided by the expected distance. The distance expected is the average distance among neighbors in a hypothetical random distribution. If the index is less than 1, the pattern shows grouping; if the index is more than 1, the trend tends as adispersion or competition[11].The formula of ANN :

$$ANN = \frac{\bar{D}_0}{\bar{D}_E}$$

$$\bar{D}_O = \frac{\sum_{i=1}^{m} d_i}{m}$$

$$\bar{D}_E = \frac{0.5}{\sqrt{\frac{m}{A}}}$$

Note: $D_0$is the average distance observed between each feature and their closest neighbor, whereas $D_E$is the average distance that is expected to feature with a random pattern. M is the number of events, and A represents the area. The analysisof ANN usedArcMap 10.1.

**Ethical Clearance**: The study protocol was approved by the Research Ethics Committee, UMY on April 25th,2016 (no: 165/EP-FKIK-UMY/IV/2016).

## Result

Palangkarayais the Capital city of CentralKalimantan, and was one of the areas that endured the haze as an impact of Forest Fire.In October 2015, the value of PM 10 variedinday to day, as shown in table 1 from 1st of October up to 31stof October 2015. The variation level of PM 10 was influenced by many factors, such as wind direction, rain fall, geography, etc.

**Table 1.** Level of PM10 in October 2015

| Date | Level | Categori |
|---|---|---|
| 1st to 4th | 330.97 | Dangerous |
| 4th-5th | 423.5 | Dangerous |
| 5th to 8th | 530 | Dangerous |
| 9th | 382 | Dangerous |
| 10th | 457 | Dangerous |
| 11th | 371 | Dangerous |
| 12th to15th | 775 | Dangerous |
| 16th to19th | 200 | Very Unhealthy |
| 20th to 25th | 65 | Moderate |
| 26 th | 25.4 | Good |
| 27th to 31 th | 51 | Moderate |

Table 1.shows the level of PM10 in October 2015, based on data from the Environment Ministry Provision No 45 /1997 about Air Pollutant Index. The category of dangerous level of air quality meansit can be harmful to population health in general. Very Unhealthy level of air quality means the level of air quality can be detrimental to health on exposed segments. Unhealthy level of air quality meansthe level of air quality that is detrimental to humans or groups of animals that are sensitive or can cause damage to plants or aesthetic value. Moderate level air quality means the level of air quality that does not

affect human health or animal groups but influences sensitive plants and aesthetic values. Good level of quality meansthe level of air quality that does not have an effect on human health or animal groups and does not affect plants, buildings or aesthetic values. This research shows that in early of October the level of PM10 was 330.97 referring it as dangerous.

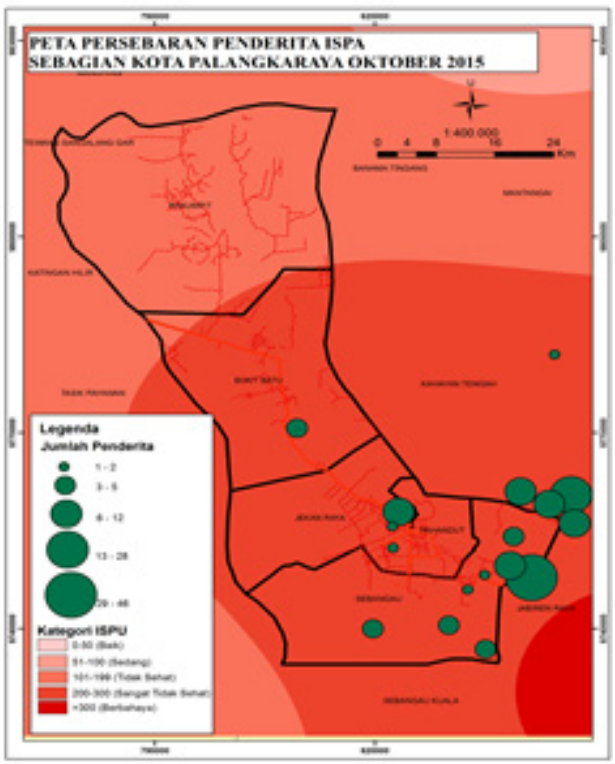


Figure 1. Distribution of Children with ARI at Palangkaraya

The highest PM10 was reaching 775 at the middle of October 2015 and decreased to moderate at the end of October.The decrease level of PM 10 was assumed to be caused by the coming of rain fall.The dangerous level was occurring for almost 2 weeks in which the level of PM 10 was more than 300.

The persistence of higher level of PM10 was extremely dangerous for children due their immunity whenever they were attacked by the haze. The number of children under five years old with ARI during October was around 68 children in Palangkaraya. They were distributed across diversed places in various level of PM10. As shown in figure 1, the number of children with ARI was at the different level of PM10. Some areas of Palangkaraya had lower level of PM10 than other areas, but its level was higher than other area. The secondary data from local authority were not equipped with a complete address, and was difficult to locate using maps. Therefore, a grouping was done among the sample if children were located at similar area. The pattern of distribution of the children with ARI in October 2015 is as shown in figure 2.

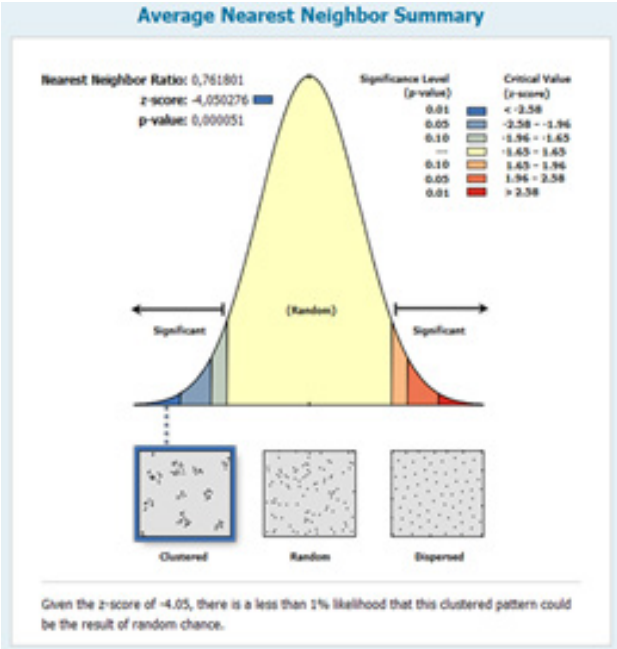


Figure 2. The Average Nearestneighbor

Based on Average Nearest Neighbour analysis it shows that the ANN ratio is 0.7618.The ANN method was used to analyze the model of distribution ARI in October 2015 at Palangkaraya. This method was based onthe distance of spot ofchildren with ARI in one area to the spot of nearest location of children with ARI, and then the average of all the nearest distance was determined. The values in index ratio between the distance of the location of children withARIand the distance expected. There aretwo values of ANN ratio to analyze: Less of 1 means that the distribution model is cluster. If the value is more than 1, itmeans that the distribution model is disperse[12]. If the value is morethan 1, it means the distribution model is random.

Z score and p valueshow that the data to analyze is significant andtrustworthy and p value less than 0.01 is very significant. Based onZ score, it shows that the hypothesis of data that are in cluster form is accepted. Z score is -258 on p value of 0.01, and this means that the data are acceptable as cluster. This research shows that z score is – 4.05. The distribution of children with ISPA in Palangkarayais cluster. It shows that in one part of Palangkaraya city, the patients were more massive than the other parts.The cluster pattern is in line with the situation of area such

as Pahandut district. Pahandut area was along the Kahayan River and this area was low area. Thus, the haze was accumulated in this area during the forest fire. Even the other area with PM 10 was healthy, but in Pahandut the hazewas still thick. People could not see the distance in 4-5 meter onward. So to protect children in this area from haze or other pollutan need more intense attention especially children must evacuate to other area, or oxygen tube for children must available and easy to get.

## Conclusions

The distribution pattern of children with acute respiratory infectionduring Forest fireatPalangkarayain October 2015 is in cluster form. This reflects the accumulation of the haze in certain area due to the geographical characteristics of the region. Therefore, it is important to explore which are the most important factors in influencing the number of ARI patients during the haze attack.

**Conflict of interest**: There is no commercial association that may create a conflict of interest in connection with this submitted manuscript. All authors are affiliated with the UniversitiSains Malaysia and receive no financial benefit from this study

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