

Assessment of Black Carbon Concentration in Rice Straw Open Burning Season in Lai Yen Commune, Hanoi Suburban Area

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Abstract: In recent years, rice straw open burning (RSOB) activity has commonly occurred after the harvest in the countryside of Hanoi. This activity has caused negative impacts on air quality, especially it emits a large amount of black carbon (BC), a short lived climate pollutant (SLCP). As the other SLCPs, BC directly affects human health and ecosystem. This paper presents the results of measured BC concentrations in RSOB season in Lai Yen commune, Hoai Duc district in Hanoi. The results showed that the hourly average BC concentrations in three monitoring periods were $8.43 \pm 0.67 \mu\text{g}/\text{m}^3$ (23 - 25 Oct. 2015), $7.64 \pm 0.73 \mu\text{g}/\text{m}^3$ (26 - 28 Feb. 2016) and $3.74 \pm 0.30 \mu\text{g}/\text{m}^3$ (15 - 19 Jun. 2016), respectively. The lowest BC concentration was $0.36 \mu\text{g}/\text{m}^3$ while the highest nearly reached $36.8 \mu\text{g}/\text{m}^3$. BC concentration in this study is higher than that of Lang air quality-monitoring station. This result is useful for national policy makers and managers for tighter control of RSOB activities.

Keywords: Black carbon, rice straw open burning.

1. Introduction

Black carbon (BC) is a distinct type of carbonaceous material that is a strongly light - absorbing component of particulate matter, primarily emitted from the incomplete combustion of fossil fuels, biofuels and biomass [1, 2]. There is about 90% of BC contained on PM_{2.5}, aerosol which is the main human and ecosystem - affected reason [3].

BC is a short-lived climate pollutant (SLCP), only exist in the atmosphere from few days to a week, but BC contributes to atmospheric warming, surface dimming, the formation of Atmospheric Brown Clouds (ABCs), Snow/ice albedo, and changes in the pattern and intensity of precipitation [2, 4, 5, 6]. Anthropogenic activities as biomass burning, transportation, solid waste burning, residential etc. are considered a main BC emission resource. In 2000, global BC sources emissions were estimated about 42% - the largest portion -

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from open burning [7]. According to the published literatures the majority of global BC emissions comes from Asia, Latin America, and Africa [1, 2].

Rice straw open burning (RSOB), one of the main BC sources in agriculture, are gradually becoming an effective, timely and costly - saving methods of field cleaning, especially in Asia e.g. Thailand [5], Hong Kong [8] and Vietnam [9]. Rice straw and other field residues are no longer to be used in cooking, roof thatching, feeding domestic animals which leads to the increase of agricultural field burning activities. In Vietnam, few research on BC has been conducted, hence, the present study investigate the BC concentration in RSOB season in Hanoi suburban area.

Monitoring BC concentration was conducted in Hanoi suburban area during the rice straw open burning, the variation.

2. Methodology

The research concentrated on monitoring concentration of BC in Lai Yen commune, Hoai Duc district, Hanoi city. Sampling was conducted in three periods: (1) 23rd - 25th October, 2015: straw was scatteredly burned after harvesting; (2) 26th - 28th February, 2016: four months after harvesting; (3) 15th -19th June, 2016: rice straw was burned continuously before the new crop.

The sampler, MicroAeth® Model AE51, was set at the height of 7m above surface with the distance of about 500m in the Northeast direction from the rice field. Measurement unit is nanogram/m³, in-flow rate: 50mL/min, timebase: 300 seconds.

3. Results and discussions

In three different periods, the trend variation of BC concentration was found nearly the same, where high values were in the evening and morning, low values were at noon

(Fig. 2). It can be explained that burning time occurs mainly in late afternoon therefore concentration of pollutant kept rising from evening until the next morning. At noon time, the values of BC decrease due to dispersion and dilution.

The hourly average BC concentration from 23rd-24th Oct, 2015 was $8.43 \pm 0.67 \mu\text{g}/\text{m}^3$. In this period, rice straw burning is in dry season, the BC concentration reached the highest value $23.41 \mu\text{g}/\text{m}^3$.

Four months later, the average BC concentration and median in three monitoring days were $7.64 \pm 0.73 \mu\text{g}/\text{m}^3$ and $5.8 \mu\text{g}/\text{m}^3$, respectively. BC concentration was lower than the previous period but still high. The reason was that this time was dry season in Northern Vietnam with low precipitation.

The third period was the longest observation, from 15th to 19th June, 2016. The hourly average BC concentration ranged from $0.36 \mu\text{g}/\text{m}^3$ to $19.68 \mu\text{g}/\text{m}^3$. Although sampling was carried out in the burning time, BC concentration was relatively lower ($3.76 \pm 2.93 \mu\text{g}/\text{m}^3$) than previous periods.

The weather in this time was unstable with rain and high wind speed in late afternoon and early morning, that could lead to the decrease of BC concentration. At noon, the dispersion increase because of high solar radiation, wind speed (about 2 m/s), high temperature resulting in low BC concentration.

Pollutants rose chart (Fig.1(c)) showed that frequency of NW wind direction (with main field and there were a lot of combustion sources) was low but high concentrations of BC appeared at this wind direction. In contrast, the frequency of SE wind direction was high but BC concentration was low because of less of open burning sources (Fig. 1 (b)).

The variation of BC concentration in Lai Yen and Lang was similar but the changes in Lai Yen, which located near the combustion sources, was higher than Lang. Lang was far from open burning source and in Hanoi city center therefore, BC concentration measured here maintains low value (Fig. 3)

Meteorological monitoring equipment, ProweatherStation™, was used and set up for parameters of wind direction, wind speed, humidity, temperature and pressure.

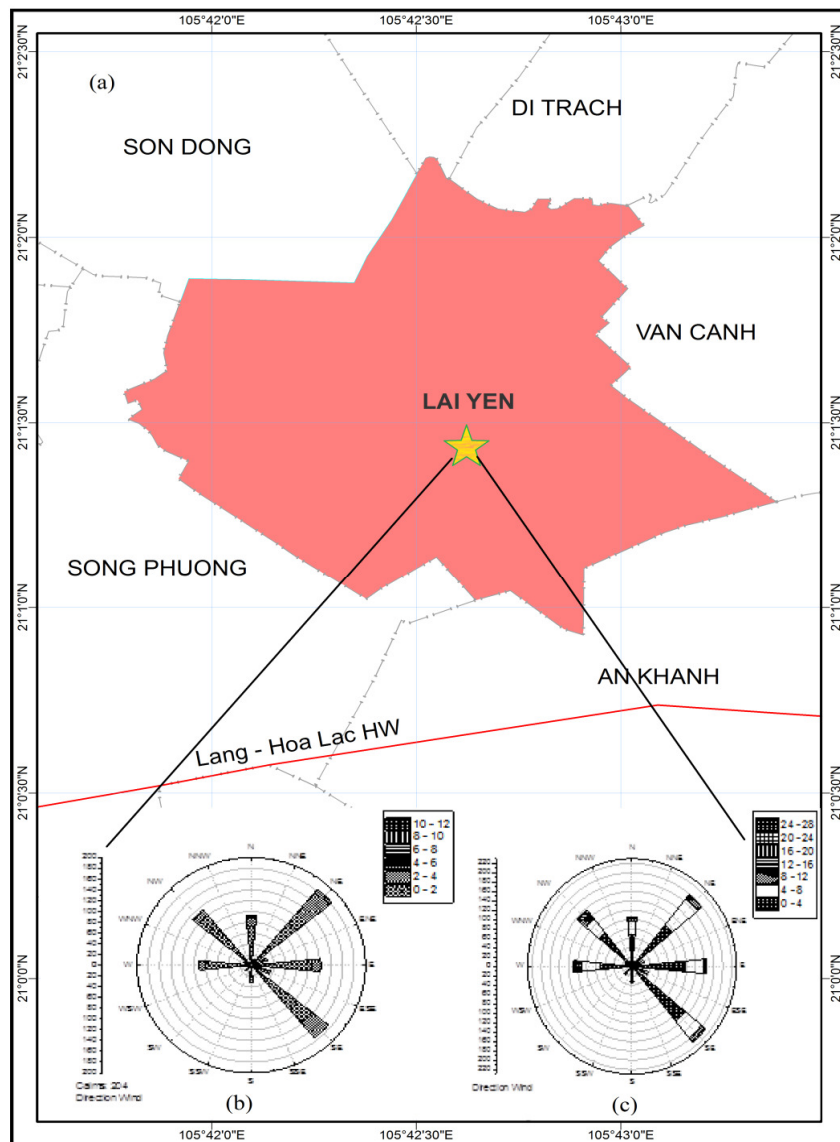


Figure 1 (a). Sample location Map.

Figure 1 (b): Wind rose (Note: The left column indicates the number of occurrences of wind direction (the length from the center), and the right column is wind speed (m/s)).

Figure 1 (c): Pollutants rose (Note: The left column indicates the number of occurrences of wind direction (the length from the center), the right column: BC concentrations ($\mu\text{g}/\text{m}^3$)).

4. Conclusion and recommendation

BC concentration in RSOB seasons which were monitored in Lai Yen commune from October, 2015 to June, 2016 was much higher than that in Hanoi center (the data of Lang air quality-monitoring station). In the period 23rd - 25th October, 2015, the hourly average BC concentration in Lai Yen was $8.43 \mu\text{g}/\text{m}^3$ meanwhile data from Lang station was only $2.43 \mu\text{g}/\text{m}^3$. The diurnal variation was found to be similar in all three monitoring periods. The increase in early morning, night and the

decrease after 9 a.m. are affected by meteorological factors, source distance, and burning time. In detail, wind direction and wind speed are considered as the most influencing factors. At wind direction with more burning sources, BC concentration can reached a greatly high value. June 2016 is also in RSOB season but BC concentration was low because of rain, high wind speed and high dispersion condition. As the results, the conclusion is that RSOB activities have been causing the increasing of BC concentration in the rural area.

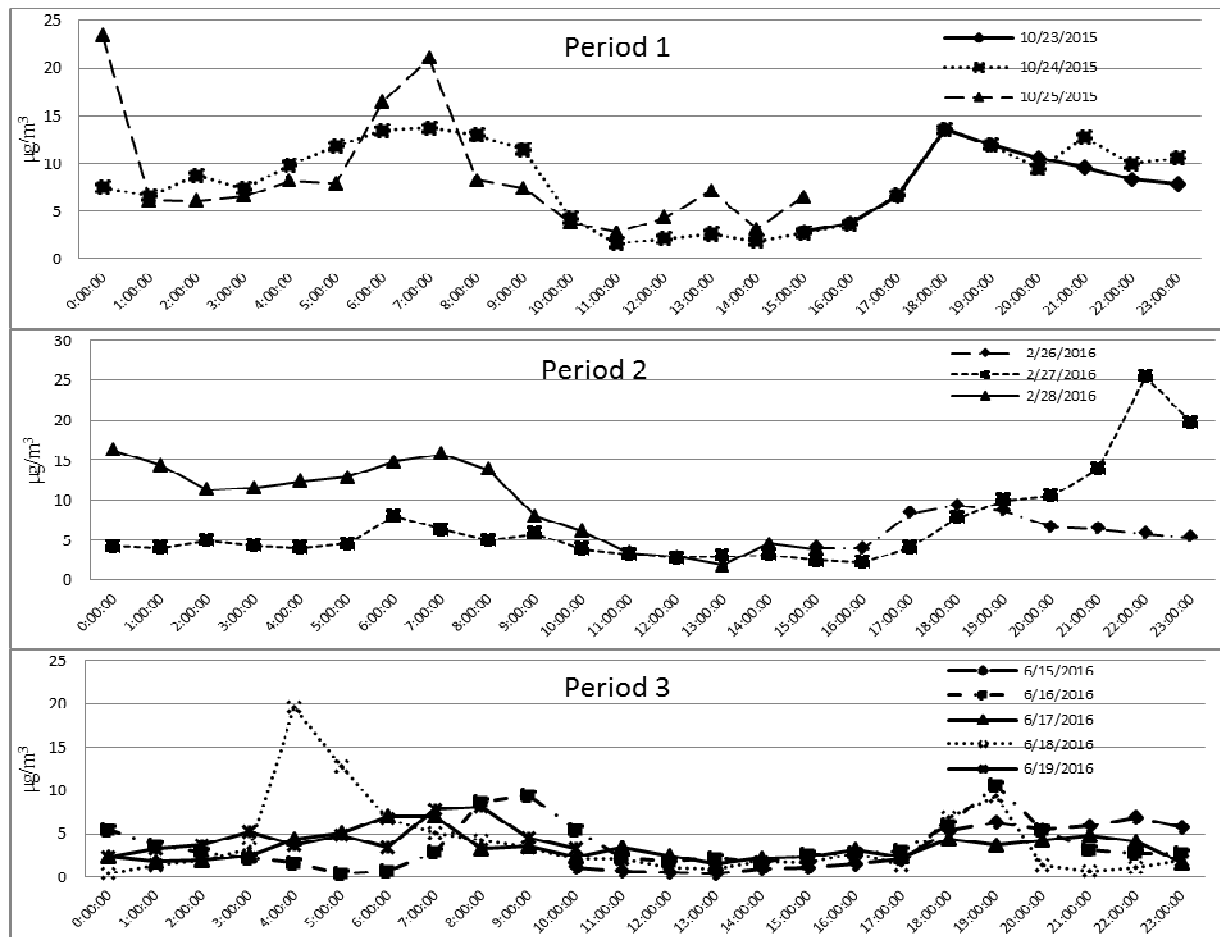


Figure 2. The hourly average BC concentration.

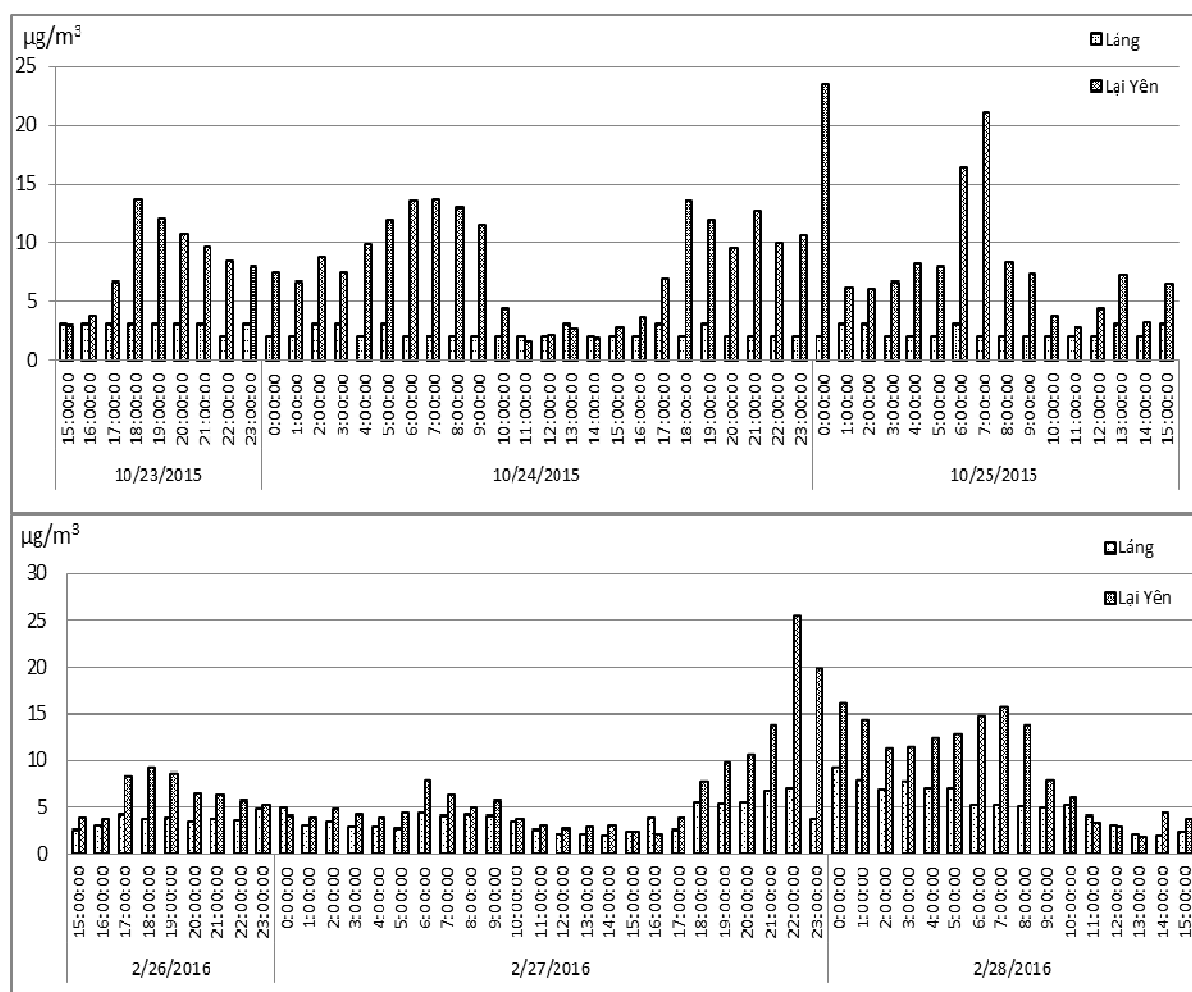


Figure 3. Comparison of hourly average BC concentration in Lai Yen and Lang station.

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Đánh giá nồng độ các bon đen trong thời kỳ đốt rơm rạ ngoài đồng ruộng khu vực xã Lại Yên, ngoại thành Hà Nội

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Tóm tắt: Trong những năm gần đây, đốt rơm rạ ngoài đồng sau mỗi vụ thu hoạch diễn ra phổ biến ở khu vực ngoại thành Hà Nội gây ảnh hưởng trực tiếp tới sức khỏe con người và biến đổi khí hậu. Bài báo này trình bày những đánh giá về nồng độ BC trong thời kỳ đốt rơm rạ tại xã Lại Yên, huyện Hoài Đức, thành phố Hà Nội. Kết quả nồng độ BC trung bình giờ tại ba giai đoạn trong vụ thu hoạch lúa mùa (23 - 25/ 10/2015); sau vụ thu hoạch (26 - 28/ 2/2016) và đầu vụ lúa xuân (15 - 19/6/2016) lần lượt là: $8,43 \pm 0,67 \mu\text{g}/\text{m}^3$; $7,64 \pm 0,73 \mu\text{g}/\text{m}^3$; $3,74 \pm 0,30 \mu\text{g}/\text{m}^3$. Trong đó có thời điểm nồng độ BC trung bình giờ cao nhất đạt tới $19,67 \mu\text{g}/\text{m}^3$ và nồng độ BC thấp nhất là $0,36 \mu\text{g}/\text{m}^3$. Kết quả cho thấy nồng độ BC trung bình giờ tại xã Lại Yên trong khoảng thời gian đốt rơm rạ ngoài đồng cao hơn so với giá trị đo được tại trạm Láng. Kết quả nghiên cứu này rất hữu ích cho các nhà hoạch định chính sách quốc gia và các nhà quản lý để góp phần kiểm soát chặt chẽ hơn các hoạt động đốt rơm rạ ngoài đồng ruộng.

Từ khóa: Các bon đen, đốt rơm rạ ngoài đồng ruộng.