Extended Abstract

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INVESTIGATION OF LICHEN DIVERSITY AND DENSITY WITH SO_2 CONCENTRATIONS IN SELECTED LOCATIONS IN COLOMBO DISTRICT

1. Abstract

Lichens have been used as a bioindicator to determine the air quality worldwide and corticolous lichens have gained much attention in studies carried out in urban areas. The study was carried out to investigate the changes in diversity and density of corticolous lichens from August to November 2016 in ten sites along the Highlevel road starting from University of Colombo to Awissawella. The density, diversity of lichens were studied using a 450 cm^2 transparent grid fixed on host trees. The lichens were identified using the taxonomic keys. In addition, the SO_2 concentrations during morning, afternoon, evening were obtained in each site at each sampling day of the study site. The traffic data too was obtained. Data were analyzed statistically using regression analysis and correlation analysis. Altogether, 45 lichen species were found in this study. Sulphur dioxide concentrations varied from 1.64 mg/m^3 (University of Colombo) to 0.16 mg/m^3 (Labugama). A strong significant negative correlation was found between distance and the afternoon concentration of SO_2 ($r = -0.838$, P-value = 0.002), indicating that the SO_2 levels in the atmosphere decrease when moving away from Colombo Fort. A strong significant negative correlation was found between lichen diversity ($r = -0.711$, P-value = 0.021), density ($r = -0.655$, P-value = 0.040) and the SO_2 concentration. The results of this study indicate that from the city (University of Colombo, with the highest SO_2 concentration recorded) towards Seethawaka (final study site), the SO_2 concentration has decreased mainly due to the changes in vehicular emissions. Accordingly, both the density and diversity of lichens were found to be correlated negatively with elevated SO_2 concentrations.

Keywords: Colombo, diversity, density, lichens, sulphur dioxide.

2. Introduction and research problem/issue

Air pollution which is a major concern worldwide occurs through either human action or natural causes. The fossil fuel burning in vehicles contribute much to it by releasing a variety of emissions to the atmosphere. The pollutants released by the vehicles are ozone, particulate matter, nitrogen oxides, carbon monoxides and other hazardous air pollutants. Sulfur dioxide is released by the burning of sulfur containing fuels like diesel and once it is in the atmosphere it creates problems. Burning of fossil fuels is one of the major contributor to air pollution. Among others, sulphur dioxide which is regarded as a major air pollutant is released to the atmosphere when sulphur contain fuels are burnt (Dulcea, Ionel, & Pascu, 2015).

More than 150,000 people from South Asia die before their life span due to the illnesses such as cancers, respiratory diseases (bronchial asthma, chronic bronchitis) and cardiovascular diseases (heart attacks,

hypertension) based on the air pollution (Jayathilake, 2016). Apart from that air pollutants also contribute to environmental impacts such as causing damage to vegetation, wildlife and other habitats etc. (US EPA, 2016).

In Sri Lanka the air pollution has become a severe problem. The expansion in the industries with the economic growth in the country, higher living standards of the people have lead the air pollution to be an increasing problem in the country specially in cities. It is reported that the contribution from the transport sector for the air pollution in the Colombo city is about 55-60% (Jayathilake, 2016) and sulphur dioxide is reported to contribute to air pollution related impacts significantly.

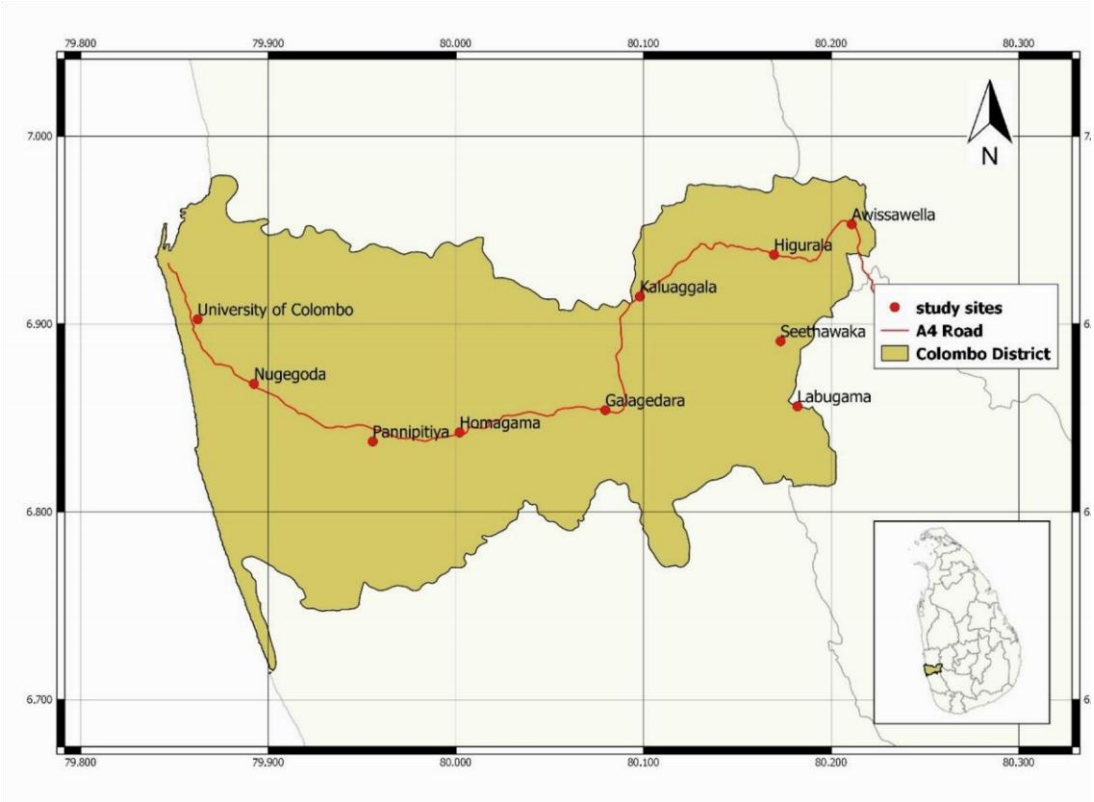
Lichens are used worldwide to monitor air pollution because effects from even minute amounts of air pollutants is inevitable in lichen as responses in community composition, growth, reproduction, and in physiology. These could be used in different methods in monitoring air pollution. Commonly used lichen biomonitoring methods in air pollution are, tissue analysis (biochemical methods), transplant studies and species composition analysis (Blett et al., 2003).

This research was carried out to investigate the air pollution with a special focus on SO_2 using lichen as a bioindicator.

3. Research Methodology

This study was carried out from June to November 2016 in sites representing high, intermediate and low vehicular traffic areas (Figure 1) in Colombo district. Thus, ten sites along the Highlevel road from the University of Colombo to Awissawella were chosen and sampled during six months period.

Figure 1: The distribution of the sampling sites



A simple apparatus, a SO_2 sampling train to determine SO_2 concentration was built in the laboratory as described by Gokhale (2009) (Figure 2).

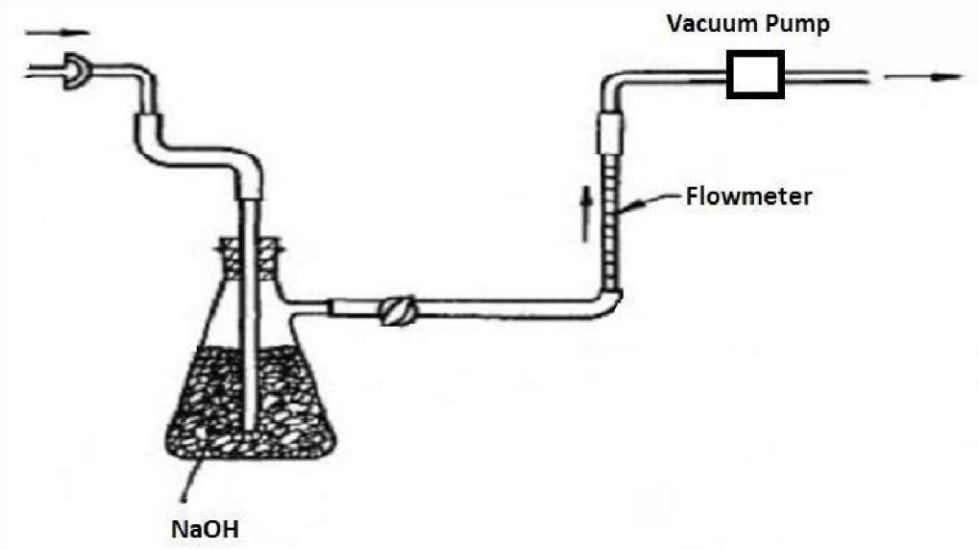


Figure 2: SO_2 Sampling Train (Source: Gokhale, 2009)

The apparatus (Figure 2) was placed in the sites where the sampling was carried out and was run for period of one hour, at 06:00h (morning), 12:00h (afternoon) and 18:00h (evening) at a constant flow rate to trap SO_2 in the atmosphere. Different time periods were selected to highlight the effects of variation of vehicular traffic. The samples were analyzed in the laboratory using gravimetric method.

Host trees that included coconut, jak fruit, rubber, mango, *Acasia* sp. etc were carefully observed to study lichens. A quadrat of 24 cm × 25 cm was attached to the tree trunk at the breast height in four aspects (North, South, East and West) (Asta et al., 2002) and the number of lichen species and the density were recorded. Standard filed guides and expert advices were used to identify species. The diversity was calculated using the Shannon Weiner diversity index (Krebs, 2014).

4. Results and findings

The concentration of SO_2 in the afternoon was higher than the other times except in Galagedara, Kaluaggala and Higurala where the amount of SO_2 is higher during the morning. Except in Labugama the SO_2 concentrations in other study sites exceeded the air quality standards for 1 hour average time (Figure 3).

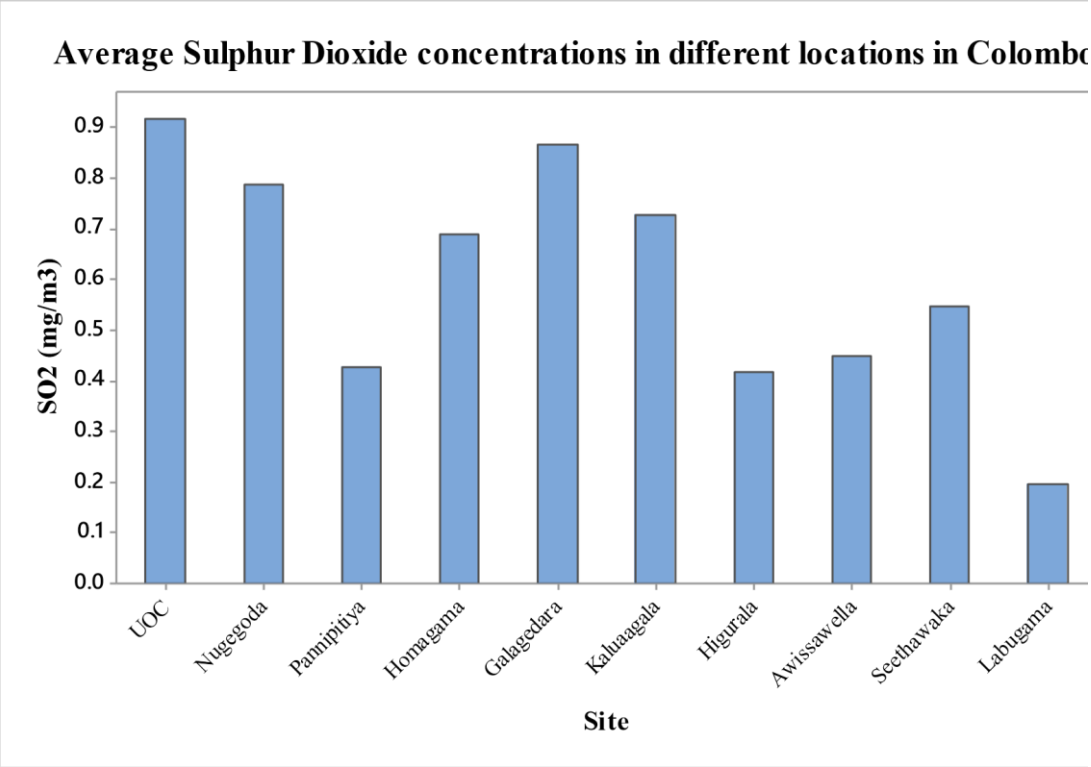


Figure 3: The average SO_2 concentration in study sites in Colombo district during different times of the day

In this study, we found 45 lichen species and the majority of them were *Herpothallon* sp., *Pyxine* sp., *Lepraria* sp., *Fissuarina* sp., *Graphis* sp., *Myriotrema* sp., *Dirinaria* sp., *Trypethelium* sp., *Ocellularia* sp., and *Leptogium* sp. Interestingly, *Herpothallon* sp. was common to all the sites except in one. The highest number of genera was recorded from Pannipitya and Seethawaka while the lowest were found in Kaluaggala.

The highest lichen diversity index was recorded from the Pannipitiya and Seethawaka and the lowest was observed in Kaluaggala. Total density of each lichen species was calculated and the mean densities of lichens increased when moving away from the city towards the interior side.

The Pearson's correlation was conducted to assess the relationship between the concentrations of SO_2 during different times of the day and the distance from Colombo Fort. There was a strong significant negative correlation between distance and the afternoon ($r = -0.838$, P-value = 0.002) SO_2 concentrations.
The lichen density and diversity was correlated using the Pearson correlation with the SO_2 concentration. It was revealed that diversity of lichen was significantly positively correlated with number of genera of lichens ($r = 0.743$, P-value = 0.014), while a significant negative correlation also existed with the SO_2 average concentration ($r = 0.653$, P-value = 0.041). There was no significant correlation observed between density of lichens and SO_2 average concentration.

5. Conclusions, implications and significance

According to the current study, both density and diversity of lichens showed a significant negative correlation with elevated SO_2 levels in the study sites. The results suggest that lichen density and diversity can be used as indicators of vehicular pollution. In addition, this study revealed that all sites starting from University of

Colombo to Seethawaka showed degraded air quality in relation to SO_2. The findings of the study highlight the importance of more studies with regard to air pollution and the essential need of managing air pollution to ensure health of communities and environment.

6. References

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