



## Assessment of Ambient air quality status before and after Shifting Cultivation in an Indo-Burma hotspot region

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### Abstract

*This study assessed the ambient air quality status after the period of biomass burning through shifting cultivation (i.e. summer) and in other seasons when there was no shifting cultivation. The present study performed the assessment of air quality with respect to suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), nitrogen dioxide (NO<sub>2</sub>) and sulphur dioxide (SO<sub>2</sub>) at two sites namely Ramrikawn (peri-urban area) and Tanhril (rural area) of an Indo-Burma hotspot region. The average concentration of SPM and RSPM were found to be higher in the peri-urban area than rural area. Apart from this NO<sub>2</sub> and SO<sub>2</sub> levels at both sites remain under prescribed limits of Central Pollution Control Board (CPCB) of India. It has been observed that the concentrations of the particulate pollutants are high in summer in comparison to the winter and rainy seasons. The average air quality index (AQI) value of peri-urban area was recorded higher than rural area. The deviations in seasonal air quality particularly in context of SPM and RSPM may be attributed to the impact of biomass burning through shifting cultivation.*

**Keywords:** Shifting cultivation, SPM, RSPM, sulphur dioxide, nitrogen dioxide, air quality index.

### Introduction

Vehicular pollution perturbs the air quality particularly in populated urban regions. However, in hilly areas other factors like biomass burning through shifting cultivation for agriculture<sup>1</sup> also exacerbate the problem of air pollution. Air quality is generally described as a combination of the physical and chemical characteristics that make air a healthful resource for human being, animal and plants<sup>2</sup>. Atmospheric pollutants, in both gaseous and particulate form pose a serious threat to air quality<sup>3,4</sup>. The major sources of air pollution in Indian cities is due to rapid industrialization, poor roads, vehicles conditions and lack of environmental awareness<sup>5,6</sup>. Nitrogen dioxide (NO<sub>2</sub>) and sulphur dioxide (SO<sub>2</sub>) and suspended particulate matter (SPM) are regarded as prime air pollutants in India<sup>7</sup>.

The increased vehicular pollution due to rapid urbanization and other activities including soil erosion, mining, stone quarrying and shifting cultivation in Aizawl, may lead to increases in the concentration of SPM and RSPM in the ambient air. Shifting cultivation is locally called as slash- and-burn agriculture or "jhooming". Shifting cultivation is major agricultural practices in the North Eastern (NE) Himalaya of Indo-Burma hotspot region<sup>1</sup> and it started during Neolithic times. In the light of these factors, ambient air quality of the Aizawl (capital of Mizoram state in NE India) has been monitored in the present study. This study aims to investigate the ambient air quality status and air quality index (AQI) at selected monitoring sites of Aizawl, Mizoram. At these sites, practice of shifting cultivation during is common; therefore, we also tried to investigate that whether it also affects the air quality during summer season. Till now, no

research work attempted to investigate the impact of shifting cultivation on air quality.

### Material and Methods

**Study area:** Mizoram (21° 56' - 24°31'N and 92° 16' - 93°26'E) is one of the eight states under northeast India, and it covers an area of 21,081 km<sup>2</sup>. Aizawl (21°58' - 21°85' N and 90°30' - 90°60'E), the capital of Mizoram is 1132 meter above sea level (asl) (figure-1). Aizawl district comes under Indo-Burma hotspot region of North East India<sup>1,8</sup>. This area is of extreme ecological relevance as it comes under an Indo-Burma hot spot region. The air temperature in this region generally ranges from 20 to 30° C in summer season while 11 to 21°C in winter season<sup>9</sup>.

**Study sites:** The present study was carried out in Aizawl district of an Indo-Burma hotspot region which was categorized in to two sub sites. The first study site was Ramrikawn which is a peri-urban area including market, bus-stand and food storage (Food Corporation of India) and the second study site was Tanhril which is a rural area having low vehicular activity, located in western part of Aizawl district.

**Ambient air quality monitoring:** Sampling was done using 'High Volume Sampler' (Envirotech APM 460) 24 hour for different air pollutants (SPM, RSPM, NO<sub>2</sub> and SO<sub>2</sub>) in the months of January, 2012 to December, 2013 with a frequency of once in a week. The apparatus was kept at a height of 2 m from the surface of the ground. Once the sampling was over, the samples were brought to the laboratory and concentration of

different pollutants was determined. RSPM were collected by glass fibre filter papers (GF/A) of Whatman and SPM were trapped in the different containers at average air flow rate of 1.5 m<sup>3</sup>/min. NO<sub>2</sub> and SO<sub>2</sub> were collected in a specific absorbing solution (sodium hydroxide for NO<sub>2</sub> and sodium tetrachloromercuate for SO<sub>2</sub>) at an average flow rate of 0.2- 0.5 min<sup>-1</sup>. The concentration of NO<sub>2</sub> and SO<sub>2</sub> were measured by Modified Jacobs-Hochheiser method<sup>10</sup> and Modified West and Gaeke method<sup>11</sup> respectively. Using air pollutants data the air quality index (AQI) was measured by modifying the equation given below<sup>12</sup>.

$$AQI = 1/3(SO_2/S_{SO_2} + NO_x/S_{NO_x} + SPM/S_{SPM}) \times 100$$

### Results and Discussion

Table 1 and Table 2 represents the air pollutants concentration (SPM, RSPM, NO<sub>2</sub> and SO<sub>2</sub>) and AQI [(1/4)(SO<sub>2</sub>/S<sub>SO<sub>2</sub></sub> + NO<sub>2</sub>/S<sub>NO<sub>2</sub></sub> + SPM/S<sub>SPM</sub> + RSPM/S<sub>RSPM</sub>) × 100] at two monitoring sites of Aizawl. The study demonstrated seasonal variation in the ambient air pollutant levels during different study period (figure-2 and 3). The results revealed that at both the sites SPM and RSPM concentration was very high which

may have human health implications. Concentration of SPM at Ramrikawn area was 260.41, 272.26 and 100.04 µg m<sup>-3</sup> during winter, summer and rainy, respectively, where it was 157.08, 163.75 and 60.01 µg m<sup>-3</sup> respectively for the same period in the Tanhril area. The standard limits as prescribed by Central Pollution Board of India for SPM is 200 µg m<sup>-3</sup> for residential area. RSPM at Ramrikawn area was 217.15, 225.13 and 59.01 µg m<sup>-3</sup> during winter, summer and rainy seasons, in Tanhril area it was 122.01, 130.01 and 21.01 µg m<sup>-3</sup>, respectively, for the same period. The standard limit prescribed by Central Pollution Board of India for RSPM is 100 µg m<sup>-3</sup> for residential area. As per the general trend the SPM and RSPM should be high in winter season, however, we recorded their high values during the summer season which may be due to the impact of biomass burning through shifting cultivation. Biomass burning may lead to increased emission of particulates in the air. The highest concentration (5.02 µg m<sup>-3</sup>) of SO<sub>2</sub> was also recorded during summer at Ramrikawn area, which was again 79.28 % higher when compared with the Tanhril area. Similarly highest concentration (23.16 µg m<sup>-3</sup>) of NO<sub>2</sub> was observed during summer at Ramrikawn area, which was 51.98 % higher when compared with the Tanhril area.

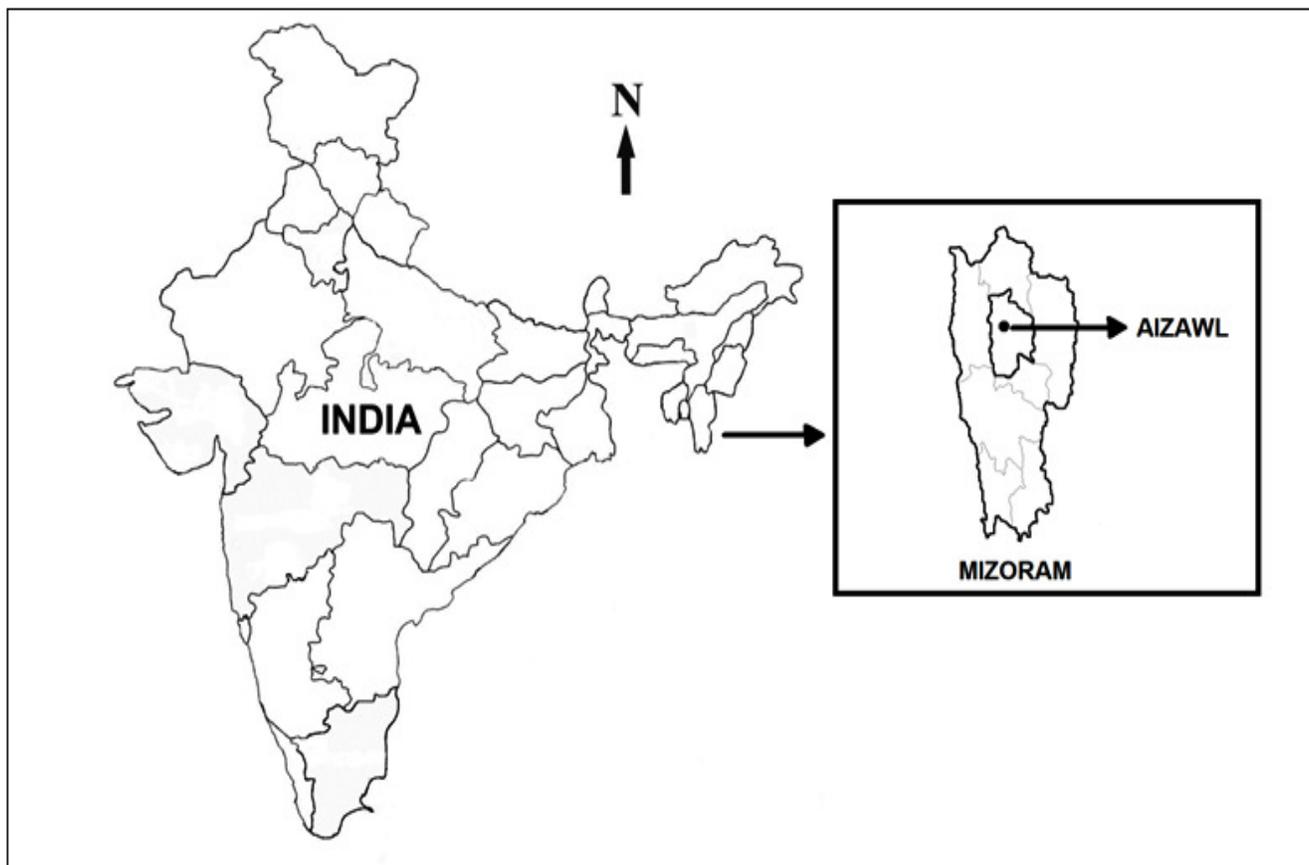
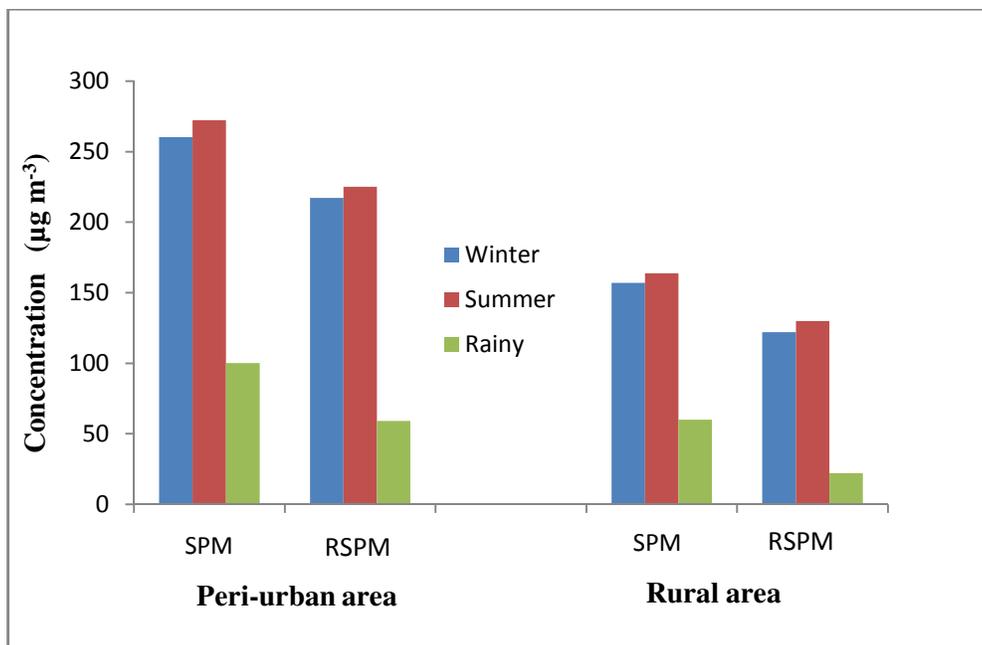
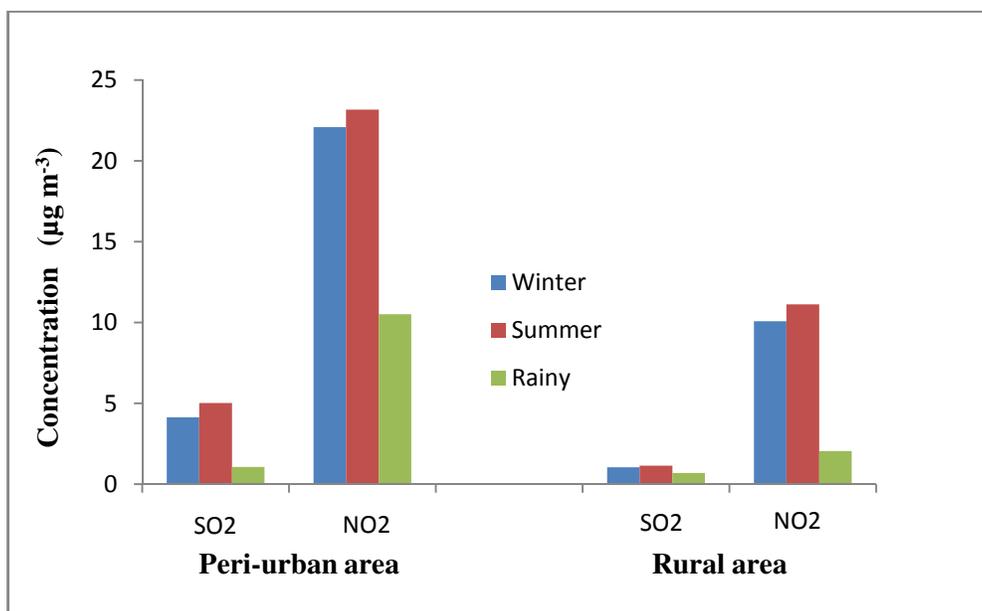


Figure-1  
Map of the Study Area, Aizawl, Mizoram



**Figure-2**  
 Seasonal variation of SPM and RSPM at both study site



**Figure-3**  
 Seasonal variation of SO<sub>2</sub> and NO<sub>2</sub> at both study site

In the present study, the amount of SPM and RSPM at peri-urban area was much higher than the prescribed limits of Central Pollution Control Board of India, while the concentration of NO<sub>2</sub> and SO<sub>2</sub> was still under the prescribed limits. The air quality index (AQI) may act as a valuable tool and also act as proxy of ambient air quality status. The concentration of the air pollutants are evaluated and then transformed in to AQI (table-1) and rating scale (table-2) was also calculated by using standard formula mention in material

and methods. The higher value of an index refers to a higher level of air pollution<sup>13</sup>. AQI values in our study was calculated by using the concentration of SPM, RSPM, SO<sub>2</sub> and NO<sub>2</sub>. The AQI values at peri-urban area was 94.75, 98.75 and 30.75 during winter (Heavy Air Pollution-HAP), summer (Heavy Air Pollution-HAP) and rainy seasons (Light Air Pollution-LAP). In the rural area, AQI ranged from moderate air pollution during summer and winter to clean air during rainy seasons.

**Table-1**  
**Seasonal variation of air pollutants (Average of three values) and AQI at two selected sites in Aizawl city**

Site	SPM ( $\mu\text{g m}^{-3}$ )		RSPM ( $\mu\text{g m}^{-3}$ )		SO <sub>2</sub> ( $\mu\text{g m}^{-3}$ )			NO <sub>2</sub> ( $\mu\text{g m}^{-3}$ )		AQI		
	Winter	Summer	Winter	Summer	Winter	Summer		Winter	Summer	Winter	Summer	
P R	Rainy		Rainy		Rainy			Rainy		Rainy		
	260.41	272.26	217.15	225.13	4.13	5.02	1.07	22.08	23.16	94.75	98.75	
	100.04		59.01		1.04	1.15	0.68	10.52		30.75		
	157.08	163.75	122.01	130.01				10.07	11.13	53.25	56.25	13.5
	60.01		22.01					2.04				
	200.00 $\mu\text{g m}^{-3}$		100.00 $\mu\text{g m}^{-3}$		80.00 $\mu\text{g m}^{-3}$			80.00 $\mu\text{g m}^{-3}$		CPCB standard		

Abbreviations: SPM- Suspended particulate matter, RSPM- Respirable suspended particulate matter, AQI- Air quality index, CPCB Central Pollution Control Board, New Delhi, India, P- Peri-urban area and R- Rural area.

**Table-2**  
**Rating of AQI values at different study sites**

Index values	Remarks	Peri-urban area			Rural area		
0-25	Clean Air (CA)	Winter	Summer	Rainy	Winter	Summer	Rainy
26- 50	Light Air Pollution (LAP)						
51-75	Moderate Air pollution (MAP)	HAP	HAP	LAP	MAP	MAP	CA
76-100	Heavy Air Pollution (HAP)						
>100	Severe Air Pollution (SAP)						

Climatic and meteorological conditions are inextricably linked to air pollution<sup>14,15</sup>. In this research work we observed maximum concentrations of SPM, RSPM, NO<sub>2</sub> and SO<sub>2</sub> in summer season when compared to winter and rainy season. As discussed earlier, the problem of shifting cultivation may be responsible for higher values of air quality parameters during the summer season. Air pollutants tend to concentrated in winter season which may be attributed to high atmospheric stability and inversion factor<sup>15,16</sup>.

### Conclusion

Air pollution level of the two sites in an Indo-Burma hotspot region revealed a fact that the values of air quality parameters were highest during the summer season due to the impact of shifting cultivation. The amount of SPM and RSPM at peri-urban area (Ramrikawn) was much higher than the prescribed limits of CPCB<sup>17</sup> of India, while the concentration of NO<sub>2</sub> and SO<sub>2</sub> was still under the prescribed limits. High values of SPM and RSPM may have human health implications in this region of ecological relevance. The AQI values were found higher at the Ramrikawn during summer and winter seasons thus rating it as Heavy Air Pollution (HAP) zone. The increased level of air pollution at Ramrikawn is mainly due to higher vehicular emission combined with the impact of shifting cultivation particularly during the summer season.

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