Analysis on the Effect of Emitted Gases upon the Environmental Atmosphere around the Cement Factories, Kyaukse Area, Mandalay Region

Pyae

Abstract

This paper studies environmental ethics based on atmospheric conservation around the cement factories of Kyaukse area in Mandalay Region. In association with land ethic concept of Aldo Leopold, it is examined how humans perceive themselves in relation to the environment. Regarding this, by using ecosystem approach, it is investigated how much gases the factories emit and whether the gases pollute the air of nearby downwind area. The relevant data on the amount of emitted gases from the five cement factories are collected through the surveys of testing the air quality with the help of Haz-Scanner (Model-EPAS) and Portable Gas Analyzer and from the reports of Mandalay Region Department of Natural Resources and Environmental Conservation. According to the data analyses, it is found that the factories are emitting, in total, 3,357 mg/Nm^3 of NO_x, 931.67 mg/Nm^3 of SO_2 and 1618.90 mg/Nm^3 of CO per hour in the month of January. If compared to those of 2018, the emitted amount has increased by 1,453 mg/Nm^3 in NO_x, by 1326.4 mg/Nm^3 in CO but has decreased by 187.31 mg/Nm^3 in SO_2. Moreover, Nitrogen Oxide (NO_x) diffusion significantly increases starting from 9:00 a.m. and reaches its maximum by 2:24 p.m. Then it gradually decreases to about 30 ppb and falls down to 1 ppb by the time of 0:41 a.m. Such NO_x diffusion of 1 ppb level occurs till 8:00 a.m. Normal distribution of CO was found between 12 a.m. and 4 p.m. and reaches maximum at 6:57 with 907 ppb. High diffusion of CO is found during night. This means that the natural process still works regularly as before and maintains the environmental ethics but in long run decomposing process of the gases may not catch up with refreshment and cleaning of the surrounding air by means of photosynthesis. This paper indicates that land ethic and environmental ethics can be changed by humans' decision-making and technology varying with time.

Keywords : environmental ethics, land ethic, pollution, ecosystem

Introduction

This study comes from the association with land ethic concept of Aldo Leopold. He stated" A land ethic is reflects the existence of an ecological conscience and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity for self renewal. Conservation is our effort to understand and preserve this capacity". Land ethic is changing with decision-making and technology of human beings and also with the environment, the components of the relevant ecosystem.

General Description of the Study Area

The study area is in the vicinity of Kyaukse in Mandalay Region, Myanmar. It is located between Latitudes 21˚29' 06.47" North and 21˚32' 46.92" North and between Longitudes 96˚ 9' 55.07" East and 96˚ 9' 55.07" East. The emphasized area is cement factories and their surrounding area. The cement factories namely Alpha , Double Rhinos and Sinmin, as northern group, lie at the distance of 10.4km (6.5miles in the direction of 100°), 12.11km (7.57 miles in 109°) and 13.3km (8.31 miles in 95°) while Myanmar Elephant, Tiger Head and Tripple A cement factories, as southern group, are at the distance of 20.04km (12.5 miles in 125°), 20.93 km (13.1 miles in 123°) and 22.58km (14.11 miles in 121°) from Kyaukse respectively (Map-1). To the southeast of Alpha and Double Rhinos factories lie Sadongyin Hill (1014) and Yadanamyayzu Hill (1079) while near north of Triple A, Myanmar Elephant and Tiger Head cement factories are, from west to east, Taungnima

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Taung (2080 feet), Phawarsant Taung (2201 feet) and Bodawgyi Taung (2253 feet). There is no village within 4 kilometres to the west from the northern factories and around the southern factories. To the east lies the western Shan escarpment which is higher than 3,000 feet above sea level and is covered with *Indaing* forests and mixed deciduous forests. These factories lie at altitudes of 353 feet to 560 feet above sea level. All of the factories themselves and their environments are on Kyaukse alluvial plain on which thorny plants grow widespread. Prior to the establishment of the cement factories, the sites and environs existed as dry fields of *Ya* land and unused waste land.

The areas west, south and north of the plants have experienced the dry climate whereas the area to the east suffers from the Tropical Savanna Type and the Sub-tropical Monsoon Climate. The plants and the environs get an annual rainfall of 30.63 inches and mean temperature of 81.1° F. Therefore, it can be assumed that Kyaukse area has the Tropical Steppe Climate (Than Than Myint, 2013). January is the coldest month with the average mean temperature of 70.68° F and April is the hottest month with the average maximum temperature of 103.4°F, the average minimum temperature of 72.99°F and the average mean temperature of 88.29° F. These physical conditions and climatic condition show the land ethic and environmental ethic of the study area.

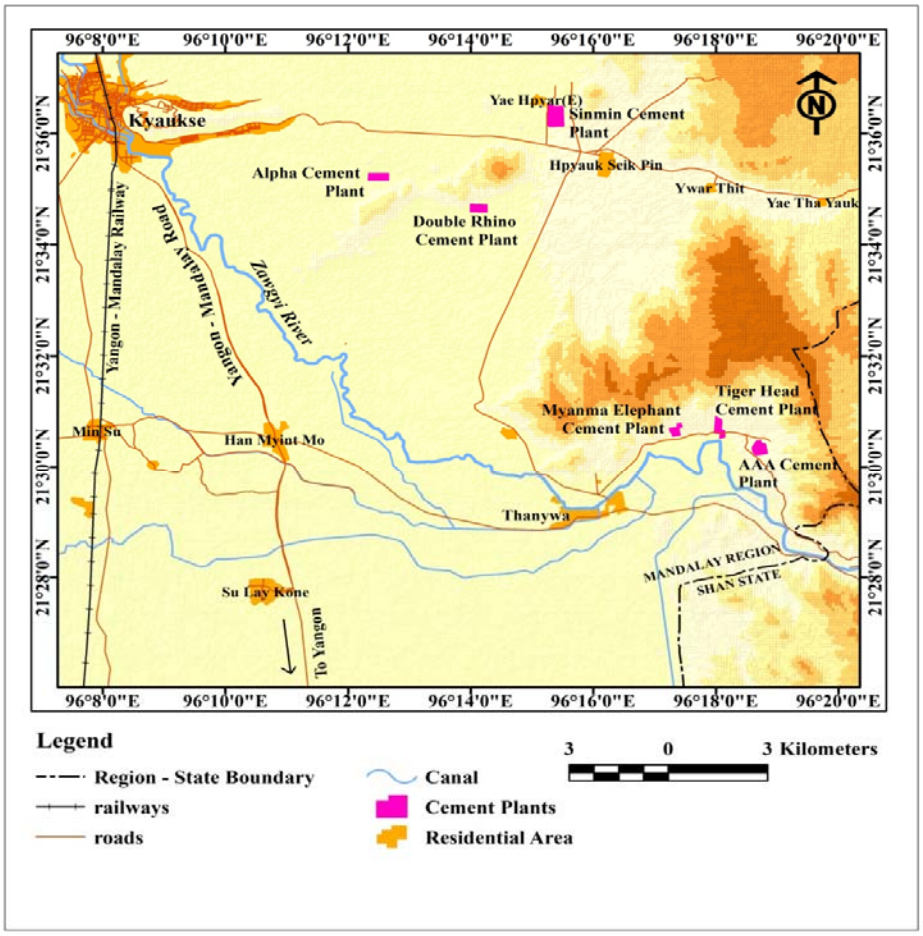


Figure (1). Map-Location of Cement Factories in Kyaukse Area
Source : UTM 2196-02, 2096-06, 2196-07 & 2019 Google Earth Image

Aim and Objective

Main aim is to analyze the effect of emitted gases upon the environmental atmosphere around the cement factories**,** and the objective is to assess the concept of the Aldo Leopold's Land Ethic.

Methodology

In this study primary data are used. Primary data on emitted gases from the cement factories and on ambient air were collected with the help of the staff from the Conservation Department of Mineral Resources and Natural Environment and most of the data from that department. Relief and climatic data of the study area were obtained from the UTM maps and the Google Earth Images on which distances and directions were measured. Based on wind directions, the effect of emitted gases upon the environmental ethic based on atmospheric conservation around the cement factories has been examined.

Emitted gases were measured by using Portable Gas Analyzer (PG-350) and ambient air quality by Has-scanner of EPAS Model (Environmental Perimeter Air Monitoring Station).

Measurement of Emitted Gases and Discussion

In study area there are six cement factories. In accordance with location and wind direction, measurement was chosen to be done in January when wind blows from north to south so that the test of ambient air quality of the factories could be done. In this case, Thanywa village was chosen as test site. In this month, as factories lie upwind and Thanywa downwind, the smoke from the factories drift to Thanywa. With this consideration, the gases emitted from the factories and ambient air quality near Thanywa were measured in January and February during the years of 2017 to 2019. Besides Thanywa, the test of ambient air quality was also made near the offices of five factories excluding Sinminn. Results of chimney stack emission are described in table-1, 2 and 3.

Table (1). Gases Emitted by the Cement Factories during 22.1.2017 to 26.2.2017

No	Name of Factory	NO_x (mg/Nm3)	SO_2 (mg/Nm3)	CO (mg/Nm3)	CO_2 (Vol %)	O_2 (Vol %)
1	Alpha	-	7.671	169.22	22.2	9.2
2	Double Rhinos	-	6.448	71.47	9.4	15.7
3	Sinmin	-	12.651	14.334	0.702	20.528
4	Myanmar Elephant	-	11.694	72.27	2.8	18.9
5	Tiger Head	-	9.514	14.22	10.5	13.9
6	AAA	-	1639.695	1058.21	12.8	11.9
	EQEGs	600	400	-	-	-
	Singapore Standard	700	500	625	-	-

Source : Conservation Department of Natural Resources and Environment, Mandalay

Table (2). Gases Emitted by the Cement Factories during 22.1.2018 to 26.1.2018

No	Name of Factory	NO_x (mg/Nm3)	SO_2 (mg/Nm3)	CO (mg/Nm3)	CO_2 (Vol %)	O_2 (Vol %)
1	Alpha	408	7.67	182.33	13.8	13.4
2	Double Rhinos	251	2.33	52.90	7.2	16.8
4	Myanmar Elephant	895	-	28.38	10.5	14,1
5	Tiger Head	169	9.58	3.20	2.8	18.9
6	AAA	181	1099.4	25.69	4.6	16.7
	EQEGs	600	400	-	-	-
	Singapore Standard	700	500	625	-	-

Source : Conservation Department of Natural Resources and Environment, Mandalay

Table (3). Gases Emitted by the Cement Factories during 22.1.2019 to 26.1.2019

No	Name of Factory	NO_x (mg/Nm3)	SO_2 (mg/Nm3)	CO (mg/Nm3)	CO_2 (Vol %)	O_2 (Vol %)
1	Alpha	970	-0.829	158.75	23.4	-0.2
2	Double Rhinos	534	0.71	180.05	20.8	-0.2
3	Myanmar Elephant	720	0.91	111.10	14.2	-0.3
4	Tiger Head	967	797.88	1150.00	19.9	-0.2
5	AAA	167	133	19.00	8.6	0.4
	EQEGs	600	400	-	-	-
	Singapore Standard	700	500	625	-	-

Source : Conservation Department of Natural Resources and Environment, Mandalay

The results are analyzed in comparison with the values of the air quality standards of EQEGs and Singapore for the chimney stack emission. The standard values are 600 mg/Nm^3 and 700 mg/Nm^3 for Nitrogen Oxide (NO_x), 400 mg/Nm^3 and 500 mg/Nm^3 in Sulphur Dioxide (SO_2) respectively. In order to see implicitly, the relevant standard values are described in the all tables. The values beyond the standards are displayed in shaded figures in the tables.

According to the results, in Nitrogen Oxide (NOx) emission per day in the 2018 1nd 2019, the decrease is found in the Triple A Factory but increase in the remaining cement factories in 2019 than in 2018. Regarding the release of Sulphur Dioxide (SO_2), the decrease is found in the factories of Alpha, Double Rhinos, Myanmar Elephant and the Triple A and the increase in Tiger Head. In the release of Carbon Monoxide (CO) the amount is found to have decreased in Triple A and increased in the remaining factories in 2019 than in 2018.

Among the factories, emitted amount of Nitrogen Oxide (NO_x) in 2018 and 2019 is found larger than the Singapore Standard (700 mg/Nm3) in Myanmar Elephant Factory. Those larger than the standard levels of EQEGs and Singapore are also found in Alpha and Tiger Head Cement Factories in 2019. However, in the other cement factories the NO_x amount is found smaller than the Standards. This indicates that these three cement factories need to find a way that can reduce the emission of NO_x. It will cause ambient air pollution.

In 2019 the Tiger Head Factory is found to have emitted 797.88 mg/Nm3 of Sulphur Dioxide (SO_2) and 1150 mg/Nm3 of Carbon Monoxide (CO). These SO_2 values are found to

be more than the standards of EQEGs (400 mg/Nm3) and Singapore (500 mg/Nm3) and the CO values also to be greater than the Singapore Standard (625 mg/Nm^3). In contrast, Carbon Monoxide (CO) emitted from the factories of Alpha, Double Rhinos, Myanmar Elephant and the Triple As are found smaller than the Singapore Standard.

If it is considered overall for the year 2019, out of five cement factories, three factories namely Alpha, Tiger Head and Myanmar Elephant are found to have emitted 970 mg/Nm^3, 967 mg/Nm^3 and 720 mg/Nm^3 of Nitrogen Oxide respectively. As these values exceed the standard values of EQEGs and Singapore, it is concluded that the exceeding values of such gases can pollute the ambient air. It is also examined whether the emitted gases affect the ambient air.

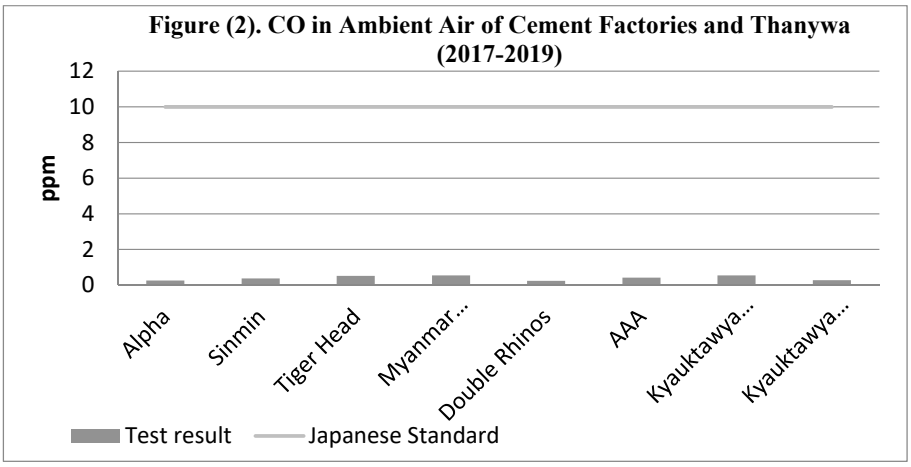
Measurement of Ambient Air Quality and Discussion

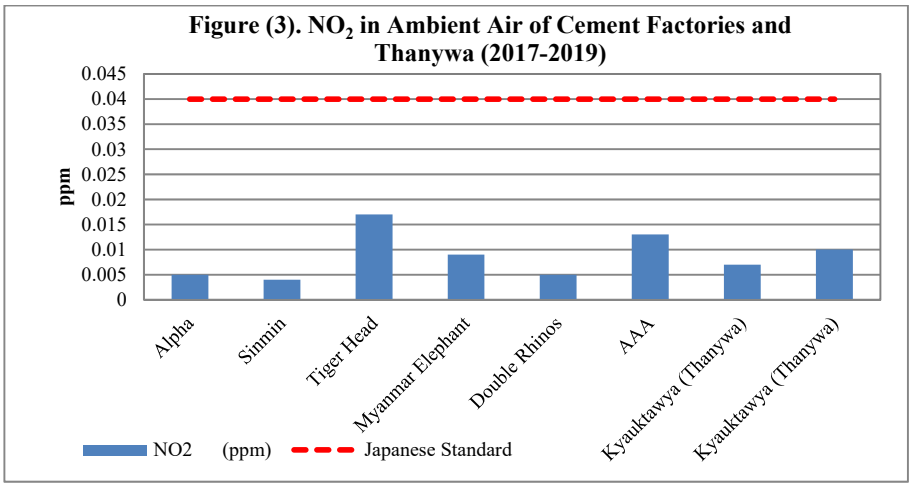
In this case ambient air quality of the cement factories and of Thanywa *Tawya* Monastery lying downwind in January and February was measured. Measuring points were chosen at the places which are free from the influence of the waving winds caused by passing trucks and far from the construction sites in order to avoid the distributing dust and particles in the air. Near the factories, places in front of the office and staff quarter houses were used and Thanywa *Tawya* Monastery as the downwind ambient point. In the ambient quality test, the harmful gases of Carbon Monoxide (CO), Nitrogen Dioxide (NO_2) and Particulate Materials (PM_{10}) are investigated. The results are described in table (4) and Japanese Air Quality Standard is shown in the last row of the table.

Table (4). Ambient Air Quality of Cement Factories and Thanywa Village (2017-2019)

No.	Place	CO (ppm)	NO_2 (ppm)	PM_{10} (µg/m3)	Date
1	Alpha	0.254	0.005	81	2.2017
2	Sinmin	0.377	0.004	84	2.2017
3	Tiger Head	0.516	0.017	115	9.2.2007
4	Myanmar Elephant	0.543	0.009	120	13.2.2017
5	Double Rhinos	0.242	0.005	52	1.2.2017
6	AAA	0.424	0.013	82	14.2.2017
7	Kyauktawya (Thanywa)	0.541	0.007	83	21.1.2018
8	Kyauktawya (Thanywa)	0.274	0.010	2	27.1.2019
	Japan Standard (24hr)	10	0.04 - 0.06	100	

Source : Conservation Department of Natural Resources and Environment, Mandalay





Source : Table (4)

In the Japanese Standard, CO is 10 ppm. In the ambient air of the study sites, the CO contents were found ranging from 0.242 to 0.543 ppm. Therefore, these values are found less than the standard. It is clearly seen in Figure(1).

In Nitrogen Dioxide distribution, the Japanese Standard is between 0.04 and 0.06 ppm. Nitrogen Dioxides (NO_2) that occurred in the ambient air of the studied sites were found between 0.005 ppm to 0.017 ppm. Therefore, NO_2 contents distributed in the ambient air of the study sites are found less than the standard (Figure-2).

In the particulate matters (PM_{10}), the Japanese Standard is 100 µg/m^3. The values of PM_{10} that occurred in the ambient air of the observed sites were recorded as ranging from 2 µg/m^3 to 115 µg/m^3. Among them, PM_{10} values occurred in the ambient air of Tiger Head and Myanmar Elephant Factories in 2017 were found greater than the Japanese Standard Index of PM_{10} (Figure-3).

Regarding ambient air quality near Thanywa village, the content of CO was found to be 0.541 ppm in 2018 and 0.274 ppm in 2019, the content of NO_2 was 0.007 ppm and 0.010 ppm, and the contents of PM_{10} were 83 µg/m^3 and 2 µg/m^3 respectively. This reveals that the ambient air quality of Thanywa is still in normal condition. Even in Thanywa, if the contents in 2019 are compared to those in 2018, CO is found to have decreased from 0.541 ppm to 0.274 ppm in 2019, and PM_{10} also decreased from 83µg/m3 to 2 µg/m3 in 2019 but NO_2

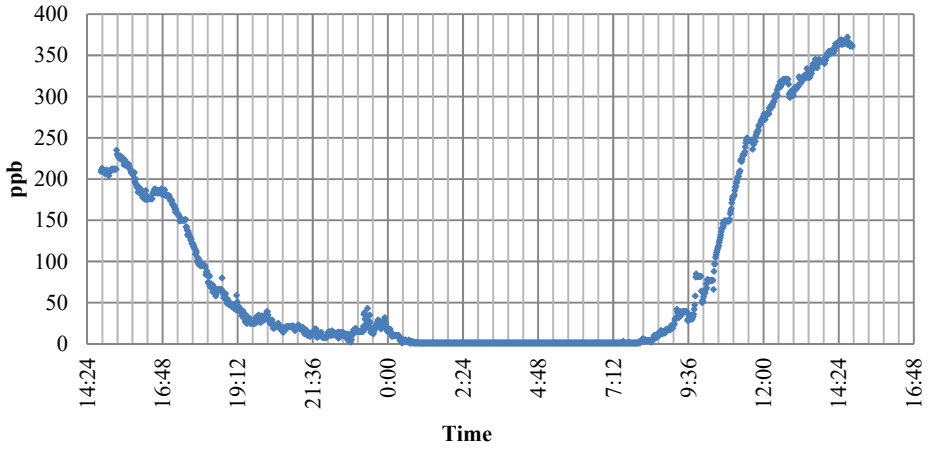
increased slightly from 0.007 ppm to 0.010 ppm. If the increase of Nitrogen Dioxide goes on at this rate (0.003 ppm/year), the Nitrogen dioxide contents contained in the ambient air of Thanywa will become greater than the Standard Index just after 20 years later and consequently the ambient air quality will be affected toward the negative impact.

From the above-mentioned examinations, the total amount of emitted gases is estimated. According to the 2019 data, five factories of the study area are emitting, in total, 3,357 mg/Nm^3 of NO_x, 931.67 mg/Nm^3 of SO_2 and 1618.90 mg/Nm^3 of CO per hour in the month of January. If compared to those of 2018, the emitted amount has increased by 1,453 mg/Nm^3 in NO_x, by 1326.4 mg/Nm^3 in CO but has decreased by 187.31 mg/Nm^3 in SO_2. This indicates that the factories need to seek the way that can reduce the amount of such harmful gases.

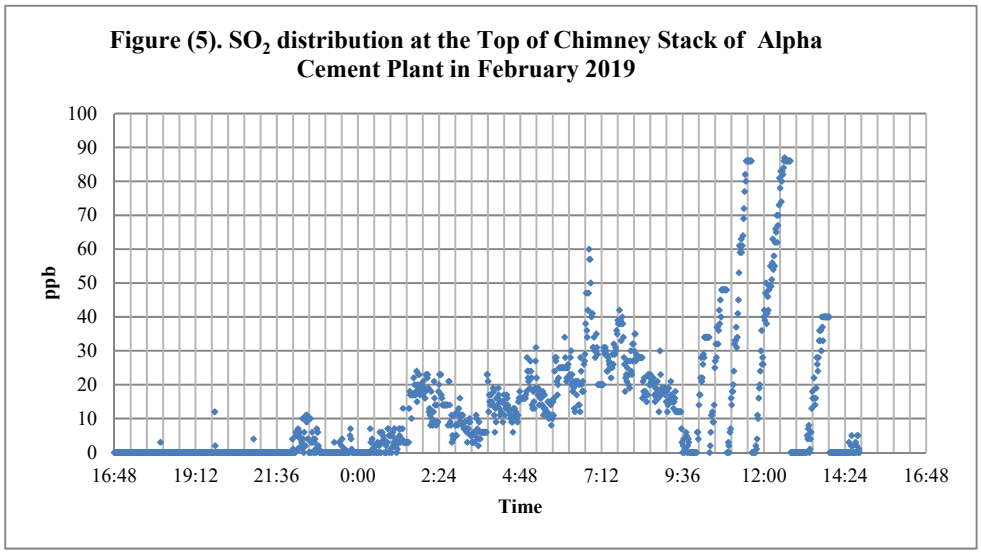
Examination of Gas Distribution at the Stack under the 24-hour Watch

In this examination, chimney stack emission was made at the immediately above the stack during the whole day including running hours and non-operation hours. It was recorded with one minute interval. In order to know how gases are distributed, the gas contents recorded in one-minute interval are transformed into graphical method as shown in Figure-4, 5 and 6. According to the figure (4) it is found that Nitrogen Oxide (NO_x) diffusion significantly increases starting from 1 ppb at 9:00 a.m. and reaches its maximum (372 ppb) by 2:24 p.m. Then it gradually decreases to about 30 ppb and falls down to 1 ppb by the time of 0:41 a.m. Such diffusion of 1 ppb level occurs till 8:00 a.m. This means that emitted NO_x amount has been distributed to the downwind air or that has been already adjusted to the normal air condition.

Figure (4). NO_x Distribution at the Top of the Chimney Stack of Alpha Cement Plant in February,2019

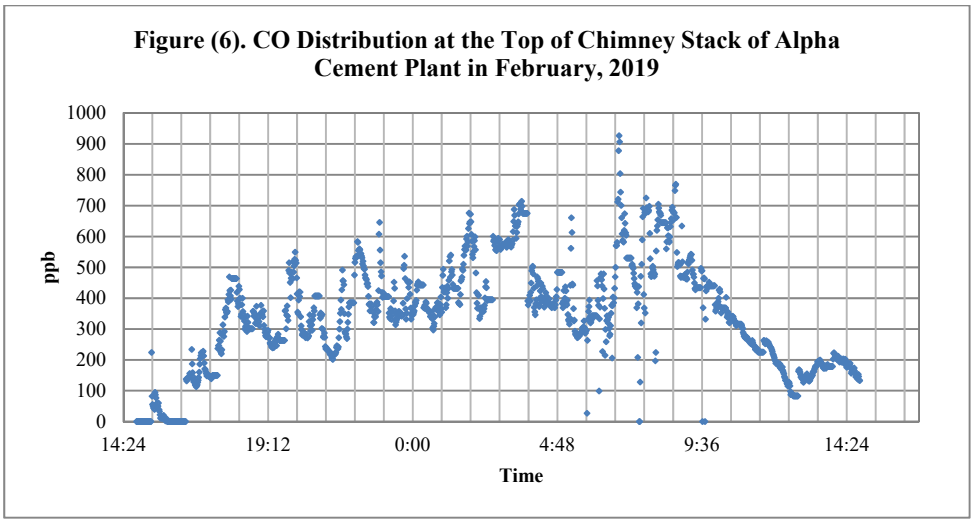


Source : Conservation Department of Resources and Natural Environment, Mandalay



Source : Conservation Department of Resources and Natural Environment, Mandalay

Regarding SO_2 distribution, in the figure (5) it is clearly seen that the diffusion level gradually increases starting from 0 ppb (about 1:00 a.m.) and reaches to 87 ppb (at 12:45 a.m.). Then the diffusion is found distinctly calming down to 0 ppb after 3 p.m. This also shows that emitted SO_2 amount has been distributed to the downwind air or that has been already adjusted to the normal air condition.



Source : Conservation Department of Resources and Natural Environment, Mandalay

In CO distribution, figure (6) shows that normal distribution was found between 12 a.m. and 4 p.m. After 4 p.m. it began to diffuse and maximum diffusion occurs at 6:57 with 907 ppb. This shows that distinct diffusion of CO is found in cool period, particularly during night. According to this finding and Table (4), CO concentration is found higher in the southern part of the study area, particularly ambient air of Myanmar Elephant Plant, Thanywa, Tiger Head Plant and Triple A Cement Plant, where natural vegetation, especially trees are distributed more densely than in the northern part of the study area.

According to Thanywa villagers in field observation, it is known that they have to feel sometimes suffocating. This is the probable one. According to this research, although

ambient quality is known falling within the range of the Japanese Standard, it can be remarked that today's ambient quality of Thanywa appears to have become a little more polluted than the 15 years ago. Their words high-lighten their awareness on their environment including land, atmosphere and natural vegetation.

The above-mentioned findings describe that original land ethic (the condition before the establishment of Cement Factories) has been changed into a new one due to the human activities. After the completion of the factories, local people begin to know the value of their land and environments. In accordance with changing environment, the dwellers living not very far from the factories learnt to know that the land and the environment exist as cogs and wheels of the ecosystem and they are responsible to protect and manage their land and environment to become lush and green. The earth's health has also been paid more attention than ever, particularly in working to recover the endangered phenomena, species and to conserve their lands and environments including biomes and atmosphere. If compared to the previous time, they begin to become passionate lovers of nature and to know to conserve all elements of their ecosystems without doing single-one management. This ecological conscience of local people in Thanywa is found coinciding with the concept of Aldo Leopold's Land Ethic (1949).

Conclusion

In conclusion this research provides that all of the cement factories are emitting more than 3000 mg/Nm^3 of NO_x, 900 mg/Nm^3 of SO_2 and 1600 mg/Nm^3 of CO per hour in the month of January in 2019. It has increased by 1,453 mg/Nm^3 in NO_x, by 1326.4 mg/Nm^3 in CO but has decreased by 187.31 mg/Nm^3 in SO_2 than in 2018. Of the factories, Tiger Head Cement Factory is found emitting such three gases more than the Standards. Therefore, the factories need to seek the way that can reduce the amount of such harmful gases. As ambient quality, the measured ones are found within the Standards and so ambient air quality of the studied sites are assumed to be in normal condition. The 24-hour watch indicates that Nitrogen Oxide is being distributed mostly between 9 a.m and 7:12 p.m., Sulphur Dioxide between 1 a.m. and 4:30 p.m., and CO between 4:24 p.m. and 10:36 a.m. Regarding ambient air quality, it appears to have become a little polluted than 15 years ago. This condition has become popular to be paid awareness more than ever. Local people have learnt to know it recently and begin to try to conserve their land and environment. It is inferred that land ethic and environmental ethics are changing with time and are interrelated each other and exist as the dynamic equilibrium.

Acknowledgement

I would like to express my gratitude to Dr Nu Nu Lwin, Professor and Head, Department of Philosophy, Yadanabon University, for her encouragement to accomplish this paper.

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